ISPRA
Istituto Superiore per la Protezione
e la Ricerca Ambientale

10° ITALIAN ENVIRONMENTAL DATA YEARBOOK 2011

KEY TOPICS

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KEY TOPICS

Environmental Data Yearbook

2011

ENVIRONMENTAL PROTECTION AGENCIES OF THE REGIONS AND AUTONOMOUS PROVINCES

LEGAL INFORMATION

Law 133/2008, which converted, following modification, Legislative Decree no. 112 of 25 June 2008, established the ISPRA – Institute for Environmental Protection and Research . The ISPRA carries out the functions that were the responsibility of the Environmental Protection and Technical Services Agency (the former APAT), of the National Institute for Wildlife(former INFS) and of the Central Institute for Scientific and Technological Research Applied to the Sea (the former ICRAM). The present publication refers to activities carried out during a period preceding the merger of the three institutions, meaning that it still contains references and titles the three institutes no longer in existence.

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verum animo satis haec vestigia parva sagaci
sunt, per quae possis conoscere cetera tute.[1]

Titi Lucretii Cari – De rerum natura
(Liber I, 402-403)

[1] To a shrewd mind these small footprints are sufficient: with them you can know the rest

Foreword

I am pleased to present the 10th edition of the Environmental Data Yearbook produced by ISPRA and ARPA/APPAs with the collaboration of numerous technical-scientific bodies, such as the institutions Main Reference (IPR).
The Environmental Yearbook 2011, the result of a consolidated process of production and management of statistical data on the environment, confirming a publication institutional extremely rigorous and thorough with regard to the scientific content and methodologies that they receive.
In order to ensure the integration of data sources and information as well as a more comprehensive application, starting from this edition was initiated a process intended to engage operationally in addition to the Environmental Agency System also other public institutions/organizations technical and scientific, both in the phase of consolidation methodological and population of the indicators, both in the phase of refereed total.
The document, directed not only to experts but to all citizens, promotes the analysis and understanding environmental phenomena taking place in our country and is a valuable support for the policies of resource conservation and sustainable development.
The air and water quality, the biodiversity, the generation and disposal of waste are environmental aspects of the current situation which, of course, require a monitoring and control always careful and relentless action and public dissemination information leading to an urgent reflection on the common good.
The themes of the sea and the forest, at the center of a collective mark today are some of the environmental priorities of the Italian and international environmental agenda.
The Framework Directive 2008/56/EC on the Strategy for the Marine Environment - Marine Strategy Framework Directive - has sanctioned the implementation by the Member States by 2020, with the objectives and programs of measures in defense of the sea, based on a knowledge of the ecological status of the different marine regions and their ecosystems.
The Community strategy Italy also requires the identification of causal factors at the origin of maritime pollution and impacts from human activities on the waters of the Mediterranean, and the definition of a set of environmental targets to be achieved.
The marine ecosystem, which plays an essential role in human life, it offers as well as other important resources, such as woodland and forest, huge growth potential and social and economic progress.
The year 2011 was declared by the General Assembly of the United Nations “International Year of Forests ", in order to spread the purpose of the management, conservation and sustainability of all types of forests and in continuity with 2010 dedicated itself to Biodiversity .
The Forest play a key role to limit global emissions of carbon dioxide, the effects of climate changes and to protect the biodiversity.
The national conference on forest resources and ecosystem services, organized by ISPRA, showed the link between biodiversity conservation and sustainable management of forest areas, which contribute to the wealth of Italian species and habitats. The Environmental must be considered an integral part of the development process.
The savings and the improvement of resources, the recycling, the use of renewable

energy sources and new production models, compatible with the carrying capacity of natural systems can be safe investments for current and future generations.

Sustainability needs to interventions involving the different sectors of society. In fact, only with the cooperation between government, business, scientific research and the citizens will be able to achieve significant efficiency and innovation targets.

It is decisive to generate these changes, the work of ISPRA to collect and disseminate environmental data and information, through the reporting activities and comply with the guidelines provided by the General Directive - 2012 - the Minister of Environment and Protection of Land and Sea on the functions and duties of the Institute.

In particular, with the regular production of the environmental data Yearbook, the Institute promotes the dialogue between the state and citizens useful to combine the economic development with the protection of the environment.

The creation of an editorial product is so diverse, complex and at the same time complete is the result of the efforts of many professional and competent in ISPRA and in the Agency System, to whom I extend my most sincere thanks for this edition.

Prof. Bernardo DE BERNARDINIS
The President ISPRA

Introduction to the Environmental Data Yearbook

The Environmental Data Yearbook, now in its 10th edition, is still the most complete and authoritative collection of the environmental data and information, published in Italy with continuity and methodological rigor. The work of selection and dissemination of scientific information is carried out by ISPRA in compliance with its institutional functions and targets, as confirmed and reinforced by General Directive of the Minister of Environment and Protection of Land and Sea Corrado Clini, relative to 2012, on the performance of the functions and tasks of the Institute.
The Data Yearbook comes from ten years experience, in the field of environmental reporting in APAT first and then ISPRA and from the commitment synergistic and with the environmental protection agencies of the Italian regions and of the autonomous provinces. Important and qualified contributions to the development and the improvement of the information in the document have been provided by institutions ex ICRAM and ex INFS, merged into ISPRA. Several technical and scientific organizations have contributed actively to the realization of this document providing, for this edition, a contribution with regard to the validation and processing of data.
Within the activities of the Agencies System Area C - Development - Management - dissemination of environmental information as defined by the three-year program 2010-2012 and approved by the Federal Council, activities finalized to insurance an organic and harmonized production and diffusion of the environmental information were conducted. In particular, a line of action is addressed to define a methodological standards of the System’s reporting, related to the techniques and methodologies for processing of data and information.
The revision of the core set of indicators and the creation of a glossary, objectives introduced as early as the previous editions, have been followed, this year, by a special Working Group. The main objective of this group has been the study of indicators and related data, available on the Regional environmental Data Yearbook, to compare and homogenize them with the contents of the National environmental Data Yearbook in order to assess their possible integration.
In particular, the review and consolidation of the core set of indicators have included: the validation of each indicator, based on the objectives set by national, European and international laws and regulations and by the corresponding reporting obligations and/or guidelines; the assessment of the indicator’s ability to represent the phenomenon being investigated; the verification of the availability of the data needed to populate the indicator; the evaluation of the scientific relevance and solidity of the indicator; the inclusion of new types of indicators (e.g. indicators of decoupling, performance indicators, efficiency indicators, sustainability indicators, composite indices, etc.); the relocation of some indicators between the different topics.
In addition, to ensure the integration of the data sources and of the information of the priority areas identified for this edition, have been involved in addition to the Agencies System other public institutions/organizations technical and scientific, both in the phase of consolidation methodological, populating environmental indicators and during the refereed total.
The environmental information base 2011 of the Yearbook (10th edition) is returned through seven products, in order to ensure a more timely dissemination of information. The usual versions (Full version, Key Topics, Yearbook Indicators Database, Multimedia Version) are also added three new publications: Key Topics light (instead of the Vademecum), Environmental Data Yearbook in figures (a

statistical brochure) and Newspaper (cartoon version of an issue of the Yearbook).
The Environmental Data Yearbook full version presents the factsheet indicator populated in 2011, organized by Production Sectors, Environmental Conditions and Responses.
The overview, an introduction to the chapter, contains some information about the indicators and their representation by tables and figures, and the updating frequency. The structure of the board (section metadata), it was simpler than that used in the database directory, through the selection of essential information relating to the indicator: Description, Quality of Information, Target fixed by law, State and trends, Comments on tables and figures.
The general structure of the document is divided into four sections with indicators structured according to the DPSIR model (Section A - General Elements; Section B - Production sectors; Section C - Environmental Conditions, Section D - Protection and Prevention). Compared to the previous editions, the introductions of topic and of SINAnet theme have been simplified and reduced, in order to allow content reading easier and more immediate: the first track briefly an overview of the issue, outlining the main features, both in terms of physical phenomena or both of the main issues of environmental concern, and the second briefly describes the themes that make up the topics.
It has been introduced a new chapter focused on the household, designed to outline the relationship between consumption patterns adopted and the environment. In particular, the chapter that supports and integrates environmental aspects of family life, introduce the last year, shows the role and responsibilities of families with respect to the environmental situation of today, indicating the types of consumption that generate the greatest environmental pressures .

The full version of the 2011 edition is produced in both paper and electronic formats (PDF available on CD-ROM and at the sites www.isprambiente.it and http://annuario.isprambiente.it/), is available through following products:
• *Key Topics* – A version (available in Italian and English language) containing supplementary information on priority environmental issues, subject to specific prevention and reclamation. It is available in both paper and electronic formats;
• *Key Topics light* (instead of the Vademecum) – A short version of the Key topics (available in Italian and English language). It is available in both paper and electronic formats (PDF);
• *Environmental Data Yearbook in figures* - Statistical brochure (in Italian and English language) containing the graphics more representative of environmental issues and statistical information and brief notes of depth. It is available in paper and electronic format (PDF);
• *Database* – A tool for on-line consultation of the indicator fact-sheets and the production of reports;
• *Multimedia* – A tool for communicating the Yearbook data and information in a quick and easily understandable way through film sequences and web applications. The movie Environmental Data Yearbook 2011 edition (in Italian) is available on CD-ROM and at the site www.isprambiente.it;
• *Newspaper* - cartoon version of a specific environmental Yearbook. It is available in paper and electronic format (PDF).

The volume Key Topics contains an integration of data elements of the Data Yearbook related to environmental issues that now has need of priority actions by the

environmental protection policies.
For each issue are examined: the existing condition (state/impact), the causes that have contributed to generate it (Driving/Pressure) and solutions undertaken or planned (Answers).
New performance and impact indicators were introduced, basing on the availability of data, and as a result of comparisons made at European and regional level.
Most of the subjects considered coincide with the topics covered in the sixth Environmental Action Plan of the EU.
In this edition, the thematic *The sea and coastal environment* and *Nuclear activities and Environmental radioactivity* were introduced.
Particular emphasis was given to the aspects related to the E*nvironmental hazard* and *Biodiversity and activities on ecosystems*, especially with regard to the state of forests and deforestation. In 2011, in fact, was declared by the General Assembly of the United Nations International Year of Forests. The event provided an opportunity to discuss ideas and propose methods to be pursued in view of a multiannual program for the management of forests that can coexist with sustainable development and climate change. For each issue was included a glossary of terms.

In *Key Topics "light"* in order to provide the public a comprehensive and immediate environmental information, the environmental issues analyzed in Key Topics were described according to the elements of the DPSIR (Driving forces, Pressures, State, Impacts, Responses), using some indicators that represent them. These indicators has been selected according to the following criteria: key indicators required by the regulations or reporting requirements; completeness of the time series (the national average); representativeness and maximum communicability, innovations/evolution/ changes.

In the *Environmental Data Yearbook in figures*, preferring an immediately communication and effective at the same time, were selected for each thematic area charts accompanied by short notes and additional statistical data, particularly significant and self-explanatory, and meeting the criteria of completeness of the time series, reference to national data and communication.

The *Database of the Yearbook*, created in order to facilitate the elaboration process of the data and metadata, is an important communication tool made available to inside and outside users. The database, through the factsheet indicator, allows to search available indicators, for all editions of the Yearbook (from 2003 to present). The data processing system allows to create customized summary versions, organized according to the needs of individual users. From this edition, it is also possible to produce other types of reports, for example, the monitoring of Environmental Action Strategy for Sustainable Development in Italy (CIPE Resolution 57/2002), the European Strategy Development sustainable (Monitoring Report 2011) and other issues of primary interest, such as Climate Change and Sustainable Production and Consumption.

The movie version of the *Multimedia*, with the help of images, graphics, sound and spoken commentary, presents a summary of the significant main content of the Yearbook, representing the priority and the greatest interest issues to the general public. It was adopted methodology based on the DPSIR framework in order to encode and transmit statistical data and environmental indicators.

The *Newspaper* entitled "The investigation of the Inspector SPRA" – work in progress – deals, annually, with one environmental issue, using the language of comics in order to disseminate information and data of the Yearbook to a young audience of non-experts. For the 2011 edition was chosen the issue "Climate Change". The narrative structure also based on the DPSIR model, is to conduct a survey investigation by the Inspector SPRA and five officers: Mr. D. (the agent who investigates determinants), Mr. P. (the agent who investigates Pressure), Mr. S. (the agent who investigates the State), Mr. I. (the agent who investigates Impacts), Mrs. R. (the agent who investigates Replies).

The *Database of the Yearbook*, and *Environmental Data Yearbook Full Version*, allow a deeper examination of the topics.

The information base of ISPRA's Environmental Data Yearbook also constitutes the backbone for other important publications. These include the document: "Piano nazionale integrato dei controlli per la sicurezza alimentare" (National Plan of Integrated controls for food safety) issued by the Ministry of the Health, "Strategia di azione ambientale per lo sviluppo sostenibile in Italia" (Environmental action strategy for sustainable development in Italy) (CIPE Resolution 57/2002), for updating the indicators for the monitoring, National Strategy of Biodiversity (SNB), for the identification and monitoring of indicators.

The Environmental Data Yearbook 2011, through such a wide range of publishing, demonstrates the high level of usability obtained in the process of dissemination of statistics to a wider audience, including policy makers, experts, and citizens. With this work, in fact, ISPRA answers to the growing demand for information on environmental conditions by the community, and direct it in the direction of that assumption of responsibility and awareness civil that affects the effectiveness of policies sustainable development.
It is hoped that the Institute will continue the dissemination of environmental knowledge and culture with continuity and consistency according to the targets achieved up to its tenth edition.

Stefano LAPORTA
ISPRA General Director

Contributors and Thanks

General considerations

In carrying out one of its most important institutional functions, namely the coordination, collection and distribution of environmental information and reporting, ISPRA constantly procures and maintains a significant supply of top-quality knowledge, translating it into thematic and inter-thematic reports, such as the Environmental Data Yearbook, which, now in its eighth edition, is drawn on by a vast range of users.
Compared to the other publications, the Yearbook, give the thoroughness of the treatment of the environmental topics, stands as the best example of the final outcome of the complex synergies involving almost all the Institute's structures in the different disciplines.
To an even greater extent than in years past, the mass of information generated, together with the complexity of the analyses required to prepare this edition of the Yearbook, called for the efforts of a noteworthy number of experts on the different topics, together with analysts responsible for the reporting.
In citing the main contributions to the publication, special mention must go to the following departments:

- State of the Environment and Environmental Metrology; Marine and Inland Waters Protection; Land Resources and Soil Protection; Nature Protection; Nuclear, Technological and Industrial Risk; Library, Documentation and Information; as well as to the Inter-Departmental Services: Environmental Emergencies, Environmental Information; Guidance, Coordination and Control of Inspection Activities and Environmental Certification;
- Monitoring of Environmental Quality, Prevention and Mitigation of Impact, Defence of Habitats and Biodiversity, Sustainable use of resource;
- former INFS.

Equally important were the contributions of the ARPA/APPA agencies, plus the numerous technical-scientific bodies.

The planning and coordination of the overall production of the work are handled by the State of the Environment and Environmental Metrology Department, through the Environmental Statistics and Yearbook Project Service.

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Editing

The phases of the editing of the Yearbook products were handled by a workgroup coordinated by Mariaconcetta GIUNTA with the contribution of Silvia IACCARINO and Paola SESTILI and consisting of: Giovanni FINOCCHIARO (processing and statistical validation of the data), Cristina FRIZZA (processing and statistical validation of the data), Alessandra GALOSI (processing and statistical validation of the data), Elisabetta GIOVANNINI (texts editing) Silvia IACCARINO (coordinator of technical revision and data validation), Alessandra MUCCI (texts editing), Matteo SALOMONE (processing and statistical validation of the data and multimedia elaboration), Luca SEGAZZI (technical revision), Paola SESTILI (processing and statistical validation of the data), Valeria STRADAIOLI (texts editing and acronyms revision), Patrizia VALENTINI (processing and statistical validation of the data and multimedia elaboration). The Databank of the Yearbook Indicators was managed by Raffaele MORELLI. The Group has also handled the preparation of specific techniques, together with the related guidelines, for compilation of the indicator fact-sheet and the Yearbook Indicators Database, as well as the integration of the contents of the work, the processing and statistical control of the data published and the overall technical review of both the information contents and the methodological/editing techniques used on those contents.

Information contents - Coordinators Units

The work involved in the preparation of the information contents of the "Environmental Data Yearbook" was carried out by a Task Force coordinated by Mariaconcetta GIUNTA.

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A detailed listing of specific contributors (authors and collaborators for the specific topics) is included at the start of each chapter of the full version.

Contributions of the Environmental Agency System

Initially, the contribution of the System involved the formulation of methodologies and the collection of data; later, it took the form of invaluable refereeing activities that made it possible to detect and, when necessary, resolve discrepancies inevitably produced by such an elaborately structured, complex process of information management.

The interface role between ISPRA and each ARPA/APPA was carried out by referees network established by Agency System Program 2010-2012 Activity Area C "Processing - Management - dissemination of environmental information":
Carlo ZAMPONI (ABRUZZO), Bruno BOVE (BASILICATA), Deborah CIMELLARO (CALABRIA), Raffaele RUSSO (CAMPANIA), Roberto MALLEGNI (EMILIA-ROMAGNA), Marco GANI (FRIULI-VENEZIA GIULIA), Alessandro DIGIOSA (LAZIO), Gino VESTRI (LIGURIA), Enrico ZINI (LOMBARDY), Federica ALLEGREZZA (MARCHE), Michela PRESUTTI (MOLISE), Giuseppina NAPPI (PIEDMONT), Maria SERINELLI (APULIA), Marilù ARMATO (SICILY), Stefano ROSSI (TUSCANY), Paolo STRANIERI (UMBRIA), Marco CAPPIO BORLINO (AOSTA VALLEY), Francesca MENEGHINI (VENETO).

Other contributions from the ISPRA technical units

Other specific technical contributions were made by:

- SISTAN interface, through the Statistics Office: Mariaconcetta GIUNTA
- coordinatoor network *EIONET*: Claudio MARICCHIOLO, as the *National Focal Point* for Italy;
- interface of information related to Biosphere with *task force Yearbook* Ettore RANDI and Piero GENOVESI;
- integration of the information related to *contaminate sites* and to topic *Hidrosphere* (*Coastal and Lagoon of Venice*): Elena ROMANO and Antonella AUSILI (*Contaminate sites*), Luisa NICOLETTI and Andrea TARAMELLI (*Coastal*), Fulvio ONORATI (*Handling of the seabed*), Chiara MAGGI e Ornella NONNIS (*Energy infrastructure*), Rossella BOSCOLO (*Lagoon of Venice*);
- integration of the information related to *Marine Protected Areas* and *Protected Species (marine)* Leonardo TUNESI with the contribution of Sabrina AGNESI, Taira DI NORA, Giulia MO;
- Network of libraries and referees for environmental education of the Agency System.

Other contributions by units

The following contributions were made on operating considerations:

- procedural and administrative considerations: Vincenzo PEZZILLO, Elisabetta GIOVANNINI, Valeria STRADAIOLI;
- graphic aspects: planning and graphic design Franco IOZZOLI, Alessia MARINELLI, Elena PORRAZZO;
- administrative considerations: the Department of General Services and Personnel Management and the Inter-Departmental Service for the Administration and Planning of Activities. With regard to the activities involved in carrying out tenders, the Tender and Contracting Sector;
- the functional support was overseen by Elisabetta GIOVANNINI.

Contributions by subjects outside of the Agency System

Numerous contributions from central and local government bodies have also been drawn on, as well as from technical-scientific structures and individual experts in different sectors.

Of the government bodies, specific mention should be made of: the Departments of Ministry of the Environment, Land and Sea, Ministry of Economic Development, Ministry of Cultural Resources and Activities, Ministry of Infrastructures and Transportation, Ministry of Agricultural, Forestry Policies, Ministry of Labour, Health and Social Policies, Carabinieri Military Police Command for Environment Protection, Italian National Forestry Corps, Manager of the National Transmission Network, Marine Environmental Unit of the Harbourmasters' Corps, National Fire-Fighters' Corps, Regional and Provincial Waste Observatories, Commissioners for the Waste Emergencies in the Regions of Campania, Calabria, Apulia and Sicily, the regional, provincial and municipal governments, PMP and Local Government bodies. Of the technical-scientific authorities and organizations, both public and private, the following should be acknowledged: ISTAT, ISS, Basin Authorities, Water Bodies Magistrates, CNR, ACI, ENEA, Italian Glaciological Committee, Italian Meteorological Society, ENEL, European Soil Bureau of the Common Research Centre of the European Commission in ISPRA (VA), EUROSTAT, Agecontrol S.p.A., Biobank, National EMAS Organizations Register, ISTIL, ODYSSEE, TELEATLAS, TERNA and IREPA.

Referee

As was done with previous editions, in addition to the numerous contributions received from subjects (individual experts and organizations) outside of the Agency System during the phases involving the formulation and production of the Yearbook, it was held best to request an additional and independent assessment of the final product from experts on the individual topics addressed in the publication.

It was not always possible to utilize all or a part of these contributions. In certain cases, the key factor was a lack of time. Other contributions that could not immediately be put to use regard proposed additions to the Indicators Database. In such cases, the proposals were not enacted because the data needed to populate the indicators were lacking.

We shall be sure, however, to return to these proposals in subsequent editions of the Yearbook. The following individuals were consulted and offered observations and proposals for additions:

Renzo BARBERIS (ARPA Piedmont), Gianfranco BOLOGNA (WWF Italy), Giovanni BRAMBILLA (IA CNR), Fabrizio BULGARINI (WWF Italy), Anna Maria DE

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Thanks

Heartfelt thanks are once again expressed to those whose contributions have made publication of the 2011 edition of the Yearbook possible.
The listing of those who have contributed in one way or another, an exercise that may prove tedious but is definitely deserved, further demonstrates, were there any need for such evidence, the complexity of the work behind this volume, which constitutes an indispensable reference for those who use environmental data and information in the course of their own activities or in order to keep themselves up-to-date on our country's environmental status. There is also no mistaking the fact that, in pursuing these objectives, ongoing efforts must be made to enlarge the network of cooperation with other organizations and institutions, without which it would prove impossible to provide a body of knowledge adequate to current demands.
These thanks go to everyone, including those who, though they contributed, are not explicitly mentioned. A few names may have been left out by mistake. We ask these people to accept our most sincere apology.
As was done for the previous editions, we again ask that readers send us any observations or suggestions for modifications they might have, so that, on the strength of such contributions, we can continue our ongoing improvements in the development of the Yearbook.

Dott. Roberto CARACCIOLO
Director of ISPRA's State of the
Environment and Metrology
Department

INDICE

I. Purpose and structure of the document

Purpose

The purpose of the document is to paint a picture of the environment in Italy, based on several topic areas viewed by the European Union as "priority areas for policy development".

Unlike the unabridged edition, which presents detailed environmental information in the form of indicator-based factsheets, this version offers a reasoned examination of the indicators referred to in the Yearbook, illustrating the selected topic areas based on the logical organisation of the data.

The strictly scientific environmental reporting method used here, to facilitate understanding by a wider public, is the DPSIR model – developed by the European Environment Agency (EEA) – where the single letters stand for Drivers, Pressures, State, Impacts and Responses.

The system is grounded on the cause/effect principle and on the circular nature of how human activities, environmental conditions and the responses to any criticalities relate to and affect each other: anthropic activities (D) generate pressures (P), which determine a certain state of the environment (S), with consequences on man and the ecosystems (I), which, however, can be mitigated, or even removed, by means of suitable countermeasures (R).

With a view to making the document increasingly reader-friendly and practical for the target group, the focus has been on the use of plain yet accurate language, clear diagrams and information-packed descriptive notes. A new feature introduced in this edition is a glossary of the key terms or words used in each topic area.

Structure of the document

The volume comprises 12 chapters, 11 of which are dedicated to specific environmental topic areas with priority status at Community level, while the twelth chapter is dedicated to the tools for broadening environmental knowledge.

Some new features, compared to the previous edition, are an introductory chapter on *Household Consumption Patterns and the Environment* and two new topics *Nuclear Activities and Environmental Radioactivity* and *The Sea and Coastal Environment*.

Great attention has been paid to Environmental Hazards and to Biodiversity, especially with regard to forests and wooded areas. These aspects, in fact, are deserving of particular notice in a country like Italy, which has an extremely varied yet very fragile natural heritage that must be preserved for the future generations by promoting actions aimed at monitoring, valorizing and protecting the natural resources.

As mentioned earlier, each topic area is described based on the data and information set out in the indicator fact-sheets of the Environmental Data Yearbook for 2011 and on the DPSIR model, highlighting the cause/effect relations between the present state of the environment, the causes that have determined it and the best possible implemented, or implementable, response measures.

Each chapter is made up of three specific components, for a better all-round understanding of the topic: the body of the chapter comprehensively describes the subject matter; the focus points in the margins help to quickly identify the areas of interest; and the diagrams and figures illustrate single aspects of the topic area.

At the bottom of each chapter, a glossary provides a short description of any subject-specific keywords.

The appendix contains a detailed description of the Yearbook Database. The Information System manages the environmental data collected by the ISPRA and can be accessed by visitors wishing to consult the indicator fact-sheets.

II. The socio-economic background

Overview of key features

Italy is a peninsula in Southern Europe jutting out in the middle of the Mediterranean Sea. The country features two large mountain chains, the Alps and the Apennines; several important rivers, the longest being the Po; and many lakes (the biggest is Lake Garda); as well as numerous islands, two large ones, Sicily and Sardinia, and 70 smaller ones.

The boot-shaped Italian peninsula is very long, almost 1.200 kilometres, while its maximum width is 530 kilometres, from Monte Chardonnet to Tarvisio.

The land area of Italy is 301,336 km^2 (not including the Republic of San Marino and the Vatican City).

Its maximum length is 1,200 kilometres (from Vetta d'Italia to Capo delle Correnti).

The country is mainly hilly and mountainous, respectively accounting for 41.6% and 35.2% of the total area. The coastline – at 8,300 kilometres – is particularly long. This mix of features ensures a variety of different landscapes.

The climate is generally temperate with regional variations. In summer, the weather in the Northern regions is warm with occasional rainfall, the Central regions are rather humid, while in the South the heat can be torrid.

In winter, the Northern cities are cold, damp and foggy, while the temperatures in the South are much milder (10-20°C).

Italy is one of the countries with the highest volcanic and seismic activity in the Mediterranean region.

Italy's specific location within the Mediterranean geodynamic context – featuring the convergence of the European and African plates, the interposition of the Adriatic micro-plate and the opening of the Tyrrhenian basin – makes it one of the countries in the region with the highest seismic and volcanic activity.

The highest seismic activity is recorded in the North-East (Friuli), the Central-Southern Apennines, and especially the inter-Apennine basin, the Tyrrhenian seaboard of Calabria and South-Eastern Sicily.

The highest volcanic activity is obviously concentrated in the areas with active volcanoes, such as the Vesuvius and Phlegraean Fields, the Island of Ischia, Mount Etna, the Aeolian Islands and, in part, the Alban Hills on the outskirts of Rome.

Italy contains half the plant species and one third of the animal species currently found in Europe.

Italy is one of the European countries richest in biodiversity, essentially due to its favourable geographical position and great variety of geomorphology, microclimate and vegetation, also influenced by historical and cultural factors. In particular, Italy contains half the plant species and one third of the animal species currently found in Europe.

Italy is one of the most densely populated countries in the European Union.

At the end of 2010, the resident population of Italy was over 60 million (7.5% of which were foreigners). Italy, in fact, is one of the most densely inhabited countries in Europe, behind Malta, the Netherlands, Belgium, the United Kingdom and Germany.

The average density in Italy is approx. 200 people per square kilometre (the EU27 average was about 114 in 2009).

Italy also hosts about 40% of the World's entire art heritage and is home to the greatest number of UNESCO World Heritage Sites, to date, with 47.

Key development in Italian society

After World War II (1945-1950), the Italian population increased at an impressive rate, in excess of 1% per year, especially in the urban areas and immediate surroundings.

Over the last 60 years, Italy has experienced significant socio-economic changes, developing from a poor, mainly rural, nation to an advanced post-industrial society.

Over the last 60 years there has been a significant drop in the birth rate, with the progressive ageing of the population and increased immigration.

Historically, the period between 1958 and 1963 is known as the "Italian economic miracle", although economic development did not spread equally throughout the country, but was concentrated in the Centre-North.

The potentially better job opportunities in the urban areas determined intense internal migratory flows, from the rural areas to the towns and cities, from the depressed mountain areas of the Alps and Apennines, Sicily and Calabria, towards Rome, Milan, Turin and Genoa. This flow towards the industrial areas is still under way, although it has considerably slowed down due to the current climate of economic depression.

Consistently with the reference framework, the structure of the Italian population has also changed – in terms of number of inhabitants and their demographic behaviour – rising from 47 million in the 50s to over 60 million today. This period has featured a significant drop in the birth rate and progressive ageing of the population, accompanied by increased immigration, determining significant changes in the population indicators.

Table II.1: Demographic indicators of the Italian population[1]

A boy and a girl born in 2010 have an average life expectancy of 79.1 and 84.3 years, respectively.

	1961	1971	1981	1991	2001	2011*	2021**
Old age index (at 1st January)	38.9	46.1	61.7	92.5	129.3	144.5	169.5
Age dependency ratio (at 1st January)	51.6	55.5	53.1	47.5	48.4	52.3	57.9
Avg age of the population at 1st January	33.5	34.5	36.1	38.9	41.7	43.5	45.5
Life expectancy at birth (males)	67.2	69	71.1	73.8	77	79.3	80.8
Life expectancy at birth (females)	72.3	74.9	77.9	80.3	82.8	84.8	86.3
Avg number of children per woman	2.4	2.4	1.6	1.3	1.3	1.4	1.5
Birth rate per 1000 population (per 1000 population)	18.3	16.8	11.1	9.8	9.4	9.2	8.4
Death rate per 1000 population (per 1000 population)	9.1	9.5	9.6	9.6	9.6	9.7	10.5
Migration rate (per 1000 population)	-2.8	-3.1	-0.5	2.2	0.8	3.9	3.1

Legend:
*estimates
**forecasts

[1] Source: ISTAT

After World War II, 42% of the economically active population still worked in the agricultural sector, although the weight of the manufacturing and tertiary sectors – accounting for 32% and 26% of the active population, respectively – has gradually increased over the years.

The industrial development of the 1960s radically changed the distribution of employment among the various economic sectors.

The industrial development in the 60s has changed the distribution of employment in the different sectors of the economy: employment in manufacturing and the service sector rose to 41% and 30% of the active population, respectively, while in agriculture it dropped to less than 30%.

In 1981, the tertiarization of the Italian economy determined a further shift of employment towards the service sector, which rose to about 50%.

In recent years, the economic crisis has heavily impacted the labour market, highlighting the still existing geographical differences, the difficulties in youth employment, a significant increase in the number of people giving up the job search (due to discouragement), and the structural weakness of female employment.

In 2010, employment dropped – on average – by 0.7% year-on-year (-153,000 jobs), especially in the manufacturing sector (-4%) and with respect to full-time permanent work.

Table II.2: Employment by job position, economic sector and geographical area (2010)[2]

Compared to the previous year, in 2010 employment figures dropped by 153,000 workers (0.7%).

Geographical distribution	Absolute figures (in thousands)			Year-on-year percentage change
	Employed	Self-employed	TOTAL	TOTAL
North	109	238	347	3.1
Centre	59	68	127	-1.5
South	261	156	417	2.0
TOTAL Agriculture	**429**	**462**	**891**	**1.9**
North	2,640	373	3,013	-3.0
Centre	679	142	820	-4.5
South	614	134	748	-7.3
TOTAL Manufacturing	**3,932**	**649**	**4,581**	**-4.0**
North	541	376	917	-2.2
Centre	259	169	428	6.4
South	398	186	584	-3.2
TOTAL Construction	**1,199**	**731**	**1,930**	**-0.7**
North	5,693	1,869	7,561	0.5
Centre	2,591	867	3,457	0.4
South	3,267	1,185	4,452	-0.4
TOTAL Services	**11,550**	**3,921**	**15,471**	**0.2**
North	8,983	2,855	11,838	-0.6
Centre	3,587	1,246	4,833	0.0
South	4,540	1,661	6,201	-1.4
TOTAL	**17,110**	**5,762**	**22,872**	**-0.7**

[2] Source: ISTAT data processed by ISPRA

The key driving forces and related environmental pressure and impact

The key features of the geographical and socio-economic contexts, in particular the population dynamics and behaviour of the economic subjects (households and businesses), are closely related to the impact of human pressure that is threatening the country's environment (pollution of the air, water, soil and nature, waste production, consumption and deterioration of natural resources).

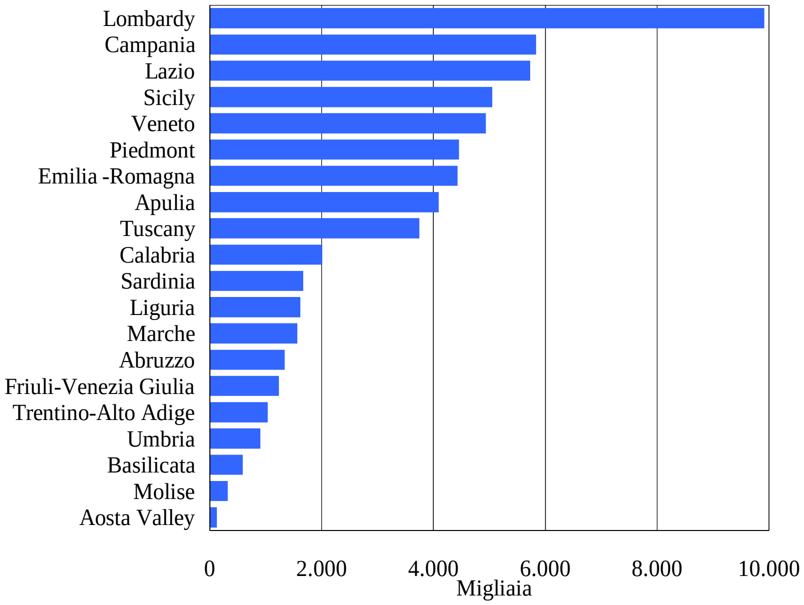
Socio-demographic aspects

At 31/12/2010, the resident population of Italy totalled 60,626,442 people.

At 31/12/2010, the resident population of Italy totalled 60,626,442 people, 7.5% of which are foreigners (7% in 2009).
At the same date of the previous year the population was 60,340,328.
The year-on-year increase of 286,114 people is due solely to immigration from abroad, a trend that has been occurring for a number of years.
This rise in the population differs geographically across the country, due to the fact that the (internal and international) migration flows are primarily directed towards the Northern and Central regions, while the natural balance is positive only in the Southern regions.

The downward trend in the resident population of Italian citizens has continued for the fourth consecutive year.

For the fourth consecutive year the resident population of Italian citizens has declined.
This has occurred in almost all the regions, although the trend is highest in Liguria (-6.9 per 1000 people), Basilicata (-4.8 per 1000 people) and Molise (-4.1 per 1000 people).
The population of Italian citizens has increased in three regions alone: Trentino-Alto Adige (+3.2 per 1000 people), Lombardy (+0.3) and Lazio (+1.1).
The Italian regions are greatly varied, in terms of population and land area.
The most populated region is Lombardy, followed by Campania (over 5.8) and Lazio (over 5.7).
The largest regions are Sicily, Piemonte, Sardinia and Lombardy.
Geographically, the population is distributed as follows: North-West 16,120,067 people (26.6%), North-East 11,643,194 (19.2%), Centre 11,950,322 (19.7%), South 14,186,373 (23.4%) and the Islands 6,726,486 (11.1%).



The most populated region, with a population of over 9.9 million, is Lombardy, followed by Campania (over 5.8) and Lazio (over 5.79).

Figure II.1: Resident population at 31 December 2010[3]

The breakdown by age of the resident population confirms a significant degree of ageing; 20.3% of the population, in fact, is made up of over-65 year olds (over-80 year olds now constitute 6% of the population), young people aged below 14 are 14% of the population.

Consumption too has been significantly affected by the population changes: in particular, the changing size of households affects disposable income and spending patterns. Households, on average, are made up of 2.4 members, a stable figure year-on-year.

11% of households in Italy are below the relative povery line, while 4.6% live in absolute poverty.

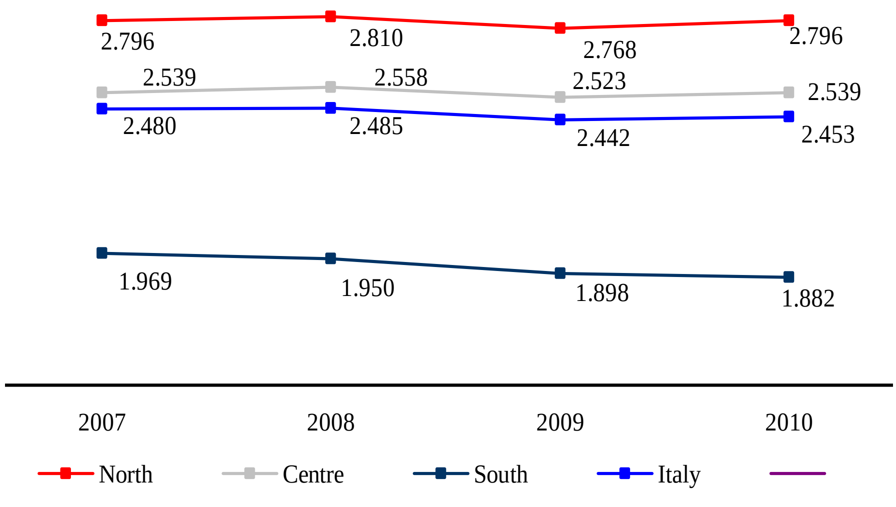
It should be highlighted that 11% of Italian households are below the relative poverty line – totalling 8 million 270 thousand individuals, accounting for 13.8% of the population – while 4.6% of households live in absolute poverty – totalling 3 million 129 thousand individuals, 5.2% of the entire population. In 2010, average monthly spending per household, in current values, totalled € 2,453 (€ 2,442 year-on-year), ranging from a minimum of € 1,715 (for a single-member household), to a maximum of € 3,245 (household of 5 or more members). Food spending, equal to € 467, has remained almost stable year on year. It accounts for an average of 19% of the total monthly spending of households. Instead, spending for fuel and energy, furniture, household appliances and home-related services is down.

Especially in the Centre-North there has been an increase in health care spending and, in all the geographical areas, spending for education.

Lombardy features the highest average monthly spending per household (€ 2,896).

With regard to regional differences, once again Lombardy is at the top of the list (€ 2,896) and Sicily at the bottom (€ 1,668).

[3] Source: ISTAT data processed by ISPRA



In 2010, North Italian households featured the highest consumption figures, with average monthly spending of € 2,796.

Figure II.2: Average monthly spending of households by geographical area[4]

Economic aspects

In 2010, economic recovery across Europe was generally slow and varied considerably country by country. Since the second half of 2009, the European GDP, after having reached its lowest point in the cycle, managed to recover only barely half the over five percentage points lost during the recession.

Exports boomed, driving the manufacturing sector.

Exports boomed thanks to the strong growth in world trade, driving the manufacturing sector, which had most suffered from the global recession. On the contrary, domestic demand was rather sluggish: consumer spending, in fact, slowed down, due to the mixture of a weak labour market and a drop in disposable income; investments in the construction industry also dropped further.

In 2010, consumer inflation in the European Union was rather low, standing at 1.6%, while underlying inflation was even lower, at 1%[5].

In Italy, the GDP at market prices, in 2010, increased by 1.1% in real terms.

The Gross Domestic Product, which represents the total output of goods and services of a country in a given period, valued at market prices, increased in Italy, in 2010, by 1.1% in real terms. In the European Union, the GDP at PPP[6] *per capita* differs considerably country by country, ranging from € 67,000 in Luxembourg to € 10,600 in Bulgaria.

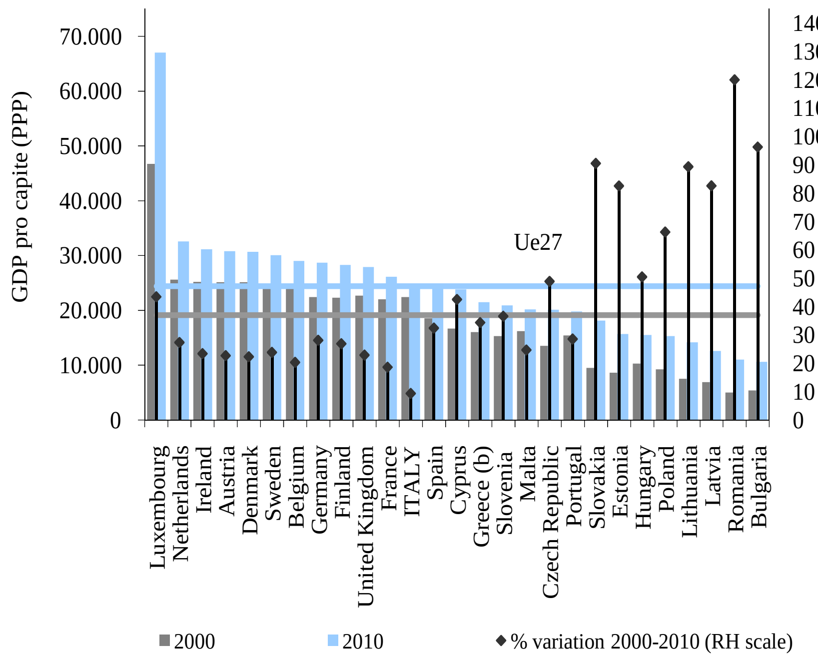
Unlike in Europe (UE27), where the countries with a lower initial GDP at PPP *per capita* are those that feature the highest growth rates, the regions of Italy do not mirror this European trend towards convergence in economic growth, due to the fact that the Southern regions are unable to bridge the gap with the richer Northern regions. Also at European level, with regard to the GDP at PPP *per capita*, unlike in 2000, when Italy ranked above the EU(15) average and France, in 2010 it dropped below the EU(15) average and now

[4] Source: ISTAT

[5] Bank of Italy, Annual Report 2010

[6] PPP = purchasing power parity

stands at slightly above the EU(27) average, due to the fact that in the year, and for another consecutive year, Italy recorded the lowest economic growth rate in Europe.



Legend:
* PPP: Purchasing Power Parity
Note:
[a] The figures are updated to 10 November 2011. Any discrepancies with the figures contained in other domestic or international publications or databases may depend on roundings off or to the fact that the latest data revisions have not been taken into account.
[b] The figures for Greece are provisional.

Figure II.3: Per capita GDP in the EU countries[7]

Having regard to consumption, which constitutes the principal component of aggregate demand[8], it can be inferred that in all EU countries, in 2010, except for Ireland and Luxembourg, consumption stood in excess of 70% of the GDP. The sum of consumption and investments defines domestic demand. In Italy, in 2010, consumption was 82.3% of the GDP, while investments totalled 19.7%. Moreover, it can be observed that, in various countries[9], including Italy, the sum of consumption and investments was higher than 100% of the GDP, which means that they consume and invest more than they produce, as a result of which they must necessarily find resources on foreign markets.

In Italy, in 2010, consumption totalled 82.3% of the GDP, while investments totalled 19.7%.

The above mentioned situation applies to the Southern Italian regions as well, which need to import goods and services to meet their high levels of consumption and investment, with respect to the GDP.
In 2010, added value increased in Italy in almost all the economic sectors; labour productivity too picked up again, albeit at a slower

[7] Source: Eurostat data (National Accounts) processed by ISTAT (http://noi-italia.istat.it)
[8] Eurostat, Database New Cronos
[9] Ibidem

pace than in the other main European economies. In a phase in which the growth of international demand is the main lever for improving production, Italian companies are unable to exploit these opportunities because they find it hard to innovate and access foreign markets, especially in the emerging countries. In 2010, on average, added value increased in Italy, in real terms, by 1.5% year-on-year, with increases in practically all the economic sectors.
Having regard to Italy's production structure, based on the Eurostat[10] data on structural business statistics and the ISTAT "ASIA"[11] Archive for Italian businesses, it can be observed that the sectoral breakdown in Italy is similar to that of Germany, although, in the latter case – as in all the continental European economies – large companies prevail. Instead, in Central Italy there is a prevalence of: large service companies in Lazio, micro-enterprises in Tuscany and small enterprises (10-49 employees) in Marche and Umbria. On the contrary, in the South of Italy there is a prevalence of micro-enterprises, in particular service companies in Campania, Calabria and Sicily, and manufacturing enterprises in Puglia, Basilicata, Abruzzo, Molise and Sardinia. In the North-East there is a prevalence of small and medium manufacturing enterprises, while large companies prevail only in the North-West, and especially in Piemonte.

Figure II.4: Prevailing business sector and company size by region, compared to the national average (2009)[12]

Industry

Industrial plants invariably and deeply change and transform the

Industrial plants invariably and deeply change and transform the surrounding environment, due to emissions of polluting substances into the atmosphere, water and soil, the exploitation of natural

[10] Eurostat, *Structural Business Statistics* (SBS)
[11] ISTAT, Archivio Statistico delle Imprese Attive (ASIA)
[12] Source: ASIA data processed by ISTAT (http://noi-italia.istat.it)

resources, the production of waste, increased traffic, etc.. The larger the number of plants, the greater the pressure, of course, although this can also depend on other elements, such as the type of hazardous substances used.

surrounding environment, due to the emissions of polluting substances into the air, water and soil, the exploitation of natural resources, the production of waste, increased traffic, etc..

In Italy, in 2009, there were nearly 4.5 million active enterprises – i.e. those operating for at least six months in any given year – in the industrial and service sectors, employing a total of 17.5 million people.
There were just over 452,000 industrial companies, employing a total of 4.46 million people, comprising 637,686 self-employees (owners, shareholders, cooperative members, etc..) and 3,824,873 employees.
Compared to the tertiary sector, industrial companies are generally bigger, with a number of employees, on average, ranging from between 9.5 (manufacturing) to 29 (electricity, gas, steam and air conditioning suppliers).
The number of industrial companies dropped, between 2008 and 2009, by -4.2%, in particular, almost all manufacturing and mining activities dropped (by -4.5% and -9%, respectively).
On the contrary, companies supplying electricity, gas, steam and air conditioning significantly improved their output (19.6%).
This shrinking of jobs in the industrial sector affected manufacturing in particular, with 5.4% less jobs, in all the geographical areas: -4.4% North-West, -4.9% North-East, -6.7 Centre, -4.9 South e -3.5% Islands.
Over 30% of industrial companies are based in the North-West, with 37.8% of total employees, 24% are based in the North-East, 20.5% in the Centre, 17.9% in the South and 7.5% in the Islands.

Over 30% of all manufacturing companies are based in the North-West.

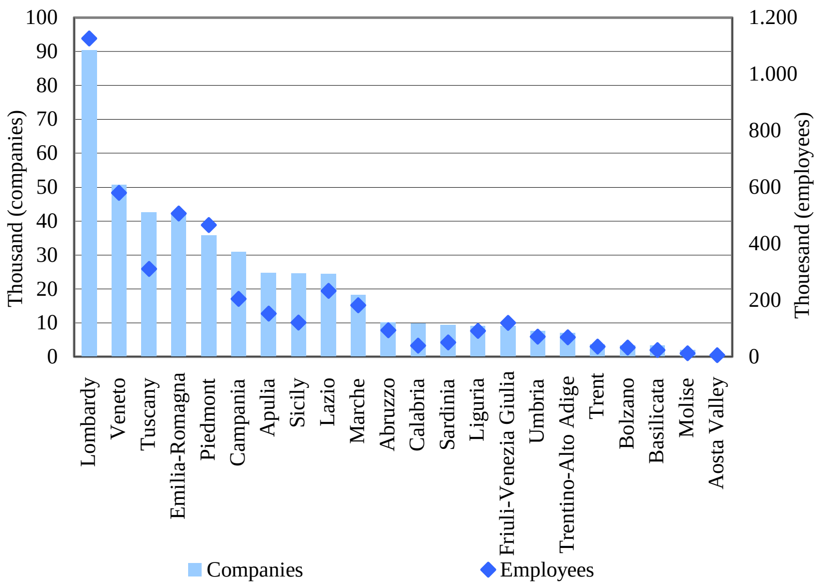


Figure II.5: Industrial companies and their employees (2009)[13]

Lombardy still decidedly maintains its role as the country's top industrial region.
Also of interest is the geographical location of industrial plants

Plants posing a significant accident

[13] Source: ISTAT data processed by ISPRA

posing a significant accident risk, which can determine environmentally critical situations due to the use of hazardous substances or the potential accident scenario.

risk (SAR) can determine environmentally critical situations.

At 31 January 2012, in Italy, there were 1,131 plants posing a significant accident risk (565 pursuant to article 6/7 and 566 pursuant to article 8). The regional distribution points to the fact that about 25% of industrial plants (286) are located in Lombardy, and that other regions with a large-scale presence of plants at risk of accidents are Veneto (108), Emilia-Romagna (100) and Piemonte, with 8.6% (98).

In Italy there are 1,131 SAR plants, 25% of which are located in Lombardy alone.

In these regions, moreover, there are some areas with a particularly high concentration of such plants, such as the traditional oil refinery and/or petrochemical districts of Trecate (Novara), Porto Marghera (Venice), Ferrara and Ravenna, as well as other industrial districts in the provinces of Turin, Alessandria, Bologna, Verona and Vicenza. With regard to the type of activities, there is a predominance of chemical and/or petrochemical plants and liquid gas deposits (especially LPG), which account for about 50% of all the plants.

The LPG deposits are particularly numerous in the Southern regions, while the mineral oil deposits are particularly concentrated near the larger cities and those with important industrial ports (Genoa, Naples, Civitavecchia). Of the 17 oil refineries, 5 are located in Sicily and 3 in Lombardy.

Energy

The figures relating to the energy industry in Italy highlight: a high level of energy dependence (82.1% in 2010), a better performance than the European average, in terms of energy intensity and the ratio of final to total consumption of energy, and a series of changes under way in respect of procurement.

With regard to Italy, certain structural features of the national energy system are confirmed, along with a number of changes under way in supplies.

With regard to the latter, there has been a growth in the role of natural gas, compared to oil products, and a tendential increase in the contribution of renewable energy sources and cogeneration.

In 2009, renewable energy sources contributed 8.9% to the gross final consumption of energy (GFC)[14], while the contribution of combined heat and power (CHP) to the net thermoelectric energy output has risen from 27.9% in 2000 to 49.2% in 2010.

The gradual commissioning, since 1999, of combined cycle power plants – which are more efficient than conventional plants – explains the drop in the average specific consumption of fuel in the net production of electricity from fossil sources.

In 2010, in fact, this consumption dropped by 12.8% compared to 2000.

The energy industry dynamics are influenced not just by the international fuel market trends, but also by the regulatory developments, with the liberalisation of the energy markets and the

[14] Directive 2009/28/EC establishes the share of energy from renewal sources, with respect to gross final energy consumption, to be achieved by each EU country by 2020; these shares include both consumption of energy from renewable sources for the production of electricity, and those for heating and transport. The renewable energy consumptionh target assigned to Italy is equal to 17% of the gross final consumption.

introduction of further incentives for producing electricity from renewable energy sources, through a minimum threshold of renewable sources for each electricity producer.

Gross domestic consumption, in 2010, stood at 188 Mtep. As shown in Figure II.6, there was an upward trend from 1990, which peaked in 2005 and then turned downward, increasingly so since 2009, due to the global economic and financial crisis; in 2010 there has been a recovery of gross domestic consumption of 4.1%, compared to the minimum recorded in the previous year.

In 2010, gross domestic consumption stood at 188 Mtep.

The primary energy demand in 2010 stood at 188 Mtep.

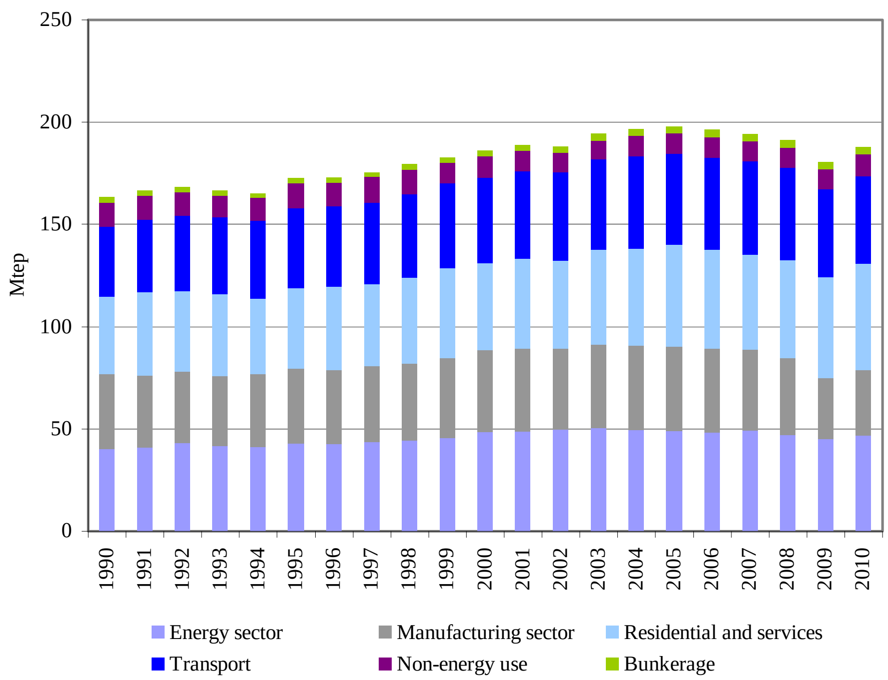


Figure II.6: Final domestic energy consumption by economic sector[15]

Agriculture

The relations between the environment, agriculture and forestry are very complex and, at times, contrasting.

On the one hand, agricultural land areas are increasingly encroached on, either directly by other production sectors (e.g., soil consumption), or indirectly, as a result of alterations in the physics and chemistry of the atmosphere or the occurrence of extreme weather events.

On the other hand, agricultural activities – which in the last few decades have intensified, concentrated and specialised land use and farming practises – are included among the principal causes of water pollution, diminished soil stability and soil pollution and soil acidification, the greenhouse effect, the loss of biodiversity, landscape simplification and the diminished well-being of livestock.

Undoubtedly, agriculture, besides ensuring a good capacity of production of foodstuffs, timber and fibres, can also play an

Agriculture plays an important environmental

[15] Source: Ministry for Economic Development

important role – if properly executed – in protecting the environment, preserving the biological and genetic diversity of ecosystems and species, reducing pollution and soil/water deterioration.

protection role.

In particular, in recent years, the complexity of the relations between the environment, agriculture and forestry has been enhanced by the appearance of a number of significant challenges: producing more food, fibres and timber for an increasing population, which is increasingly concentrated in the urban centres, with declining numbers of workers in the rural areas; supplying biomass for producing energy for a potentially enormous market; contributing to the development of the poorer countries, which largely depend on agriculture.

The Italian agriculture and forestry sectors, due to the unceasing process of globalization and expansion of international trade, cannot escape these challenges and must take some difficult decisions.

On the one hand, there is the need to respond to the growing demand of "conventional" and "new" quality products (including biofuels), on the other hand, it is necessary to increasingly integrate the environment and sustainability in the management and production systems.

In the last few decades there has been a significant drop, in Italy, of both farm enterprises and, to a lesser extent, the UAA.

In the last few decades, in parallel with the stagnation of the population and of demand for agricultural products, with the migration from rural areas and the increase of productivity per unit area, there has been in Italy a significant reduction of both the number of farm enterprises and the utilised agricultural area (UAA).

In particular, based on the provisional data of the Agriculture Census of 24 October 2010, it emerges that in Italy there are 1,630,420 active farm/livestock enterprises (-32% compared to 2000) and the Utilised Agricultural Area amounts to 12,885,186 hectares (-2.3 compared to 2000).

Over half the farm enterprises (54.6%) is concentrated in 5 regions.

The number of farm enterprises has dropped, while the average size of the enterprises has risen from 5.5 hectares of UAA in 2000 to 7.9 hectares in 2010. The drop has been most significant in the case of farm enterprises with less than 1 hectare UAA, which have dropped, in the decade, by over 50%.

Over half the farm enterprises (54.6%) are concentrated in the following 5 regions: Puglia, Sicily, Calabria, Campania, Veneto.

Table II.3: Farm enterprises and Utilised Agricultural Area (UAA) by Region[16]

REGION	Farm Enterprises		% change	UAA		% change
	2010	2000		2010	2000	
Piedmont	66.930	106.969	-37,4	1.048.350,45	1.068.872,59	-1,9
Aosta Valley/ Vallée d'Aoste	3.520	5.981	-41,2	55.384,41	71.120,32	-22,1
Lombardy	54.107	71.350	-24,2	984.870,55	1.039.592,36	-5,3
Liguria	20.121	37.340	-46,1	43.033,35	63.834,79	-32,6
Trentino-Alto Adige	36.666	51.456	-28,7	380.502,92	414.115,72	-8,1
Bolzano/Bozen	*20.238*	*23.150*	*-12,6*	*243.519,27*	*267.386,15*	*-8,9*
Trent	*16.428*	*28.306*	*-42,0*	*136.983,65*	*146.729,57*	*-6,6*
Veneto	120.735	178.404	-32,3	806.319,31	851.275,55	-5,3
Friuli-Venezia Giulia	22.327	33.302	-33,0	219.909,72	237.969,86	-7,6
Emilia-Romagna	73.441	106.363	-31,0	1.066.773,17	1.129.317,92	-5,5
Tuscany	75.459	122.409	-38,4	755.295,11	855.805,89	-11,7
Umbria	36.201	52.035	-30,4	327.868,41	366.452,41	-10,5
Marche	46.373	61.323	-24,4	473.063,85	492.595,95	-4,0
Lazio	98.026	191.205	-48,7	648.472,52	721.051,18	-10,1
Abruzzo	66.854	76.906	-13,1	449.988,65	431.081,32	4,4
Molise	27.427	31.667	-13,4	196.527,69	214.626,18	-8,4
Campania	136.867	234.721	-41,7	547.464,53	586.059,65	-6,6
Apulia	275.633	336.697	-18,1	1.280.875,86	1.247.577,83	2,7
Basilicata	51.772	76.034	-31,9	512.280,88	537.532,79	-4,7
Calabria	137.699	174.693	-21,2	551.404,94	554.848,84	-0,6
Sicily	219.581	349.134	-37,1	1.384.043,04	1.279.717,80	8,2
Sardinia	60.681	107.464	-43,5	1.152.756,54	1.019.957,81	13,0
ITALY	**1.630.420**	**2.405.453**	**-32,2**	**12.885.185,90**	**13.183.406,76**	**-2,3**
North-West	**144.678**	**221.640**	**-34,7**	**2.131.638,76**	**2.243.420,06**	**-5,0**
North-East	**253.169**	**369.525**	**-31,5**	**2.473.505,12**	**2.632.679,05**	**-6,1**
Centre	**256.059**	**426.972**	**-170.913**	**-40,0**	**2.204.699,89**	**- 231.205,54**
South	**696.252**	**930.718**	**-234.466**	**-25,2**	**3.538.542,55**	**- 33.184,06**
Islands	**280.262**	**456.598**	**-176.336**	**-38,6**	**2.536.799,58**	**237.123,97**

Note:
Surface in hectares

The UAA is used for the following purposes, in order of importance: crops, permanent grasslands and pastures, fruit trees and shrubs. Livestock breeding farms too have dropped in number, although their average size has increased; 59.2% of livestock farms breed cattle. About 70% of the cattle stock is located in the Northern regions of Lombardy, Veneto and Piedmont.

The UAAs are used primarily for growing crops.

Transport and mobility

With regard to the modes of transport in Italy, freight transport, which had featured a constant growth until 2007, started dropping from 2008, unlike passenger transport, which has featured an alternating trend, remaining stable between 2005 and 2008 and then rising in 2009 (+4%) and dropping in 2010 (-2%). In particular, in 2010, overall domestic freight traffic – estimated in slightly over 211 billion tonnes-km[17] (approx. 254 billion tonnes-km, if we also consider the domestic and international transport of freight by road, using vehicles with a cargo carrying capacity of at least 3.5 tonnes[18])

[16] Source: ISTAT
[17] With regard to road freight transport, the minimum distance travelled taken into account is 50 km
[18] See the indicator called “Freight transport demand and intensity” - Chapter 3 Transport – Environmental Data Yearbook 2011

– dropped by 2.8% compared to 2004. The analysis of freight traffic data by mode of transport, besides confirming the absolute predominance of road transport, which, in 2010, accounted for 63.3% of overall carried freight (in tonnes-km), also highlights a growth, between 2004 and 2010, of approx. 2 percentage points, to the detriment of rail transport, which has dropped by 3 percentage points. In the same year, the percentage breakdown of other modes of transport was: 23% by waterway; 13.1% by rail and oil pipeline; 0.46% by air, which continues to represent an almost neglectable proportion of domestic freight transport, due to the fact that it is used primarily for international transport (Figure II.7).

In 2010 there was an absolute predominance of freight transport by road (63.3%).

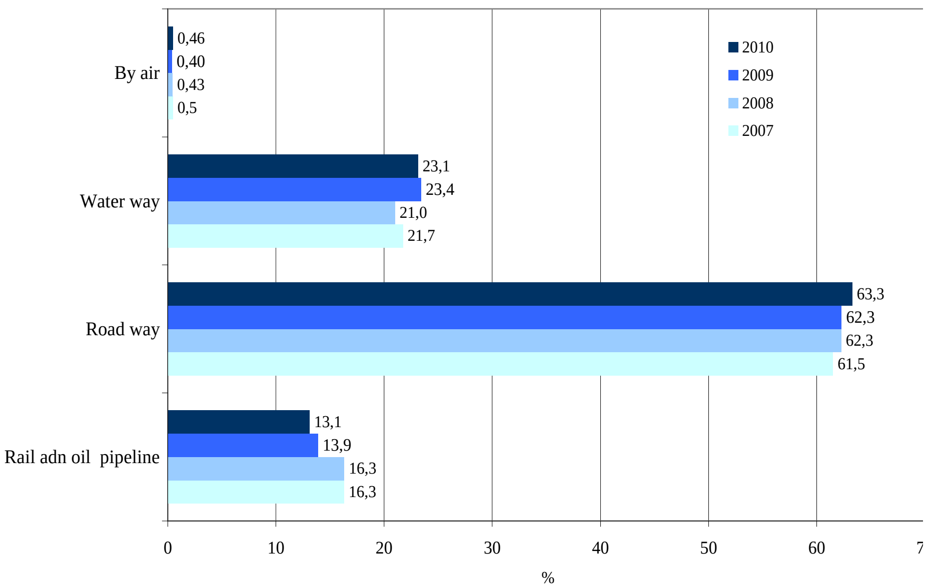
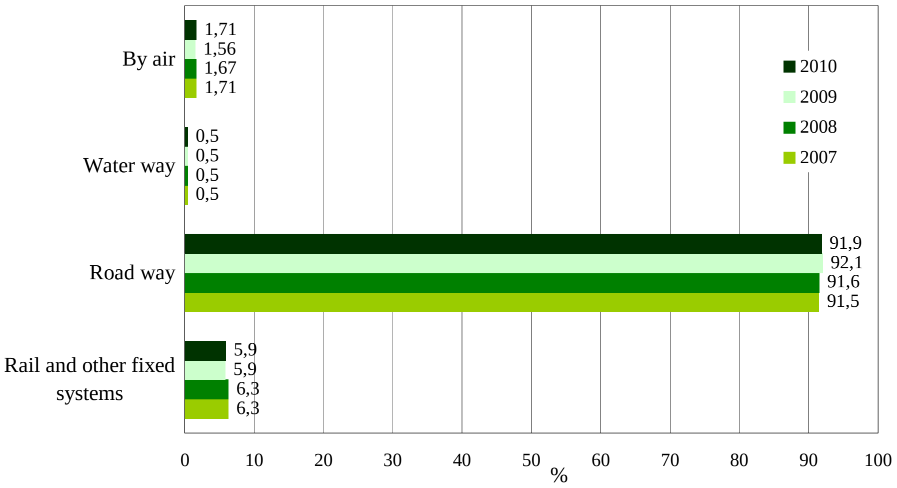


Figure II.7: Percentage breakdown of domestic freight traffic by mode of transport[19]

A detailed examination of domestic passenger transport, which in 2010 approached 919 billion passengers-km carried, shows that, despite the alternating trend between 2007 and 2010, the percentage breakdown by mode of transport has remained practically unchanged, with a predominance of road transport at 91.9%. The full breakdown is: 5.9% by rail and other fixed systems, 1.7% by air and only 0.5% by waterway (Figure II.8).

In 2010, road transport accounted for 91.9% of all domestic passenger transport.

[19] Source: CNT data (2009-2010) processed by ISPRA



In 2010, road transport accounted for 91.9% of all domestic passenger transport.

Figure II.8: Percentage breakdown of domestic passenger traffic by mode of transport[20]

Moving on to a more detailed analysis of traffic by mode of transport, a number of different situations can be highlighted. In particular, the data for airport traffic between 2004 and 2010, based on the movements of aircraft in connection with (domestic and international) commercial air transport, feature an alternating trend; after peaking in 2007 (1,532,987 movements), in fact, airport traffic drops until 2009 (-9.8%) and then rises again in 2010 by 3.7%[21].

Airport traffic grew in 2010 by 3.7%.

Analysing vehicle traffic over the long term – 1990-2010 – (Figure II.9), one can notice an increase in the kilometres travelled by light and heavy vehicles on Italian motorways of approx. 60.3%. This sharply growing trend continued until 2007, after which it stabilised at about 83 billion vehicles/km[22].

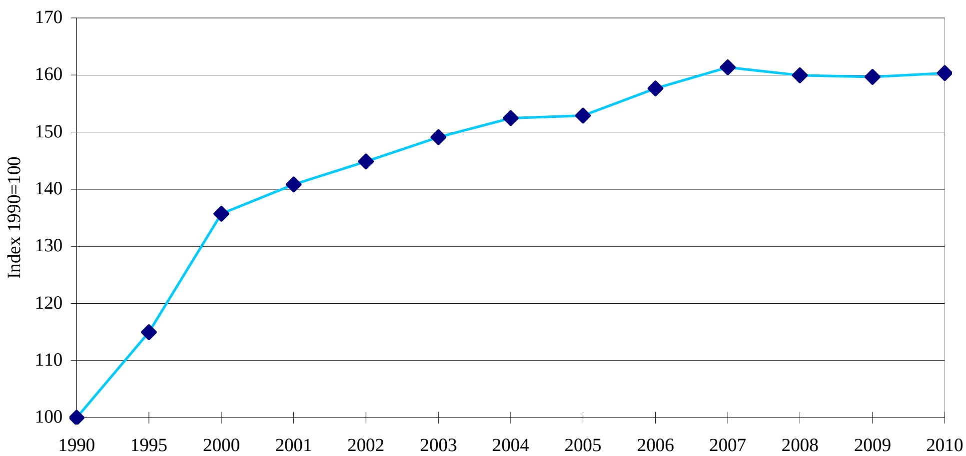


Figure II.9: Road traffic trend on the motorway network (1990-2010)[23]

[20] *Ibidem*
[21] ENAC data
[22] AISCAT data
[23] Source: AISCAT data processed by ISPRA

With regard to rail traffic, in 2009, 314 million passenger trains-km travelled on the network of lines of Ferrovie dello Stato (+5.2% compared to 2004) and approx. 42.7 million freight trains-km (-32.5% compared to 2004). In particular, in 2009 there was a sharp reduction compared to 2008 of freight rail traffic (26.7%), due to the economic crisis.

In 2009, freight rail traffic dropped by 26.7%.

To better understand the pressure exercised in our country we also need to examine the situation of the existing means and infrastructure.

At 31 December 2009, the national primary road network (not including minor roads at municipal level) was 180,549 kilometres long, broken down as follows: 6,661 km of motorways, 19,375 km of other roads of national significance, and 154,513 km of regional and provincial roads, up by approx. 7.65% since 2000.

At 31 December 2009, the national primary road network (not including minor roads at municipal level) was 180,549 kilometres long.

With regard to road traffic statistics in Italy, AISCAT (Associazione Italiana Società Concessionarie Autostrade e Trafori) provides data relating to traffic volumes on the motorway network collected through ongoing traffic surveys (5,523.2 km at 31 December 2010), based on which it can be observed that, in 2010, the theoretical average daily vehicles were 41.3 million (just below the figure for 2009, equal to 41.4 million), of which 32 million light vehicles (77.5%) and 9.3 million heavy vehicles (22.5%).

The railway network in 2009 was approx. 20,134 km long, up by 717 km compared to 2000. The electrified and double-track lines have increased by 10.2% and 23%, respectively.

The available data also highlights a significant nationwide port and maritime infrastructure. In particular, at 31 December 2010, there were 259 ports, with total quay length in excess of 415 kilometres, with an average docking length of approx. 236 metres and of over 1.6 kilometres per port.

In 2010, maritime transport featured 1,761 dockings, up by 57.4% compared to 2001.

With regard to airport infrastructure in Italy, in 2008 there were 102 airports across the country, 47 of which for commercial traffic, with a total area of 308,338 km^2 and a land density of 6,400 km^2 [24].

In 2010, maritime transport increased by 57.4% compared to 2001. There are 102 airports across the country.

Tourism

Tourism is becoming increasingly important in people's lives, as they are willing to travel more for both leisure and business. The environment, natural attractions and the cultural heritage play a fundamental role in tourism demand and supply, which means that conservation is of the essence and effective planning and governance strategies need to be implemented to maintain and, possibly, enhance the attraction of Italy's many tourist destinations, while at the same time ensuring a respectful and sustainable development of tourism.

Internationally, in 2010, after a period of crisis, there was a 6.6% rise in tourist arrivals, which, however, was much lower in Europe (+3.3%), where the highest world tourist flow is concentrated (50.7% of all international arrivals).

In 2010, in Italy, the number of visitor arrivals and overnight stays

In 2010, in Italy, visitor arrivals and

[24] ENAC data, *Autorità per l'aviazione civile – Rapporto 2010*

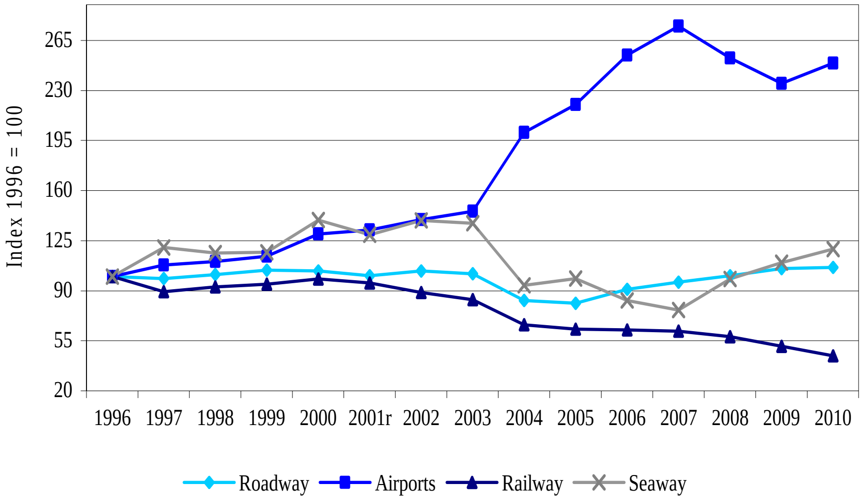
recorded by all types of tourist accommodation facilities increased by 3.5% and 1.3%, respectively. Tourists stayed on average 3.8 days, which figure is down slightly year-on-year, confirming the typical trend in recent years of shorter holidays.

overnight stays recorded by all types of accommodation facilities increased by 3.5% and 1.3%, respectively.

The weather is one of the key drivers of the seasonal nature of tourism demand, defining the length and quality of stays, and plays a fundamental role in the choice of destination and budget. In 2010, the seasonal tourist flows remain concentrated in the third quarter (with 50% of arrivals).

The economic crisis has negatively impacted travel by Italians, down by 12.3%; however, 64% of all leisure journeys are made by car. There has been a significant increase in maritime journeys (+29.2%). Italians continue to prefer air travel (16.9% of all journeys), thanks to low-cost flights, the huge number of available destinations, and, in part, the shift in attitudes towards holidays, with rising numbers taking short breaks. Regarding the means of transport used by foreign tourists to reach Italy, there has been a 2.2% increase of tourist flows recorded at border crossings, predominantly by sea (+8.5%) and air (+6.1%) (Figure II.10). Foreigners too, however, use the car as their preferred means of transport (65.9%).

As a result of the economic crisis travel by Italians is down by 12.3%.



Legend

r: the 2001 data relating to border crossings by road/air have been revised, following the improvement of the survey methods

Figure II.10: Changes in the number of foreign visitors at border crossings[25]

Tourism inevitably brings change; the request for environmental and cultural values and the desire to make new experiences can alter the social and environmental balance. The factors responsible for the pressure on the environment produce different effects, although a number of constants can be observed: large numbers of visitors, seasonal concentration of flows, use of more polluting means of transport, etc.. Moreover, a typical trait of large cities is becoming more and more manifest: to the problems caused by residents we must add those due to the fact that these are becoming extremely popular tourist destinations.

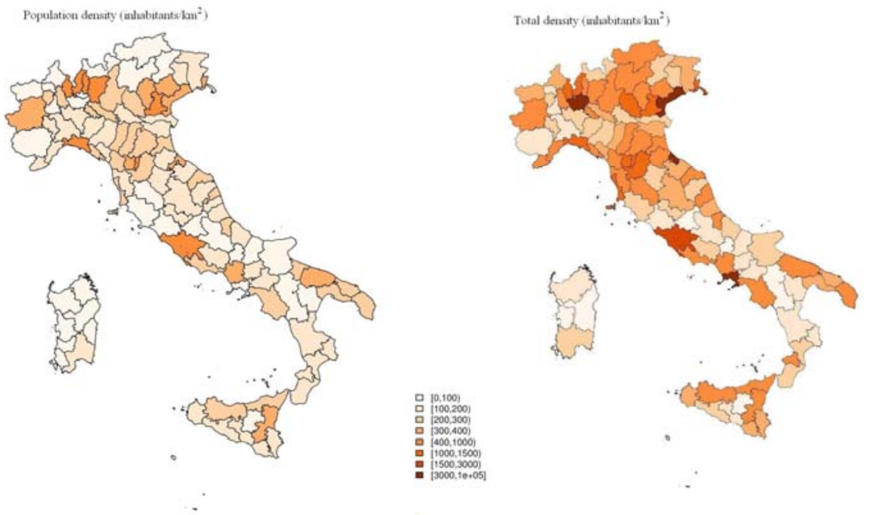
In some cases tourism can alter the social and environmental balance.

[25] Source: Bank of Italy data processed by ISPRA

Tourism flows can radically alter the population density in several Italian provinces; in normal circumstances cities like Florence, Venice, Rimini and Rome feature a density (considering only the resident population) of 284, 350, 382, 779 people/km^2, respectively, which then rises considerably with the arrival of tourists. In particular, Florence, whose population density is equal to that of provinces such as Livorno, Lodi or Lecce, while the presence of tourists contributes to increasing its density (1,485 people/km^2) to almost twice that of Rome (Figure II.11).

Tourists contribute to increase the population density of a small city like Florence to almost twice that of Rome.

Tourism flows significantly alter and increase the population density of the Italian provinces.



Note:
The map on the left "Residential density" classifies the Italian provinces according to eight classes of residential density; the map on the right "Total density" classifies the Italian provinces according to eight classes of total density (i.e. resident population + arrivals) / area in km^2. Observe the density changes in the provinces moving from the map on the left to that on the right.

Figure II.11: Changes in the population density of Italian provinces as a result of the tourism flows (2010)[26]

[26] Source: ISTAT data processed by ISPRA

Glossary

Biodiversity:
The set of genetically different living organisms and the related ecosystems.

Tertiarization:
The process whereby the economic system moves towards the predominance of the third sector (trade and services) compared to the other economic sectors.

Recession:
A macroeconomic condition characterised by a lower production output than could be achieved through the full and efficient use of all the available factors of production.

Gross Domestic Product:
The total value of the goods and services produced in a country over a certain period of time, usually a year.

Added value:
Measures the increase in value, with respect to the production and distribution of goods and services, thanks to the input of production factors such as capital and labour.

Cogeneration:
Also combined heat and power, the simultaneous production, by means of a single process, of heat and electricity and/or mechanical energy.

Globalisation:
A process whereby markets and production become increasingly interdependent, by virtue of the exchange of goods and service and the movement of capital and technology.

III. The environmental aspects of daily family life

Introduction

Today, information and communication concerning the environment represent important tools for political decision-makers, operators and ordinary citizens, for gaining knowledge and enhancing participation. Numerous institutional or other stakeholders are increasingly promoting an environmental culture, in order to make scientific and technical knowledge available to citizens, improving their awareness of and focus on the sustainability of their lifestyles and behaviour, both individual or collective.

43% of Italians aged over 15 years and 38% of Europeans do not consider themselves adequately informed on environmental issues.

Despite this, 43% (in 2007, 54%) of Italians aged over 15 years, and 38% (in 2007, 42%) of Europeans do not consider themselves adequately informed on environmental issues (*Eurobarometer* 2011[1]). It is worthwhile to note the importance given by Italians to information on the environment, being deemed the most effective means for tackling environmental problems, compared to other policy measures based on "positive" approaches, such as incentives, or "negative" measures, such as penalties or fines, or more restrictive laws and regulations.

This chapter, once again, presents the principal environmental characteristics of the daily life of the European and Italian populations and their "environmental" expectations, habits, knowledge, and priorities.

In particular, part one focuses on the opinions of Italian households regarding the country's priorities, showing the importance given by Italians to environmental problems at various levels: at the national level, at neighbourhood level and even at the level of the home. This is part of a more general discussion about how families represent one of the main sources of pressure on the environment in modern society. They act not only by generating direct pressures, but also by influencing the production of goods and services in their role as end consumers.

The consumption patterns of households (see chapter IV on "Household consumption patterns and the environment") and the recent and continual dissemination of new independent nuclei exert an effect, for example, on the production of waste and on the demand for electrical power, for new houses, and for gasoline for motor vehicles.

Household expenditure has become less focused on primary goods and more on highly processed products. That is, the demand for goods and consumables that lead to further consumption, such as household appliances, leisure time, communications, transport, is on the rise. On the other hand households are starting to dedicate more attention to the environment. More obvious signals are the choice of natural gas for heating the home, the increase in sales of energy-efficient household appliances and the ever greater interest shown in products with an eco-friendly mark.

[1] European Commission (2011) – *Special EUROBAROMETER 365 "Attitudes of European citizens towards the environment"*

In part two, some of the principal eco-compatible behaviours and habits of households are observed: from mobility, and the related environmental pressures, to separate waste collection.
In part three there is a short overview of the perception and degree of awareness of Italian and European citizens, with respect to two among the most recent environmental issues, which are the subject of current international debate, such as the efficiency of natural resources and the safe use of chemicals.
The data analyzed comes mainly from European and national studies aimed at measuring the opinions, attitudes and behaviour of the Italian population (households or individuals) with regard to the environment and its problems.

The environmental priorities of households

Among the country's macroproblems taken as top-priority by persons fourteen years of age and older, in 2010, "environmental problems" were considered such by only 15% of the population, although slightly up compared to 12.8% in 2009 (figure III.1). This figure, which is still rather small if compared to the cross-sectoral importance and global nature of the environment, is the result of the (slightly) increased interest shown by women (15.1%), more than by men (14.8%). It is precisely this cross-sectoral and global nature of the topic that leads the population in thinking that other problems have higher priority, because they are more material to and present in their daily lives, problems such as unemployment (80.1%), crime (52.1%) and immigration from non-EU member countries (25%).

Only 15% of Italians consider "environmental problems" as a top priority..

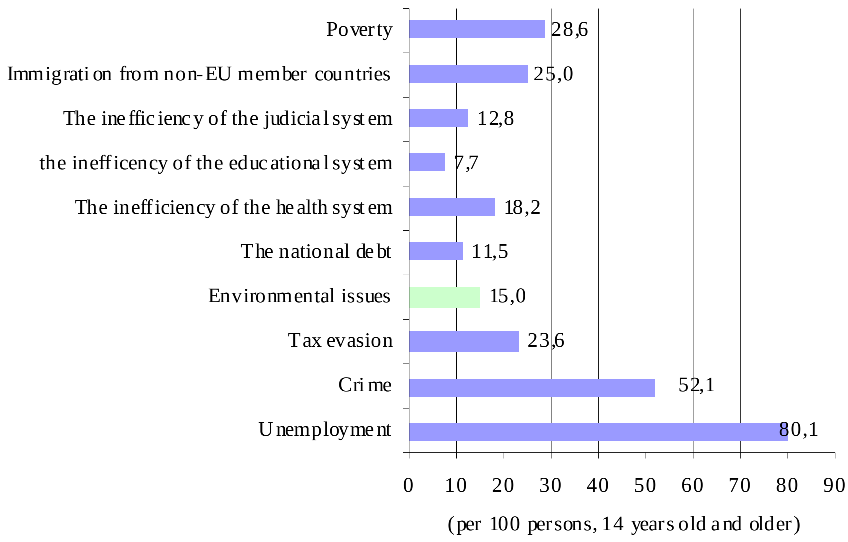


Figure III.1: Opinion expressed by persons aged over 14 about the country's top-priority problems (2010)[2]

Just as in 2009, in 2010 too it was the very young (14-17 years),

The very young (14-

[2] Source: ISTAT data processed by the ISPRA –Annual *Multiscope* survey on families: "Aspects of daily life"

people living in the South and students featured the highest percentages of those who consider environmental problems as the highest priority: 22.4% of the population in the 14-17 age group, 17.4% of the population of the South and 21.4% of the student population. At the regional level, as in 2009, it was still the non-urban population that featured the highest percentages of those who consider environmental problems to have top priority (21.9% of the non-urban population), probably owing to the waste-disposal emergencies affecting non-urban areas over the past years.

17 years), people living in the South and students featured the highest percentages of those who consider environmental problems as the highest priority.

In more detail, from the analysis of the country's top-priority problems to the characteristics of the neighbourhood in which people live - an important aspect of the overall quality of life of families - the most deeply felt problems can be understood.

In this regard, in 2010, the problems that most concerned Italian households feature several aspects regarding environmental problems, such as traffic (42.6%), air pollution (38%) and noise pollution (32.9%), which rank 2nd, 4th and 5th, respectively, among the top ten problems perceived as very or excessively present in their neighbourhood (figure III.2). Furthermore, referring to the sphere of the environment and in particular to the topic of "waste", at the bottom of the league table are rubbish in the streets (30%) and unpleasant odours (19.6%).

Traffic (42.6%) ,air pollution (38%), and noise pollution (32.9%) are the environmental problems most deeply felt by families in the neighbourhood in which they live.

A good five of the ten principal problems listed by families as affecting the neighbourhood in which they live are of an environmental nature

Figure III.2: Families that consider as very or excessively present several of the problems affecting the neighbourhood in which they live in by type of problem (2010)[3]

The environmental issues shown above are most perceived in provincial capitals with metropolitan status. In particular, in the geographic distribution of the problems it is the South that has the largest share of households reporting the presence of noise (37%), while it is the Islands that prevalently complain about filth in the streets (35.3%). The North-west reports for the most part air-pollution problems (45.3%) and unpleasant odours (21.3%), while

The environmental problems affecting residential neighbourhoods are most perceived in provincial capitals with metropolitan

[3] Source: ISTAT data processed by the ISPRA –Yearly *Multiscope* survey on families "Aspects of daily life".

pollution problems (45.3%) and unpleasant odours (21.3%), while the Center reports the most traffic problems (46.5%).

metropolitan status.

Confirming how much the environmental problems of cleanliness, or more in general pollution of the cities, are perceived as having high priority by Italy's population, we note too a very recent (2011) European survey of the *Eurobarometer*[4] series, aimed at measuring the opinions, the attitudes and the behaviours relative to the environment of the citizens of the EU's 27 Member States. First of all, it is important to note that, for 85% of Italians, the "declare of the environment" influences quality of life, although as yet a little less than do economic aspects (89%) and a little more than social aspects (82%). Furthermore, 51% of the replies provided by the Italian sample in this European survey (considerably higher than the mean value for EU27, which is 39%, and that of all 27 European countries considered) immediately associate urban pollution with the generic topic "the environment". Hence the Italians' concern that the quality of their lives can be put at risk by environmental pollution.

For 85% of Italians the "declare of the environment" influences quality of life.

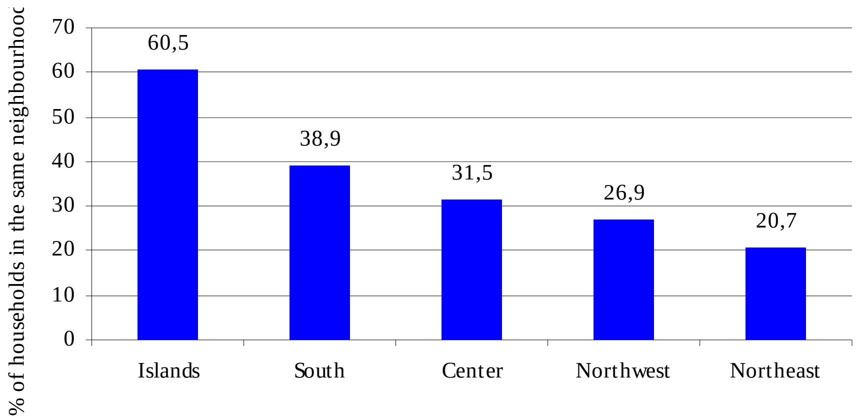
That same survey brings out the environmental problems that Italians take most to heart, worrying them not a little, such as: human-caused catastrophes, such as oil dumped into the sea, and industrial accidents (40% Italy, 42% EU27), water pollution (36% Italy, 41% EU27), air pollution (36% Italy, 36% EU27), the constant increase in the amount of waste (32% Italy, 33% EU27), the impact on health of the chemicals in products of daily use (31% Italy, 34% EU27%), and natural disasters (earthquakes, floods, etc.) (31% Italy, 31% EU27).

The environmental problems that most worry Italians are: catastrophes caused by man (40%), water pollution (36%) and air pollution (36%)

Continuing in the analysis of the priorities most deeply felt by households, at an increasing level of detail, i.e. from the neighbourhood to the home, we can once again observe certain issues that are closely related to the environment or to its management. In particular, 10.8% of households view irregularities in water supply (in the Islands 23.9%) and a good 32.8% do not trust tap water. This lack of confidence in the quality of drinking water, up year on year, is particularly widespread in the South (38.9%) and especially in the Islands (60.5%) (Figure III.3).

10.8% of households see irregularities in the supply of water and a good 32.8% do not dare drink water from the tap

[4] European Commission (2011) – *Special EUROBAROMETER 365 "Attitudes of European citizens towards the environment"*



60.5% of Island households declare that they do not trust the quality of tap water.

Figure III.3: Households declaring that they do not trust tap water, by geographic area (2010)[5]

The eco-compatible behaviour of households

Although people often declare that they are "for" the environment and its protection, we need to become truly acquainted with the concrete actions that people take in this regard. To this end, based on the recent European survey on the environment, we can understand how European citizens in general, and Italians in particular, address this issue. Most Europeans declare that they predominantly carry out separate waste collection (66% EU27, 58% Italy), that they reduce their energy consumption (53% EU27, 41% Italy) and water consumption (43% EU27, 33% Italy).

Most Europeans declare that they mostly perform so-called "passive" actions, i.e. directly linked to their normal daily activities.

For example, separate waste collection (66% EU27, 58% Italy), the reduction of their energy consumption (53% EU27, 41% Italy) and of water consumption (43% EU27, 33% Italy).

These three actions, principally performed by European citizens, are directly linked to the ordinary activities of daily life and could be described as "passive" actions. In the sense that separate waste collection is already a practice institutionalized in many countries, just as parallel motives, such as economic savings, can be linked to saving energy and water, especially in particular contexts where energy costs are rising. Considered to be "pro-active" actions, instead, that is actions that demand choices or initiatives truly linked to environmental motivations; the non-intense use of the automobile, affirmed by 20% (11% of Italians) of the population forming the subject of the survey (older than 15 years), a consumption more sensitive to the environment in terms of both the purchase of eco-compatible products (17% EU27, 14% Italy) and of the purchase of local products (28% EU27, 25% Italy) (Figure III.4).

[5] Source: ISTAT data processed by the ISPRA –Yearly *Multiscope* survey on families "Aspects of daily life".

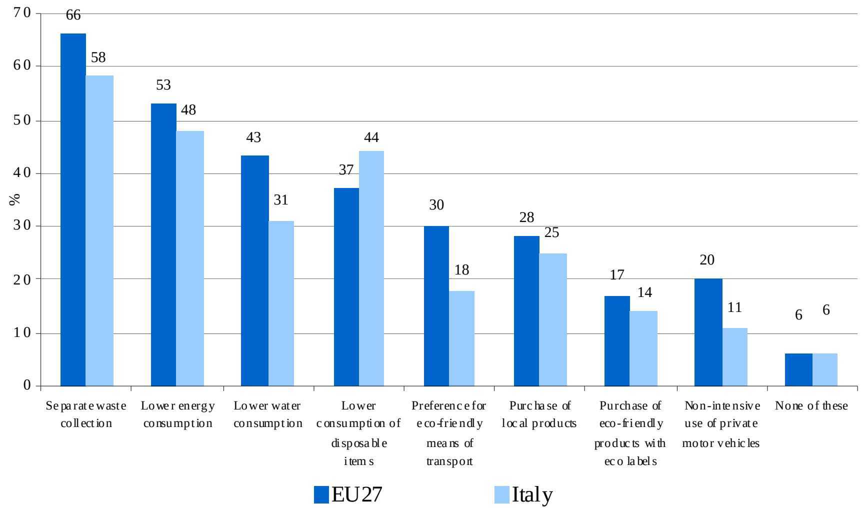
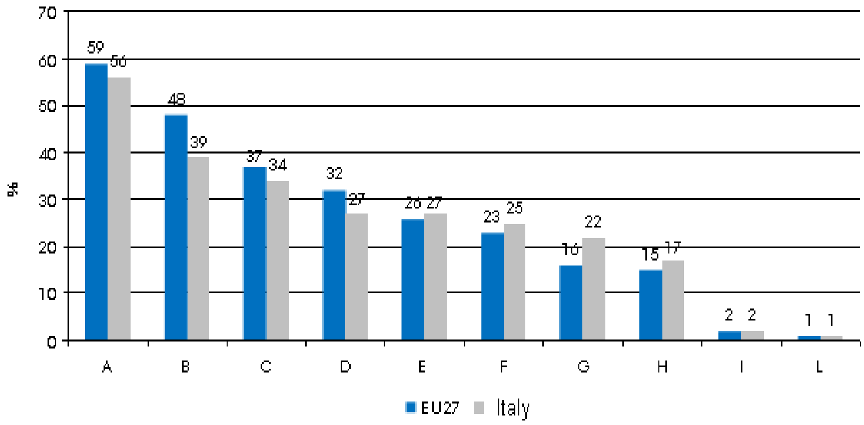


Figure III.4: **The percentage of replies to the question: "During the last month, did you perform one of the following actions for environmental reasons?"[6]** *(possible multiple responses)*

So-called "pro-active" actions, i.e. those requiring decisions/initiatives that are effectively linked to environmental motives, were carried out by a low proportion of European citizens. These actions are: the non-intensive use of private motor vehicles, more environmentally sensitive consumption, in terms of the purchase of both eco-friendly and local products.

Of equal interest are the replies provided, at the European and Italian levels, to the question complementary to that on the actions taken for environmental reasons, that is, the question on the top-priority actions that European citizens should take to safeguard the environment. Consistently with the replies given concerning the actions undertaken in daily life, at the European level, the two principal priorities are the separate waste collection (59% EU27, 56% Italy) and the reduction of energy consumption (48% EU27, 39% Italy) (Figure III.5).

6 Source: European Commission data (2011) processed by the ISPRA – *Special EUROBAROMETER 365 "Attitudes of European citizens towards the environment"*



According to Europeans, the citizens of the Old Continent should safeguard the environment prevalently by separately collecting waste (59% EU27, 56% Italy) and reducing energy consumption (48% EU27, 39% Italy).

Legend:
A= Separate the waste that can be recycled
B= Cut home energy consumption (power, heating, appliances)
C= Make more use of public transport over the private car.
D= Reduce waste, for example by the purchase of large amounts of product, or of concentrated or second-hand products, or by not purchasing packaged products, etc.
E= Purchase local products rather than those coming from outside.
F= Purchase eco-compatible products for daily needs.
G= Replace the private car with models having greater energy efficiency , even if smaller or more expensive.
H= Take into account environmental aspects when making large expenditures (e.g. trips, motorcars, heating systems, construction of houses, etc.)
I= Pay a little more taxes to protect the environment
L= None of these

Figure III.5: Percentages of replies to the question "Indicate a maximum of three of the following priorities as the principal actions that a European citizen should perform to safeguard the environment" [7] *(max. 3 replies)*

Italian households caught between the need for mobility and the environmental problems it causes

Based on a Multiscope survey conducted by ISTAT in 2010 on aspects of daily life of Italian households, information can be also be got regarding the relationship between Italian households and transport, or mobility in general, whether in terms of the diffusion of means of transport or of the perception of the problems linked to them.

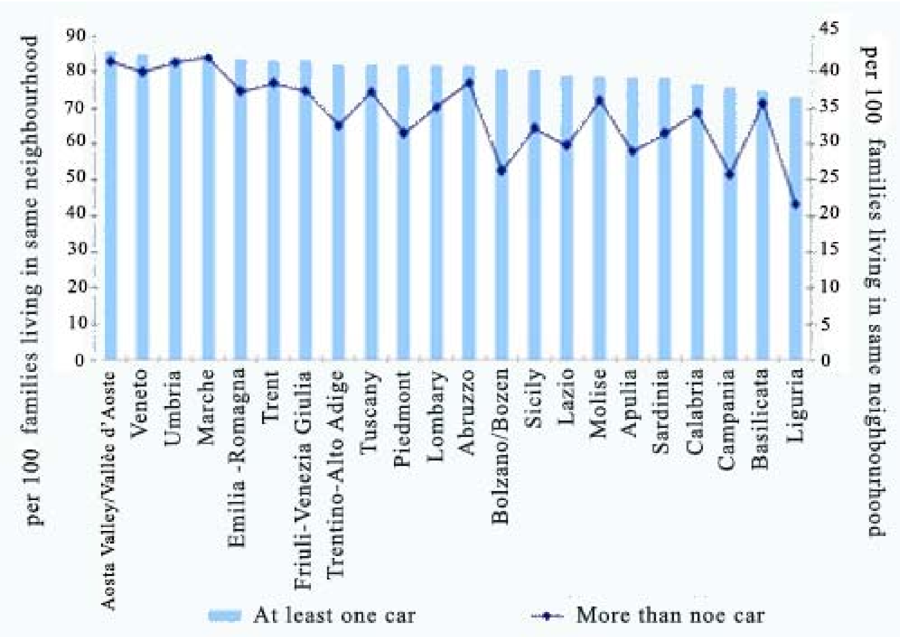
Based on Figure III.2, regarding the major concerns of households with respect to the main problems faced in their neighbourhood, we can also understand non-strictly-environmental problems, concerning transport or individual mobility in general, such as: traffic, poor road conditions, dim street lighting, difficulties in parking and the inefficiency of public transport. These conditions are sources of both mental and physical stress and of acoustic and air pollution, exerting a negative influence on the quality of life.

All of these: traffic, poor road conditions, dim lighting, difficulty in parking and the inefficiency of public transport are considered the principal problems in the local neighbourhoods.

[7] Source: European Commission data (2011) processed by the ISPRA – *Special EUROBAROMETER 365 "Attitudes of European citizens towards the environment"*

Furthermore, despite the well-known fact of how much the massive mobility of individuals and the presence of transport infrastructures and of vehicles generate problems of congestion and land occupation and, especially in urban centers, air and noise pollution as well, in 2010 – in line with 2009 – 80.7% of households declared that they owned at least one car; while 33.4% declared that they owned more than one (Figure III.6).

80.7% of Italian households declare that they own at least one car and 33.4% declare they own more than one.



Region by region, the percentage of households declaring they own at least one car, ranges from 85.8% in Val d'Aosta to 73.2% in Liguria.

Figure III.6: Regional distribution of households declaring they have a car (2010)[8]

In terms of individual behaviours in the choice of means of transport the predominant role falls to the private car. In 2010, 70.8% (69.3% in 2009) of those employed older than 15 years who leave the house to go to work use the car as drivers (76.8% in towns of up to two thousand inhabitants); 5.6% (5.3% in 2009) as passengers and 3.9% (4.4% in 2009) move around with motorcycles or motorbikes. Only 12.9% (13.3% in 2009) use public transport (trains, trams and buses, subways, intercity coaches). 38.5% (37.3% in 2009) of students (kindergarten children, grade school and students up to 34 years of age) instead, when they leave the house to go to school or the university, choose public means, 36,8% (36,3% nel 2009) use the car as passenger 5.4% (same as in 2009) take the car as driver, 2.5%, 82.8% in 2009), take the motorscooter and 2.2%, (2.5% in 2009) ride the bicycle.

In terms of individual behaviours in the choice of means of transport there emerges the predominant role of the private car.

[8] Source: ISTAT data processed by the ISPRA – Yearly Multiscope Survey on families "Aspects of daily life"

Italian households and separate waste collection

Proportionally to the increased well-being of modern-day society there has been a considerable increase in the amount of consumption, and of the resulting waste. In other words, the considerable increase in consumption by society has generated wastage. The wastage of resources translates into waste, which are one of the principal pressures on the environment. The problem of the disposal of solid urban waste is in fact, closely linked to the quality of consumption of households and directly depends on the available resources.

The increase in well-being determines the proportional increase in the amount of consumption and, therefore, of the resulting waste.

Separate waste collection is one of the "ecological" practices most greatly promoted by those who see to waste, together with the reduction of the waste themselves, through the operations of re-use, recycling and energy recovery of many processes. If properly carried out, such actions can bring about favorable conditions for sustainable development and the safeguarding of the natural environment for whatsoever territory.

In 2010 there was an increase over 2009 in the number of households declaring that they regularly separate the different types of waste, using the dedicated bins and bins. This confirms the trend starting in 2001. The share of those who express a positive opinion on the availability of bins for separate waste collection has remained stable.

Among the various types of waste taken into account, in 2010 there was a more widespread separate collection for glass (73.9%), paper 72.7%) and plastic (68.4%), followed by organic waste (65.3%), aluminium cans (61.6%), pharmaceuticals (55.4%) and batteries (51.7%).

Table III.1: Households declaring that they perform separate waste collection by frequency and type of waste[9]

In 2010, it is observed that among Italian households there was an increase in separate waste collection for glass (73.9%), paper (72.7%) and plastic (68.4%).

Type of waste	Separate waste collection																	
	Always									Sometimes								
	2001	2002	2003	2005	2006	2007	2008	2009	2010	2001	2002	2003	2005	2006	2007	2008	2009	2010
	per 100 households																	
Paper	52.6	54.5	55.3	56.5	58.6	60.7	65.9	70.6	72.7	17.2	16.2	16	15.5	14.6	15.9	13.7	12.5	11.4
Glass	56.3	57.1	57.4	59.6	60.4	62.9	67.2	71.6	73.9	17.3	16.3	16.5	14.8	14.6	15.1	12.9	12	10.9
Pharmaceuticals	39.6	41.6	40.6	43	45.8	46.7	48.8	53.1	55.4	17.4	16.5	16.7	16	14.7	16.8	16	16.2	15.6
Batteries	36.5	38.1	37.5	39.2	42.8	43.4	45.5	49.5	51.7	15.4	14.9	15.1	14.8	12.8	15.4	14.5	15	14.9
Aluminum cans	34.4	37	37.6	40.2	43.2	47.2	52.2	57.3	61.6	14.5	13	14.1	12.7	11.8	13.6	12.6	11.9	11.3
Plastic containers	46.9	48.1	49.6	52.1	53.8	55.6	60.1	64.7	68.4	14.2	13.3	14.1	12.4	12.2	13.8	11.7	11.2	10.1
Organic waste	44.8	45.8	46.4	47.4	50.5	53.6	56.4	61.9	65.3	7.9	7.7	8.5	7.8	7.7	9	8	7.7	6.9

Separate waste collection features obvious specific geographical differences, for the various types of waste. In fact, the regular

Regular separate waste collection of

[9] Source: ISTAT – Yearly Multiscope survey on families "Aspects of daily life"

[10] Source: ISTAT data processed by the ISPRA – Yearly Multiscope survey on families "Aspects of daily life"

separation of paper and glass reaches values above 88% in the North, around 64% in the Center, around 60% in the South, and only 48% in the Islands.

features obvious specific geographical differences for the various types of waste.

Instead, the separate collection of batteries is at the bottom of the list in all the macroregions, while being regularly performed by 72.2% of the households in the Northeast and only by 28.4% of households in the Islands (Figure III.7)

The regular separation of paper and glass reaches 88% in the North, around 64% in the Center, 60% in the South, and only 48% in the Islands.

The separate collection of batteries is the least practiced by households in all the geographic macroregions.

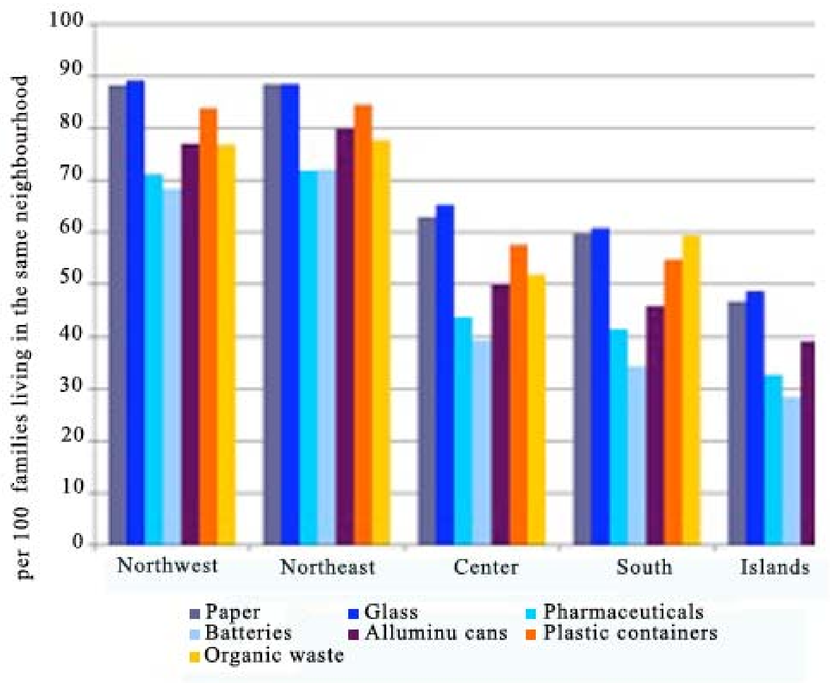
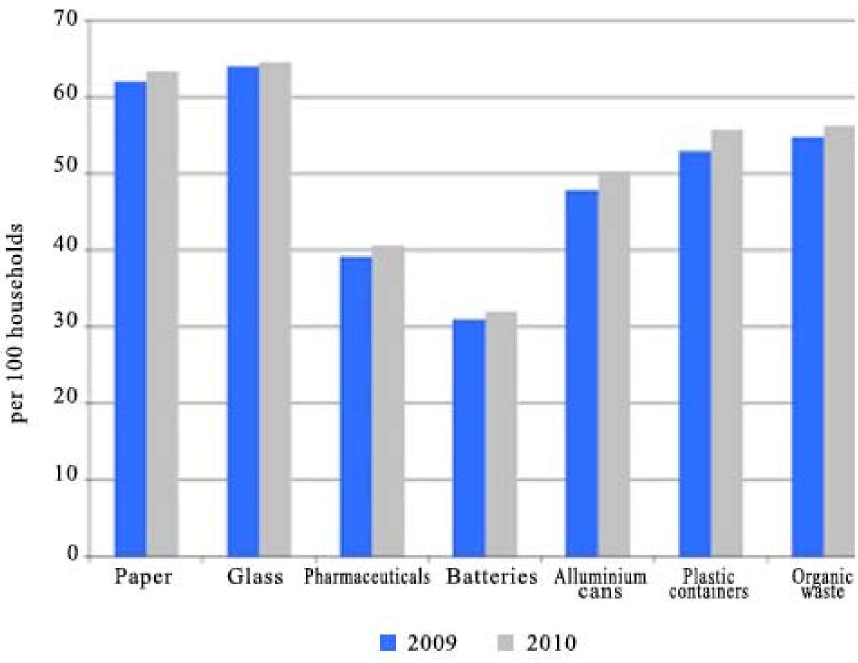


Figure III.7: Households declaring that they separate their waste on a regular basis, by geographic area (2010)[10]

As for the availability of the bins for separate waste collection, the most easily available are those for glass (64.6%), paper (63.4%), organic waste and plastic (56.3% and 55.7% respectively). Compared to 2009, the availability of bins has improved slightly for all types of waste (figure III.8)

The bins for separate waste collection most easily available are those for glass (64.6%), paper (63.4%), organic waste and plastic (56.3% and 55.7%, respectively).



Relative to 2009, availability underwent a feeble improvement for all types of waste.

Figure III.8: Households declaring that the bins for separate waste collection are easily available (2009-2010)[11]

Regarding the regular separation of waste, also as a result of the availability and accessibility of the dedicated bins, there are obvious geographical differences.

For example, the percentage of households that declare the bins for paper or glass are easily available range from 76.7% (paper) and 77.8% (glass) in the North-east, to only 39.4% (glass) and 37.9% (paper) in the Islands (Table III.2).

Table III.2: Households declaring that, in their neighbourhood, the separate waste collection bins are easily accessible, by geographic region (2010)[12]

Obvious geographical differences are found as well regarding the availability and accessibility of bins for the various types of waste.

	Easily available bins for the separate collection of:							
	Paper	Glass	Pharmaceuticals	Batteries	Aluminum cans	Plastic containers	Organic waste	Other
	per 100 households in the same neighbourhood							
Northwest	71.9	72.5	54	43.5	60.4	65	61.6	30.3
Northeast	76.7	77.8	49.3	46.1	69	70.6	71.3	34.1
Center	65.7	65.5	32.3	21.6	46.8	54.8	54.1	15.2
South	50.8	53.7	30.2	21	34.7	43.1	47.5	16
Islands	37.9	39.4	26.3	17.9	28	30.8	36.4	14.1
ITALY	**63.4**	**64.6**	**40.6**	**32**	**50.4**	**55.7**	**56.3**	**23.2**

[11] Source: ISTAT data processed by the ISPRA – Yearly Multiscope survey on families "Aspects of daily life"

[12] Source: ISTAT data processed by the ISPRA –Yearly Multiscope survey on families "Aspects of daily life"

As regards the types of city, it is found that bins for paper (74,8%), glass (73,9%) and for plastic (61,7%) are more accessible for families living in provincial capitals with metropolitan status, while on the outskirts of metropolitan areas, more easily accessible are bins for organic waste (64,2%) and aluminum cans (55%). In cities of up to two thousand inhabitants the most easily found bins are for pharmaceuticals (50,2%) and for batteries (45,2%).

Bins for paper (74,8%), for glass (73,9%) and for plastic (61,7%) are more accessible in the provincial capitals with metropolitan status.

Public opinion on the efficient use of resources and the safe use of chemicals

Public opinion on the efficient use of natural resources

The natural resources that lie at the base of the functioning of the economy and of our quality of life include such raw materials as fuels, minerals and metals, but also food, the soil, water, air, the biomass and ecosystems. Pressures on these resources are increasing. If current trends continue, by 2050 the world's population will have increased by 30%, reaching nine billion, and the emerging countries will be aspiring, legitimately, to a welfare and a level of consumption typical of the industrialized countries. As observed over the past few decades, an intensive use of the world's resources generates pressures on our planet and threatens the certainty of provisions even for the immediate future.

In order to give concrete responses to such scenarios, the European Union has identified in the efficient use of natural resources one of the seven principal (flagship) initiatives at the basis of the recent *Europe2020* European strategy. Its purpose is to guarantee a smart, sustainable and inclusive growth[13].

It is within this political and institutional discussion that the Flash Eurobarometer survey *European Attitudes towards resource efficiency* (Flash EB n.316/2011) is included. It provides information concerning the perceptions, attitudes and practices in such matters as efficient use of resources, efficient waste management, and efficient resource recycling.

Almost nine European citizens out of ten (87%) declare that Europe could make a more efficient use of natural resources. In Italy this opinion is held by 92% of the population older than fifteen years.

87% of European citizens declare that Europe could make more efficient use of natural resources.

Although in many Member States the larger part of those responding think that their own household does not produce too much waste, 41% of European citizens (38% for Italy) think otherwise.

As in the Italian survey, described in Section III.2.2, there also emerges from this European survey that a sizeable number of citizens (89% European, 91% Italian) claim that they regularly separate at least a part of their waste. Even if in 2009 the real level of separate waste collection in Italy was still only 33.6% of the total urban waste produced (see chapter 10 *The Waste Cycle*).

It is interesting to learn which initiatives could convince the population to separate more waste for recycling and composting purposes and what could lead those who declare that they do not separate their waste to begin doing so.

[13] COM(2010) 2020, EUROPE 2020 *A strategy for smart, sustainable and inclusive growth*

In this regard, for 76% of Europeans (86% Italians) the initiative that could most greatly influence the increase of separate waste collection would be the more better-quality sites for recycling and composting. The increase in door-to-door separate waste collection was indicated by 67% of Europeans (87% Italians), while 65% (82% Italians) think that better information on how and where to separately collect waste would be very persuasive. 59% of European citizens and a good 78% of Italians (the highest proportion among the 27 Member States) think that legal obligations could lead them to increase their amount of separate collection, while 39% of European citizens and 58% of Italians (the highest proportion among the 27 Member States) think that a waste management tax could produce the same result.

Better information and a better quality of the sites for recycling and composting waste are considered by 86% of Italians to be the most effective initiatives for increasing the number of persons practicing separate waste collection

In Italy, the following are considered to be the most effective initiatives for increasing the practice of waste separation: having more and better sites for recycling and composting waste (86%), improving separate collection at home (83%) and having more information on how and where to separate waste (82%). The aforesaid initiatives are considered by Europeans too as among the most effective but in lower percentages.

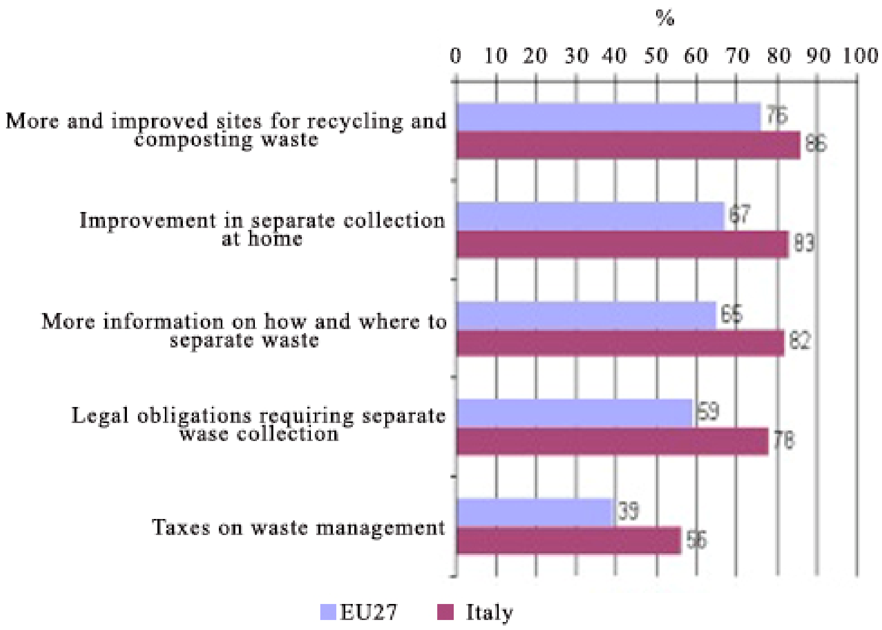


Figure III.9: Initiatives that could convince European and Italian citizens who already separate their waste, to separate even more[14] *(Possible multiple answers)*

In conclusion, based on the analysis of the national results surveyed in regard to the initiatives that would convince citizens to separate more waste, it appears that in such countries as, for example, Germany, Austria and Sweden, which have relatively more advanced waste management systems, and higher percentages of citizens who already separately collect their waste, those interviewed were less willing to think that the proposals suggested by the survey would convince them to separate yet more waste. Those interviewed in Bulgaria, Rumania, Cyprus and Italy, on the other hand, were more inclined to declare that a specific proposal would convince them to separate more. This is confirmed by the data featured above for Italy (with percentages often in excess of 80%).

[14] Source: European Commission data processed by the ISPRA – Flash Eurobarometer n.316/2011“Attitudes of Europeans towards resource efficiency”

In line with the above results described, as regards the question on the possible proposals that, according to the interviewees, would convince European citizens to increase their separate waste collection propensity, 70% of Europeans (87% of Italians) identified, as an initiative appropriate for improving the handling of waste in their own country, improvements to the quality of waste collection services. Furthermore, 65% of Europeans (80% of Italians) believe that a strengthening of the application of waste management regulations would have the same effect in their community, and a share of 63% of the Europeans (65% of the Italians) think that benefits could be obtained by having the producers pay for disposal and recycling. Finally, for 38% of Europeans (65% of the Italians – the highest percentage among the 27 Member States) requiring households to pay on the basis of the waste they produce would also be a practicable strategy.

70% of Europeans and 87% of Italians have identified as the initiative most appropriate for improving waste management in their country, the improvement of separate waste collection, in terms of quality of the service.

This preference for paying for waste disposal in proportion to actual household production is especially widespread throughout all European states, and in particular in Italy. In fact, 75% of European citizens and a good 83% of Italians would prefer to pay a waste disposal fee in proportion to the actual amount of waste produced by each household, rather than the current flat rate. Likewise, 59% of European citizens and 47% of Italians would prefer to include the waste disposal and management costs directly in the price of goods, rather than pay taxes.

75% of European citizens and a good 83% of Italians would prefer to pay a waste disposal fee in proportion to the actual amount of waste produced by each household, rather than the current flat rate.

Public opinion on the safe use of chemicals

In the past few years in Europe, in order to ensure the safe use of chemicals by citizens, which is indispensable for ensuring the well-being and a satisfactory standard of quality of life for the members of the public, the relevant laws have been subject to extensive review. In this regard, one of the most significant laws passed to regulate the use of chemicals in Europe is REACH (*Regulation, Evaluation and Authorization of Chemicals*" (EC/1907/2006). Of great importance in this respect is also the European *Eurobarometer* survey: *Consumer understanding of labels and the safe use of chemicals* (Special n. 360/2011), the purpose of which is, in fact, to analyse the opinions and perceptions of the public about the various categories of chemicals and their safe use.

Most European citizens have a negative opinion, or are worried by, "chemical products", considering them to be "dangerous", "harmful to the environment", "unhealthy", rather than viewing them positively as "useful" or "innovatory". In fact, 68% of Europeans and 67% of Italians consider chemicals to be principally "dangerous". For 63% of Europeans and 61% of Italians, they are "harmful to the environment". Only a minority of citizens automatically associate chemicals with their benefits. In fact, only 22% of Europeans and 9% of Italians consider them "useful", while 17% of Europeans and 12% of Italians deem them "effective" and fewer yet "innovatory".

Most European citizens have a negative opinion, or are worried by, "chemical products".

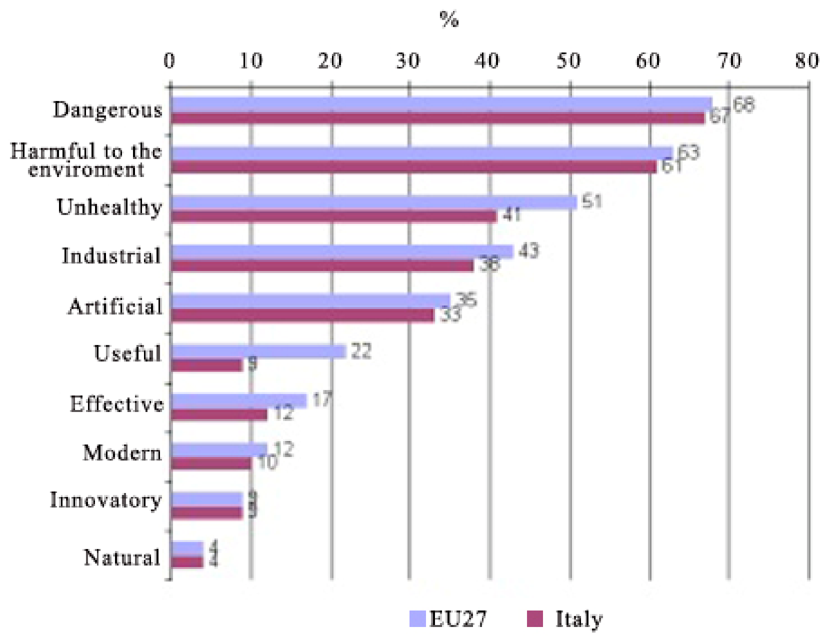


Figure III.10: Percentage of replies to the question "When you think of *chemicals* which of the following words come to mind?"[15] (possible multiple answers)

Most European citizens associate with "chemicals" negative or worrisome connotations or adjectives such as "dangerous" , "harmful to the environment", "unhealthy", rather than "useful" or "innovatory".

Also in terms of perception, it is worthwhile to note that many European – and Italian – citizens do not consider many products used on a daily basis when they think of chemicals.

Pesticides and insecticides are products that are most easily recognized as "chemicals". Exactly 75% of Europeans and 70% of Italians so recognize them. Detergents and other cleaning products are acknowledged as chemicals by 70% of Europeans and 58% of Italians, followed, with lower percentages, which entail a lower awareness, by gardening products (e.g. plant fertilizers) (59% EU and 49% Italy), "DIY products" (paints, etc.) (59% EU and 46% Italy) and, finally, car maintenance products (polishing wax, lubricants, etc.) (51% EU and 39% Italy)

Pesticides and insecticides are the products that are most easily recognized as "chemicals".

Regarding behaviours linked to safety in the use of chemicals, Italy (55%), together with Portugal and Spain, features the lowest percentages among those who declare that they read the safety instructions (warnings) to find out about a product's dangerousness. That same percentage (55%), which this time however does not rank last among the Member States, is found in Italy for those who declare they pay attention to the danger symbols.

In Europe, Italy (55%) features the lowest percentages among those who declare they use the safety instructions as a means for knowing whether a chemical is dangerous.

[15] Source: European Commssion data processed by the ISPRA – *Flash Eurobarometer n.360/2011"Consumer understanding of labels and the safe use of chemicals"*

Safety instructions for chemicals and danger symbols are the most widespread means at the European level among those that make it possible to learn whether a chemical is dangerous.

Figure III.11: Percentage of replies to the question "Which of the following do you use to know whether a chemical is dangerous?"[16] *(possible multiple answers)*

Reading and complying with warnings are also actions considered most necessary by 78% of Europeans (73% Italians) for the safe use of chemicals, more so than the use of protective clothing (gloves, masks, etc.), proper storage, using only the doses recommended, proper use of the product, and complying with the recommendations on the frequency of use of the product.
In conclusion, the European study also highlights the need to further intensify training, with respect to chemicals and safety issues. Proof of this lies in the fact that the European citizens consider themselves only moderately well informed, or not well informed, as to the hazards associated with chemicals.

[16] Source European Commission data processed by the ISPRA – *Flash Eurobarometer n.360/2011 "Consumer understanding of labels and the safe use of chemicals"*

GLOSSARY

Goods and services:
are the tangible and intangible resources used to satisfy the range of human needs.

Waste management:
the set of activities and policies aimed at managing the entire waste cycle, from generation to recovery or disposal. The actions involved are: collection, transportation, treatment (recycling or disposal) and reutilization of the discarded materials.

Raw materials:
any unprocessed materials used to manufacture final products or goods, by means of industrial, craft, etc. processes.

Eco-compatible products:
products that are compatible with the need to protect the surrounding environment. The key features for measuring the eco-compatible quality of a product are: the use of raw materials, the processes by means of which the product is manufactured, packaged, transported and distributed, the installation and maintenance operations, how the product is used and, last but not least, how it is disposed of. These features are assessed in terms of the consumption of materials, energy and water, the emissions involved and the waste produced and, lastly, the related physical agents (noise, vibrations, optical radiation, electromagnetic fields).

Natural resources:
any materials or substances that are not man-made and can produce wealth. Some natural resources can be used in their raw unprocessed form (e.g. timber), while others need to be processed before they can be used (e.g, steel). Natural resources are called raw materials when they can be technically and cost-effectively exploited.

Welfare:
a social system designed to ensure that all citizens benefit from a range of necessary social services.

IV. Household Consumption Patterns and the Environment

Introduction

This chapter is inspired by a recent study by Eurostat on European environmental statistics[1] and its main purpose is to outline the relationship that exists between the consumption patterns of European and Italian households and the environment, in order to understand whether or not there is a trend toward environmental sustainability.

This chapter will try, therefore, to provide responses to a set of specific questions, such as, for example: *What role do households play in the present environmental situation and which are their responsibilities? Which types of consumption generate the greatest environmental pressures? What are the direct and indirect environmental pressures of household's daily choices?*

In this section we will also examine: the institutional background of sustainabile consumption, the principal characteristics of European and Italian households, the trends in the different types of household consumption (food and beverages, housing, household appliances, etc.) and the related environmental pressures, the habits of households and their (positive or negative) incidence on the environment. Moreover, we will also mention how urbanization can affect consumption patterns and certain environmentally compatible initiatives. The conclusions present an overall picture of the direct and indirect environmental pressures generated by the daily decisions taken by households.

IV.1 The concept of sustainable consumption

In Italy, household spending accounts for 60% of the domestic GDP.

European and Italian households consume a significant portion of the goods and services generated by the economic system. In accounting terms, household spending accounts for a large portion of the gross domestic product (GDP) in both the EU27 (58.3%) and Italy (60%)[2], with various effects on the economy, society and the environment.

Overall, European households represent the largest contributor to environmental pressures.

Although the environmental impact of each household is relatively small if compared with that of production activities, as a whole, the millions of European households, altogether, represent a major contributor to environmental pressures. The simple choices made by individuals, with respect to purchases of consumer items, means of transport or how to manage their homes, can have a significant impact on the environment. The higher consumption of water and energy, increased air emissions, water discharges and waste production, for example, determine alterations in the environmental conditions that can have repercussions on human beings, ecosystems and infrastructures.

[1] Eurostat - *Statistical books*, 2010 edition. Environmental statistics and accounts in Europe

[2] Eurostat – *Table: Final consumption expenditure of households and non-profit institutions serving households*, http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tec00009

Internationally, the first mention of sustainable consumption was made in 1992, in Agenda 21, the first significant global political agreement laying down the need to converge towards sustainable consumption[3], identifying un-sustainable production and consumption patterns as one of the major causes of environmental deterioration. Agenda 21, in fact, emphasized that action is needed "to promote patterns of consumption and production that reduce environmental stress and will meet the basic needs of humanity" (UN, 1992). Ten years later, the Johannesburg Declaration on Sustainable Development[4] sanctioned the need to encourage the development of a "framework of programmes in support of regional and national initiatives to accelerate the shift towards sustainable consumption and production" (UN, 2002). In its resolution RES/64/236 of 23 December 2009, the General Assembly of the United Nations decided to organize, in 2012, the UN Conference on Sustainable Development (UNCSD), also known as Rio+20, because it would take place 20 years after the United Nations Conference on Environment and Development (UNCED), informally known as the Earth Summit, in Rio de Janeiro, in 1992.

Sustainable consumption according to Agenda 21.

For global sustainable development, from Rio de Janeiro 1992 to Rio de Janeiro 2012.

The Rio+20 Conference will take place on 20-22 June 2012 and will represent a key opportunity for renewing global commitment to sustainable development.

By definition, sustainable consumption can be described as "the use of goods and services that respond to basic needs and bring a better qualify of life, while minimising the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardise the needs of future generations." (UN-CSD 1995).

The definition of sustainable consumption.

Today, in the wake of renewed political concern, sustainable development has once again taken pride of place in the European political agenda. In fact, the *Europe 2020* strategy promoting sustainable growth (EC, 2001 updated in 2006), the action plan on "Sustainable Consumption and Production and Sustainable Industrial Policy" (SCP/SIP Action Plan), the EU Integrated Product Policy (IPP) (EC, 2003) and the Sixth Environment Action Programme all offer a broad range of measures aimed at promoting sustainable consumption.

Sustainable consumption is one of the topics in the current political agenda.

At national level too various European countries have developed strategies that include the concept of sustainable consumption. In Italy, however, no far-reaching plan has been developed, to date, founded on all three pillars of sustainable development: the environment, the economy and society. There is only a National Strategy for Sustainable Growth approved by CIPE, on 2 August 2002, which sets out the key objectives and actions to be implemented over the next decade, in four – exclusively environmental – priority areas, namely: the climate; nature and biodiversity; quality of the environment and of life in urban areas; the sustainable use and management of natural resources and waste.

Sustainable growth in Italy.

[3] Chapter 4 of *Agenda 21,* the United Nations (UN) Conference on Environment and Development report agreed in Rio de Janeiro in 1992

[4] World Summit on Sustainable Development in Johannesburg, 2002

Households are getting smaller. In the EU27, as well as in Italy, the average number of persons per household dropped from 2.5 in 2005 to 2.4 in 2008 and, consequently, the total number of households has increased (between 2003 and 2006, by 4% in the EU27, 5% in the EU15 and 4.5% in Italy).

The number of households is increasing, but they are getting smaller and smaller.

Tendentially, therefore, consumption has increased, and the available resources have to be shared to a lesser degree. However, changes in lifestyle can reverse this trend and foster the spread of more sustainable consumption.

Therefore, it is interesting to examine both composition and distribution of the various aspects of consumption, and observing how household spending evolves, by type of goods and services, offers an interesting insight into the adopted patterns.

In all European countries, household expenditure exceeds public spending and is increasing quite rapidly[5]. Currently, in Europe, consumption expenditure has exceeded the levels recorded in 1990, both in absolute terms and in euros per inhabitant at constant prices[6].

In Europe, household expenditure has exceeded public spending.

Although there has been an overall drop over the last two-year period, between 1998 and 2008, in the EU15, incomes increased and savings remained relatively unchanged (from 1,600 to 1,800 euros per inhabitant of net savings), although they plummeted in Italy (from 1,300 to 500 euros). This combination of growing incomes and unchanged savings has enabled households, in the EU15 countries, to spend most of the extra income, consequently modifying their consumption patterns[7].

In Italy, instead, average monthly household spending dropped by 1.7%, between 2008 and 2009, which, minus the inflation recorded in 2009, is quite significant in real terms.

In 2008, in Europe and Italy, there was a shift in consumption expenditure from basic necessities to leisure and communication activities.

Between 1998 and 2008, spending by households for basic necessities dropped, while spending for leisure and communication activities increased.

In fact, although in both the EU27 and Italy, the home, food and beverages, and transport are the main cost items for households, between 1998 and 2008 the consumption of food dropped from 13.3% to 12.3% of overall spending, and in Italy from 15.3% to 14.5%; while spending for leisure activities, culture, communications and health increased (Figure IV.1).

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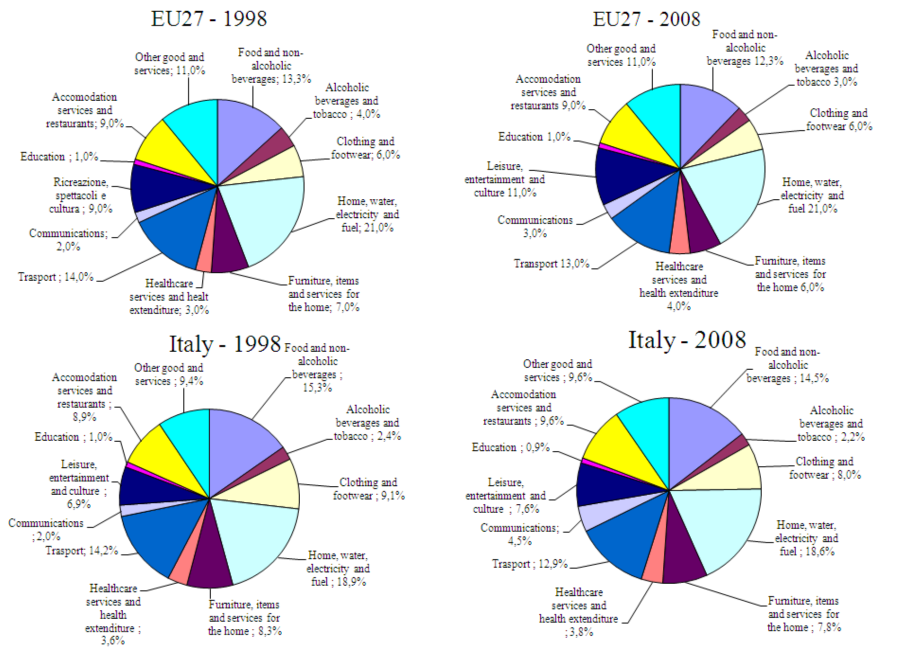
[5] Eurostat – *Table: GDP and main components* – volumes [nama_gdp_k], http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_gdp_k&lang=en

[6] Eurostat – *Table: Final consumption expenditure of households by consumption purpose* - COICOP 3 digit - volumes [nama_co3_k]; http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_co3_k&lang=en and Final consumption expenditure of households, by consumption purpose [tsdpc520], http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsdpc520

[7] Eurostat – *Table: Income, saving and net lending / net borrowing* - Current prices [nama_inc_c], http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_inc_c&lang=en



In both the EU27 and Italy, the home, food and beverages and transport represent the main cost items for households, however, between 1998 and 2008 the consumption of food dropped, in Europe from 13.3% to 12.3% of overall spending, and in Italy from 15.3% to 14.5%; while spending for leisure activities, culture, communications and health increased.

Figure IV.1: Distribution of household expenditure by type of consumption, in the EU27 and Italy – 1998 and 2008[8]

IV.2 Trends in the different types of consumption by European households

The type and level of environmental pressures associated with household consumption depend both on the absolute levels of consumption (how much is consumed), the adopted patterns (which goods and services are consumed) and the intensity of the pressure of the purchased goods and services (i.e. environmental pressures per unit of consumption).

The type and level of environmental pressures associated with household consumption depend on the absolute levels of consumption, the adopted patterns and the intensity of the pressure of the purchased goods and services.

Regarding the entire lifecycle of products, for certain goods and services the environmental pressures are highest during their use and may be attributed directly to the households themselves (for instance, energy consumption by household appliances).

In the case of other goods, such as food, the principal pressures are associated with the production, transportation, distribution and sale of the products, and indirectly attributed to households, in connection with their demand for these goods.

Ultimately, household consumption is driven by economic and social factors.

Household consumption is driven by economic and social factors.

Increasing incomes and globalization allow access to goods from all over the world. But many environmental impacts related to consumption by European households occur away from Europe, precisely due to globalization and the broadening of trade, and refer to extraction of resources, and the production, processing and transportation of the products consumed in Europe.

For example, by importing goods and services, European households inevitably use the resources extracted abroad.

Many products manufactured in Europe also exploit raw materials extracted abroad. The demand for food and drink, housing and infrastructures and mobility is responsible for approx. 60-70% of total

[8] Source: Eurostat data (nama_co3_k) processed by the ISPRA

environmental pressures, in terms of GHGs, ozone-depleting substances, acidification and resources use[9].

IV.2.1 Household consumption of food and beverages

In 2009, food and beverages consumption accounted, on average, for 12.3% of total consumption expenditure in the EU27, 11.9% in the EU27 and 14.3% in Italy (see Figure IV.2).

In Italy, the incidence of food and beverage consumption on total household expenditure, between 1998 and 2008, dropped from 15.3% in 1998 to 14.3% in 2009.

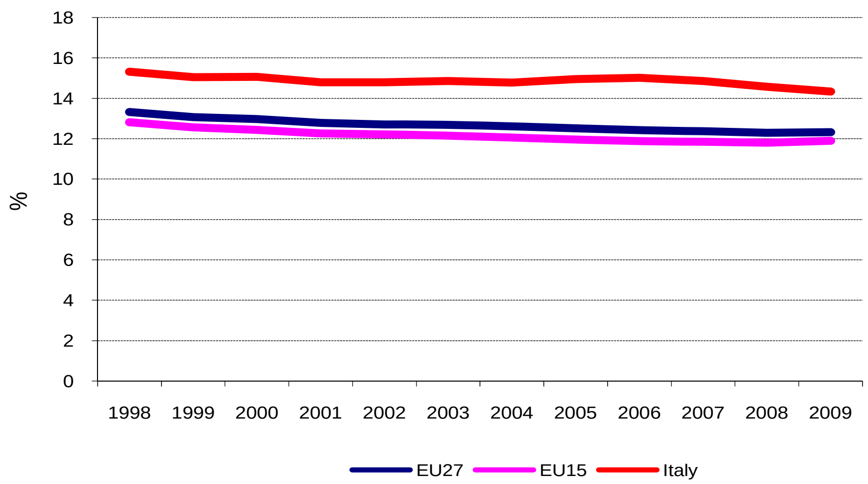


Figure IV.2: Evolution in the incidence of "food and beverages" on total household expenditure in the EU27, EU15 and Italy[10]

As income increase, the share of food and beverages in household total expenditure decreases. In Italy, the incidence of food and beverage consumption on total consumption expenditure dropped from 15.3% in 1998 to 14.3% in 2009. Food and beverages consumption by households is higher in the Member States where household incomes are lower. Considering that food is a primary need, low-income households spend a higher proportion of their income for food.

The higher the income, the lower the amount of spending, by households, for food and beverages.

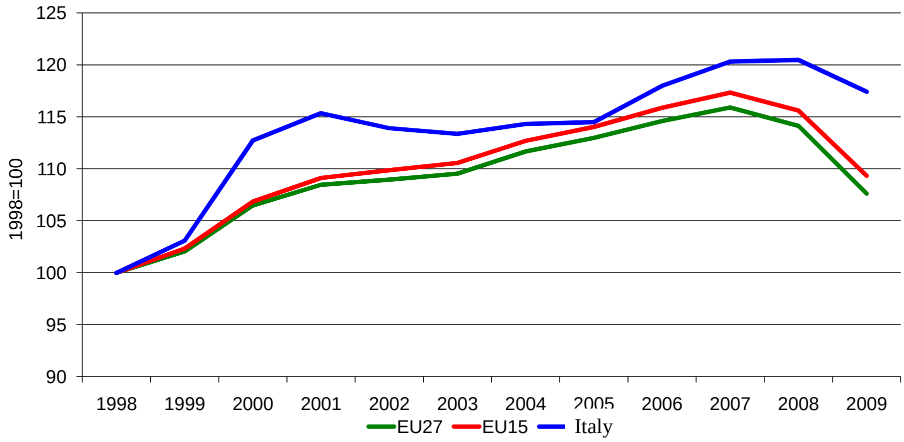
Besides the general drop in the amount of spending for food and beverages in household budgets, the following figure shows the trend, in Europe and Italy, of eating out more often and spending more in catering services (which include spending for restaurants, bars, wine bars, pubs, etc.). This expenditure, although down in the last year taken into account, increased considerably, between 1998 and 2009, in both the EU15 (+9.3%) and the EU27 (+7.6%). In Italy, it increased by 17.4% (Figure IV.3). At the same time, due to the consolidation of modern lifestyles, the time dedicated to cooking at home dropped drastically. In Europe, in fact, more and more people are consuming deep-frozen and takeaway meals and habitually eating at restaurants or cafeterias, at work or in school[11].

In Europe, people are more and more frequently consuming takeaway or deep-frozen meals and eating at restaurants or cafeterias, at work or school.

[9] *Environmental pressures from European consumption and production — A study in integrated environmental and economic analysis*, ETC/SCP working paper 1/2009

[10] Source: Eurostat data (nama_co3_k) processed by the ISPRA

[11] Laurie Michaelis and Sylvia Lorek, *Consumption and the environment in Europe — Trends and futures*, Danish Environmental Protection Agency, Copenhagen, 2004



Over the last decade, in Europe and Italy, there has been a growing trend to eat out more often and to spend more in catering services (which include restaurants, bars, wine bars and pubs).

Figure IV.3: Indexed distribution of household expenditure for catering services (restaurants, bars, wine bars and pubs) in the EU27, EU15 and Italy[12]

Most waste is generated by food products, with regard to both the organic and non-organic fractions, in the latter case, the packaging materials.

Having described the trends in food and beverages consumption in Europe and Italy, and the new habits people have acquired, it should be highlighted how most waste is generated precisely by foodstuffs.
This type of consumption, in fact, generates both organic-waste (the wettest and denser component) and, increasingly, non-organic waste, such as plastic, paper and cardboard used for packaging.
More and more frequently, households tend to buy pre-packaged food and beverages and products from distant countries (such as, for example, exotic or out-of-season fruits and vegetables), which obviously require a great deal of transport.

"New" structural conditions in both European and Italian society, such as: increased work outside the home, increasing higher incomes and less leisure time, over the last decade, have generated a drop in waste from deterioration and a considerable increase in the non-organic fraction, as a result of the packaging.

This is due to a brand new form of "convenience", which has become a decisive element in the choice of food products and is dictated by a number of factors: work outside the home, increasing incomes and less free time.
At the same time, the prices of fresh generate has increased worldwide, since they need to include packaging and transport costs.
These "new" structural conditions in European and Italian society have generated, over the last decade, a drop in waste from deterioration and a considerable increase in the non-organic fraction, as a result of the packaging.
Moreover, the increased amount of packaging, especially glass and plastic, is also due to rising consumption of mineral water and non-alcoholic beverages.

Environmental impacts from household waste are primarily caused by disposal. Paper and cardboard is generally the largest fraction of household packaging waste but with high recycling rates.
Moreover, it should be stressed that most waste ends up being disposed of in landfills[13], giving rise to a potential loss of resources,

[12] Source: Eurostat data (nama_co3_k) processed by the ISPRA
[13] Eurostat – Table: Generation of waste (tonnes, kg per person) [env_wasgen], http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_wasgen&lang=en

and that organic residues not disposed of separately release methane gas, which is a powerful greenhouse gas.

The indirect environmental pressures on the consumption of food and beverages are more important than the direct pressures.

Every stage in the "production-consumption" chain (from farming, livestock/fisheries, transport and storage, manufacturing, distribution, purchasing, consumption and dealing with waste) has effects on the environment.
The indirect environmental pressures on the consumption of food and beverages are more significant than the direct environmental effects[14]. They are essentially due to the production, processing and transportation of the food consumed and the management of the waste generated.

Nutritional choices, and the origin of the food products, are key factors in determining the environmental pressures from food consumption.

Nutritional choices are, therefore, a key factor in determining the environmental pressures due to food consumption.
Various studies have shown that meat and dairy products require a considerably higher consumption of energy, water and soil, therefore determining greater pressures[15].
At the same time, the impacts caused by the consumption of food generated by intensive farming can be higher than those generated by organic farming.
However, along with nutritional choices, the origin of food products is also of environmental relevance, in energy terms, because the amount of energy required to transport food generate from the country of origin to the place of destination is greater than that required to generate the food in the first place.
In Europe there has been an increase in the demand of out-of-season generate and of generate that cannot be locally generated, because of the climate or soil conditions.

IV.2.2 European housing

Figure IV.4 shows the evolution in the EU27, EU15 and Italy, of expenditure spending for housing, which includes actual and assumed rents and home maintenance and repair costs, in billions of euros (at the 2000 exchange rates), between 1998 and 2009.

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[13] Eurostat – Table: Generation of waste (tonnes, kg per person) [env_wasgen], http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_wasgen&lang=en
[14] Laurie Michaelis and Sylvia Lorek, *Consumption and the environment in Europe —Trends and futures*, Danish Environmental Protection Agency, Copenhagen, 2004
[15] European Commission, 2006, *Environmental impact of products (EIPRO) — Analysis of the life cycle environmental impacts related to the final consumption of the EU25*, Technical Report EUR 22284 EN (http://www.jrc.es/home/pages/detail.cfm?prs=1429)

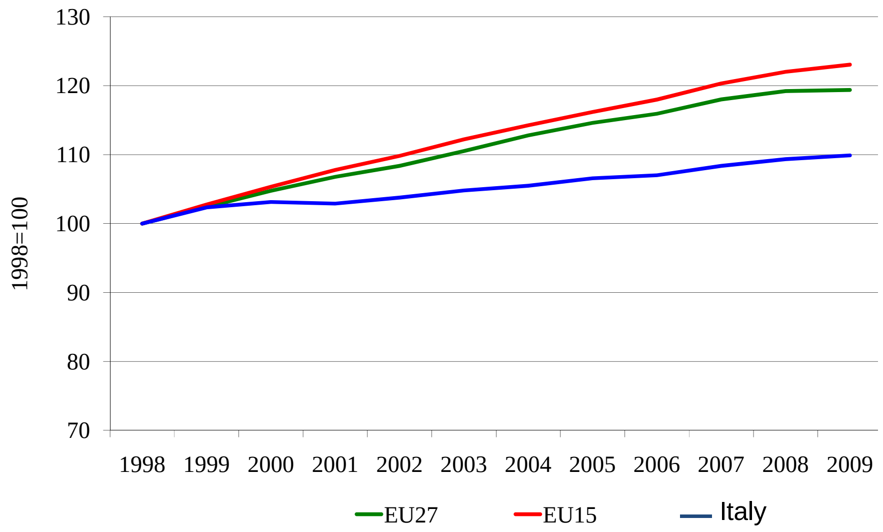


Figure IV.4: Indexed distribution of household expenditure for the home in the EU27, EU15 and Italy[16]

In 2009, household expenditure for housing represents on average 16% of total expenditure both in the EU15 and in the EU27, and 14% in Italy.

In 2009, household expenditure for housing represents on average 16% of total expenditure both in the EU15 and in the EU27, and 14% in Italy.
Over the years, house prices has increased, annually, by more than 10%, in opposite directions, according to "boom and bust" cycles, i.e. periods of "sustained growth" of the real estate market, followed by an equally sharp and rapid "contraction".
Another recent European trend is the purchase of second homes[17] for holidays or weekends use, often located in environmentally sensitive - coastal or mountain - areas.

In terms of the energy consumption of homes, the behaviour of households is often conditioned by the existing structures of the buildings.

With regard to the energy consumption of homes, household behaviours are often conditioned/predetermined by the existing structure of the buildings.
For example, if central heating cannot be controlled, households tend to perform inefficient practices, such as opening the windows, for example, to reduce the indoor temperature on warmer winter days.
Therefore, improvements in construction designs and standards, in particular, could significantly reduce energy consumption for heating purposes.
A number of design elements influence the energy efficiency of a building, such as: isolation, waterproofing, orientation and shape (which can influence solar heat gain), the use of passive lighting (led lights, for example) and of active solar protection or solar water-heating systems.

The housing sector , like food, also generates waste, especially construction and

The housing sector, like the food and beverages 6sector, also generates waste.
In particular, procurement by the "new" construction sector has determined the dismantling of the existing stocks of building

[16] Source: Eurostat data (nama_co3_k) processed by the ISPRA
[17] United Nations, Economic and Social Council, Economic Commission for Europe, Conference of European Statisticians, Group of Experts on National Accounts, 10th session, '*Second homes — Vacation home ownership in a globalised world* — Note by the United Nations World Tourism Organisation (ECE/CES/GE.20/2010/15)

products, causing an increase in the amount of waste from construction and demolition activities.
These account for approx. 33% of the total waste generated in the EU27[18].
In Italy, this incidence in 2008 was 39%. This waste includes a broad range of materials, such as concrete, bricks, wood, glass, metal, plastic, solvents and asbestos.
Due to the composition of the materials, there is a significant potential for the reuse and/or recycle construction and demolition waste.
However, the construction industry has not yet put into place widespread recycling procedures and practices and the principal disposal methods are still landfills and incineration.
Besides waste, home-related household consumption also generates significant environmental pressures of an indirect nature, such as the consumption of natural resources (for example, sand, gravel and wood) and land use.

demolition waste.

Home-related household consumption generates significant indirect pressures on the environment as well, such as the consumption of natural resources (sand, gravel and wood) and land use.

IV.2.3 Household use of electric appliances and electronic devices

Figure IV.5 shows the evolution in expenditure in households appliances, from 1998 to 2008, in the EU27, EU15 and Italy, in billions of euros.
At European level, over the last few decades[19], the amount has increased rapidly, like the number of appliances in homes.
In Italy, instead, there have been alternating trends.
Household appliances and electrical equipment include both conventional products (washing machines, dishwashers, microwave ovens, refrigerators, freezers), and new multimedia technological devices (digital TVs, DVD players, mobile phones, PCs).
The latest trends feature the introduction of MP3/MP4 and videogame players, and the replacement of old-style cathoderay-tube TV sets with screen (LCD and plasma).

In the EU27, between 1998 and 2008, household expenditure for electrical appliances increased by 25.4%, in the EU15 by 25.9% and only by 8.6% in Italy.

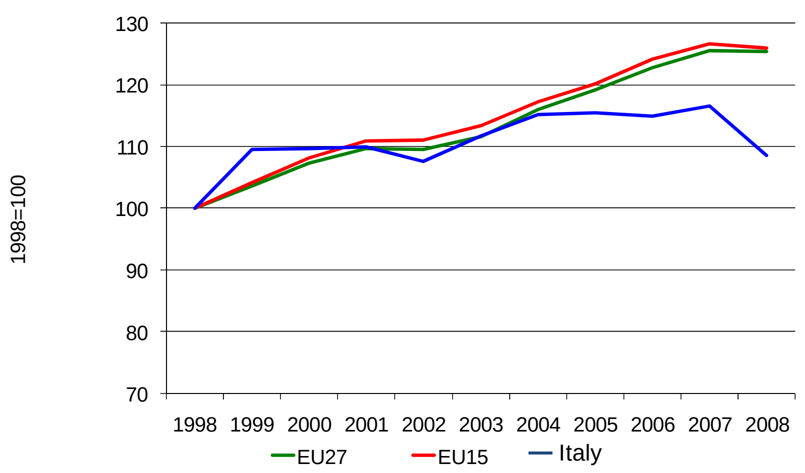


Figure IV.5: Indexed distribution of household expenditure for

[18] Eurostat – *Table: Generation of waste* (tonnes, kg per person) [env_wasgen], http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_wasgen&lang=en
[19] Eurostat, 2003, Theme 4: Industry, trade and services. Statistics in Focus 34/2003, DVD and video statistics, Sectorial profiles and detailed tables, cinema, TV and radio in the EU, statistics on audiovisual services, data 1980–2002

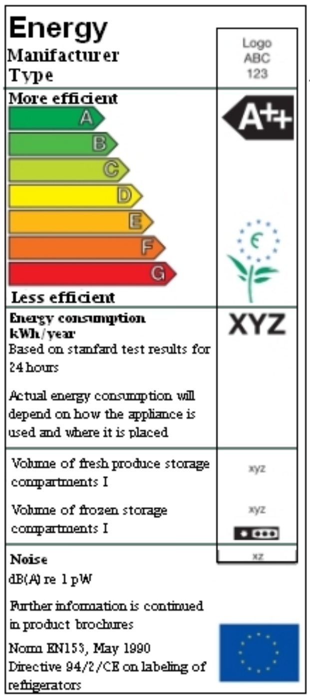
electrical appliances in the EU27, EU15 and Italy[20]

In the EU27, between 1998 and 2008, household expenditure for this class of products increased by 25.4%, by 25.9% in the EU15 and by only 8.6% in Italy.

The domestic market penetration patterns of the various appliances vary; generally speaking the highest levels are recorded in the EU15 countries, rather than in the new member States. The increase in the number of electrical appliances and equipment has created extra pressures on the environment, in terms of energy, water use and waste generation.

Moreover, many appliances consume more energy to be used, throughout their life-cycle, than to be generated.

Energy efficiency classification by means of an energy label can help consumers compare products and choose the most energy efficient ones. The labelling system features a scale from A to G, where A represents the most efficient class and G the least efficient. Classes A+ and A++ were added at a later date for refrigerating appliances.



Example of energy label for a refrigerator

Energy efficiency classification by means of labels offers consumers the possibility of comparing products in terms of their energy efficiency.

Energy labels also provide other useful information to consumers, such as the annual energy consumption of the appliance, noise levels and other essential resources, as a means for guiding consumption in an environmentally-friendly direction.

The use of marks and the range of products to which they are applied are gradually expanding. The Framework Directive (2010/30/EU) on labelling requires the mandatory labelling of refrigerators and freezers, dishwashers, light bulbs, washing machines and dryers. Labels are also being prepared for a range of other appliances, including boilers and heating equipment.

Although, on the one hand, during the last decade there has been a reduction in average energy consumption per unit, thanks to the progress achieved in terms of energy efficiency, on the other hand, the total consumption of energy in the average household has increased.

Although, on the one hand, during the last decade there has been a reduction in average energy consumption per unit, thanks to the progress achieved in terms of energy efficiency, on the other hand, the total consumption of energy in the average household has increased.

This increase is the result of the large number of electronic devices and apparatuses purchased by households and the growing use of energy in consumer electronics.

In particular, a significant contribution is provided by stand-by consumption, which accounts for the highest amount of energy use in homes. For example, a TV set switched on for 3 hours a day (which is the average amount of time Europeans spend watching TV), and left on stand-by for the remaining 21 hours, consumes approx. 40% of the

[20] Source: Eurostat data (nama_co3_k) processed by the ISPRA

energy needed for its operation[21].

The growth in the number and variety of appliances is accompanied by an increase in the amount of waste generated by households. A factor that contributes to this growth is the tendency to replace broken appliances. Due to the reduced durability of goods and to the fact that it is cheaper to replace a broken appliance with a new one, rather than repair it, consumers often prefer the former option to the latter.

The growth in the number and variety of appliances is accompanied by an increase in the amount of waste generated by households.

In the EU27, the total weight of the electrical and electronic equipment placed in the market in 2005 was 10.3 million tonnes and the estimated amount of waste generated is included between 8.3 million and 9.1 million tons[22]. Only 25% (in the case of medium-sized appliances) and 40% (larger appliances) of electrical and electronic waste, composed of a high quantity of metal, plastic and glass, is separately collected and suitably treated.

Disposal in uncontrolled landfills of the unrecovered fractions can represent a serious hazard, because these materials, in the long term, release contaminants and leak carcinogenic substances into the soil and aquifers. Incineration and/or co-incineration can determine a considerable risk of production and dispersion of toxins and heavy metals.

IV.2.4 Household use of transport

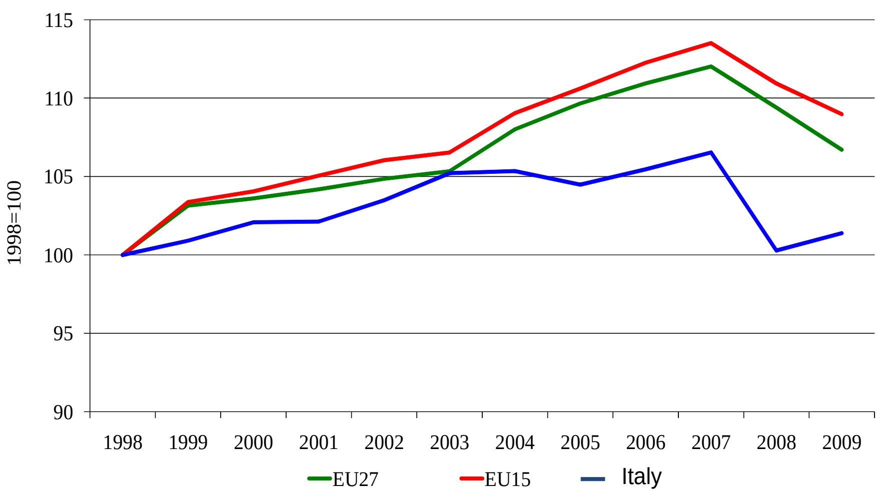
European citizens primarily use means of transport to commute between home and work or school and in connection with leisure activities (including tourism), shopping or social visits to family members and friends. Figure IV.6 shows the evolution of transport expenditure in the EU27, EU15 and Italy. In 2009, transport represented, on average, 13% of total spending for consumption in the EU15 and the new member States.

Between 1998 and 2009, the evolution in spending for transport services, chosen as a proxy for public transport, increased by 17% in the EU27, 23% in the EU15 and only 11% in Italy. In the case of private transport, the purchase of vehicles and of personal transport equipment rose by 5% in the EU27 and 7% in the EU15, although it remained constant in Italy. Public transport accounts for 2.3% of all household expenditure, while private/personal transport for 10.7%. This means that Europeans spend six times more for the latter transport. Between 1995 and 2006, the number of vehicles per person increased between 19% and 25% in the EU15 and EU27. The highest growth percentages can be found in the new member States, the lowest in the countries with an already relatively high number of vehicles per person.

Between 1998 and 2009, the evolution in spending for transport services, chosen as a proxy for public transport, increased by 17% in the EU27, 23% in the EU15 and only 11% in Italy.

[21] http://ec.europa.eu/environment/climat/campaign/control/switchoff_en.htm

[22] J. Huisman et al. *2008 review of Directive 2002/96 on waste electrical and electronic equipment (WEEE*', United Nations University, Bonn, 2007



In 2009, transport accounted for 13%, on average, of total consumption expenditure in the EU15 and the new member States.

Figure IV.6: Indexed distribution of household expenditure for transport in the EU27, EU15 and Italy[23]

The higher the number of vehicles sold, the more vehicles will obviously be scrapped, in time.
A part of these are abandoned and part are disassembled to recover certain components, while a significant portion is recycled (between 1.5 and 30 kg per capita, in 2006).
Means of transport represent a great recycling opportunity, especially since they contain steel components, the recyling process of which is cheap and does not require special requirements.
Plastic, laminate and glass materials are, in fact, decidedly more difficult to recycle.
Precisely due to the high metal content, the reuse and recycling rates are very high (in 2006, about 80% in many European countries).

At the end of the 20th century, demand for certain transport services practically skyrocketed.
Air transport sector, for example, grew at a faster rate than road transport: the number of passenger per km increased to an annual average of 5%[24].
However, the more efficient and economical modes of transport remain walking and cycling, because these “means” do not consume fuel and are more desirable for short-range trips.
Furthermore, rail and sea transport are much more efficient than road and air transport.

Differences, in terms of energy efficiency, between the various vehicles, in connection with each mode of transport.

In terms of efficiency, moreover, considerable differences exist, within each mode of transport, between the various types of vehicle.
Large public transport vehicles tend to be more efficient, in passenger per km, than small individual vehicles, provided that they are used well.
Electric trains are appreciably more convenient that diesel trains,

[23] Source: Eurostat data (nama_co3_k) processed by the ISPRA
[24] European Commission Directorate General for Energy and Transport, *Energy and transport in figures and SiF Transport,* 42/2009

while diesel motor vehicles and trucks are more convenient than petrol vehicles.
Moreover, there can be enormous differences in the fuel consumption of a vehicle, depending on its capacity, age and type of construction.
New vehicles tend to be more efficient than older ones, but this benefit is often obscured by a higher capacity, weight or power.
The number of passengers per unit should also be taken into account.
Public transport vehicles do not effectively use the resources if they carry only a small number of passengers; while a small vehicle with three or four passengers on board is obviously more cost-effective, in terms of fuel consumption (by passenger-km), than a large vehicle with only one passenger.
In the case of longer journeys, such as holidays, motor vehicles can be more efficient than airplanes.
Moreover, we should also consider, among the impacts on the environment caused by transport, the GHG emissions by air transport.
Although these sources are not statistically directly attributable to households (in fact, they refer to the transport sector) we should, in any case, record the increased number of households travelling by air and chosing increasingly faraway destinations.
Moreover, these emissions occur at the higher altitudes, and therefore their potential impact on climate change, assessed by the IPCC[25] at 2.7 times the emissions of CO_2 is particularly strong.
Other impacts are related to transport infrastructure, such as, for example, soil occupation, especially in urban areas.
Considering an equal capacity of supplied services, roads occupy a significantly larger amount of land than railways, while air and sea transport require significantly smaller amounts of land.
Furthermore, the expansion of transport infrastructures causes the fragmentation of natural habitats, affects air quality and biodiversity and generates noise problems.

The expansion of transport infrastructures causes the fragmentation of natural habitats, affects air quality and biodiversity and generates noise problems.

IV.2.5 Households energy consumption

Households are among the major final energy consumers in Europe.
In 2009, not considering transport, the energy consumed by households at home accounted for 26.5% of the total energy consumption in the EU27.
The figure appears even more significant is compared to the 24.2% of energy consumption by industry.
Moreover, in excess of half the energy consumed for transport in Europe is used directly by households in the form of fuel (petrol or diesel) for private vehicles.
The household proportion of total energy consumption has increased over the last ten years in practically all the EU15 countries and in several new member States.
Energy is consumed by households primarily to heat the home and water, power electrical appliances, lighting and air conditioning.
Between 1996 and 2009, despite higher consumption for heating, final energy consumption by households remained practically unchanged in

Households are among the major final energy consumers in Europe.

Energy is consumed by households primarily to heat the home and water, power electrical appliances, lighting

[25] IPPC= *Intergovernmental Panel on Climate Change*

the EU15 and EU27.
This trend can be explained with the improved energy quality of residential buildings.

and air conditioning.

Between 1996 and 2009, despite higher consumption for heating, final energy consumption by households remained practically unchanged in the EU15 and EU27.

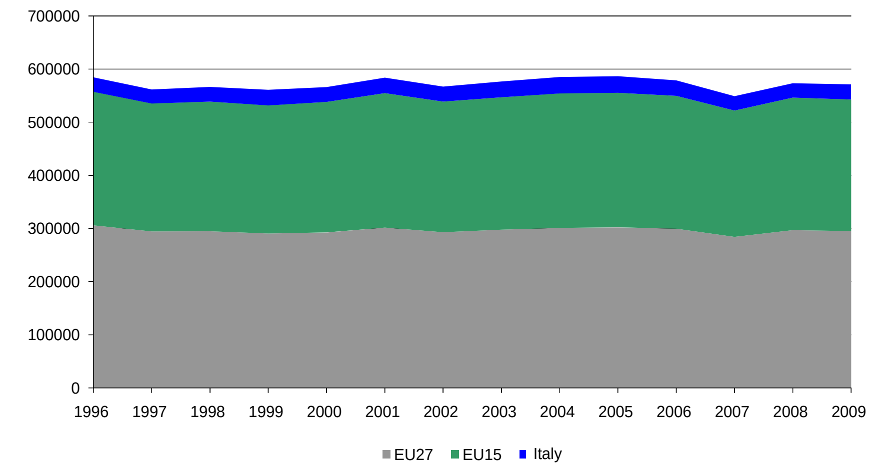


Figure IV.7: Final energy consumption by households in the EU27, EU15 and Italy[26]

In the EU27, high electricity consumption is due to electrical heating (18.8%), refrigerating equipment (refrigerators and freezers) (15.3%), and lighting (10.8%), along with water heating system (8.6%). Electrical equipment in stand-by mode rank eighth (at 5.9%) for energy consumption, above air conditioners and on a par with PCs and dishwashers, considered together (47.5 TWh/yr)[27]. Figure IV.8 shows the evolution of household expenditure for electricity, gas, liquid and solid fuels, in the EU27, EU15 and Italy, between 1998 and 2009.

In the EU27, high electricity consumption is due to electrical heating (18.8%) and refrigerating equipment (refrigerators and freezers) (15.3%).

Household expenditure for electricity, gas, liquid and solid fuels, between 1998 and 2009, increased both in Europe and Italy.

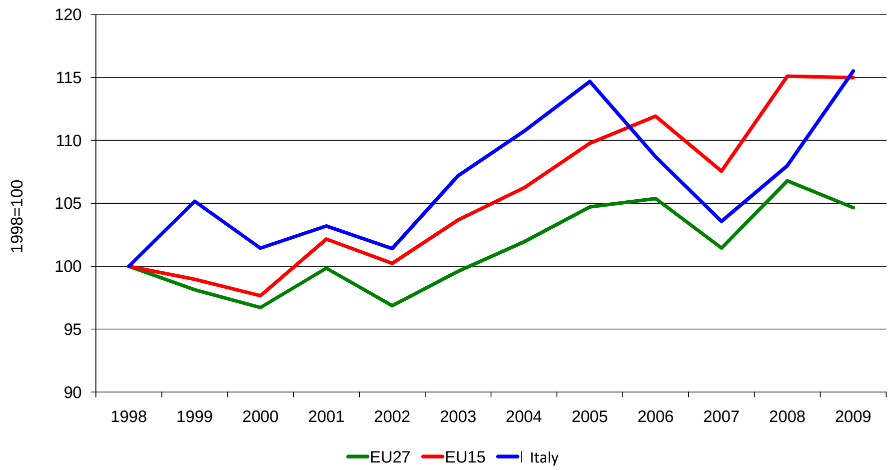


Figure IV.8: Indexed distribution of household expenditure for energy in the EU27, EU15 and Italy[28]

[26] Source: Eurostat data (tsdpc320) processed by the ISPRA
[27] *Electricity consumption and efficiency trends in European Union — Status report 2009*, European Commission. Joint Research Centre, Institute of Energy
[28] Source: Eurostat data (nama_co3_k) processed by the ISPRA

In the same period, the percentage of expenditure for energy in the EU15 (3.3%), EU27 (3.4%) and Italy (3.5%) remained practically unchanged, at about 3.4% of all household expenditure.

The spread of the Internet[29] over the last decade has offered opportunities for reducing energy consumption for transport, by enabling, for example, online shopping, telecommunications and videoconferencing. But although many trips have undoubtedly been avoided, the interactions facilitated by the new electronic technologies and the Internet have also encouraged travel.

Although there has been a significant growth in the purchase of technological products, we should nevertheless stress the greatly improved efficiency of this equipment, manufactured using less resources and designed to consume less energy during their lifetime. However, energy consumption in Europe by electronic consumer equipment and the new media, including the Internet, is steadily growing[30] and total consumption has increased to such an extent as to outweigh the benefits introduced by the technological improvements.

The improved energy efficiency of the products, in fact, is an incentive for their purchase and use, so they allow households to save money, but then the money saved can be spent on other forms of direct or indirect consumption.

For example, when a consumer chooses to buy a more efficient motor vehicle, in terms of fuel consumption, the extra cash thus saved can be spent on other goods or services.

Consumers, moreover, can respond to the efficiency of a product by reducing the efforts towards energy conservation and saving.

For example, by leaving lamps with low-energy bulbs switched on even when it’s not necessary, turning up the heating or using air conditioning with greater frequency.

However, in these examples, much also depends on how energy prices are perceived by consumers, because they always represent a decisive function for the market structures and rules.

IV.2.6 Household emissions

Figure IV.9 shows the percentage direct emissions of GHGs from households in the EU27, in 2006, in connection with transport, heating and other uses[31].

In particular, transport accounts for over 51% of all greenhouse gas emissions.

The principal effect of the increased level of transport mentioned earlier, in fact, is the increased use of fuel and, therefore, of CO_2 emissions.

Over half the energy used in the transportation sector comes from the combustion of petrol and diesel by privately-owned vehicles, which release significant amounts of GHG and other pollutants into the atmosphere, such as acidifying pollutants, ozone precursors and particulate matter.

Thanks to the more modern technical improvements for vehicles – such as catalytic converters and the other technical measures adopted to ensure compliance with the European standards – between 1995 and 2006 the emissions of acidifying pollutants by households

[29] Eurostat, ICT statistics

[30] http://ec.europa.eu/energy/efficiency/labelling/labelling_en.htm

[31] Eurostat – *Table: Air Emissions Accounts by activity* (NACE industries and households) [env_ac_ainacehh] , http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_ac_ainacehh&lang=en

Thanks to the more modern technical improvements for vehicles – such as catalytic converters and the other technical measures adopted to ensure compliance with the European standards – between 1995 and 2006 the emissions of acidifying pollutants by households practically plummeted.

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Transport is responsible for over 51% of total greenhouse gas emissions.

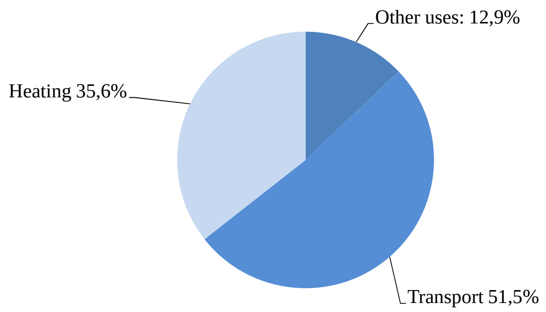


Figure IV.9: Direct emissions of GHGs from households, by type of consumption, in the EU27, in 2006 (CO_2 equivalent for three gases: CO_2, CH_4 and N_2O)[32]

In Italy, thanks to the NAMEA[33] satellite, we can compare the final energy consumption of households and the environmental pressures this has generated.

The next two figures show the contribution of final consumption of households, in terms of emissions into the atmosphere and heavy metals.

It emerges that, in 2008, final consumption by households generated 34% of the emissions generating tropospheric ozone, 25.3% of $PM_{2,5}$, 23% of PM_{10}, 18.2% of GHG emissions and 7.3 of emissions contributing to the formation of acid rain.

In the case of tropospheric ozone, the contribution by households is primarily the result of the use of fuel for private vehicles (67.5%), while the remainder is down to domestic heating (16.1%) and the use of paints and solvents (16.4%).

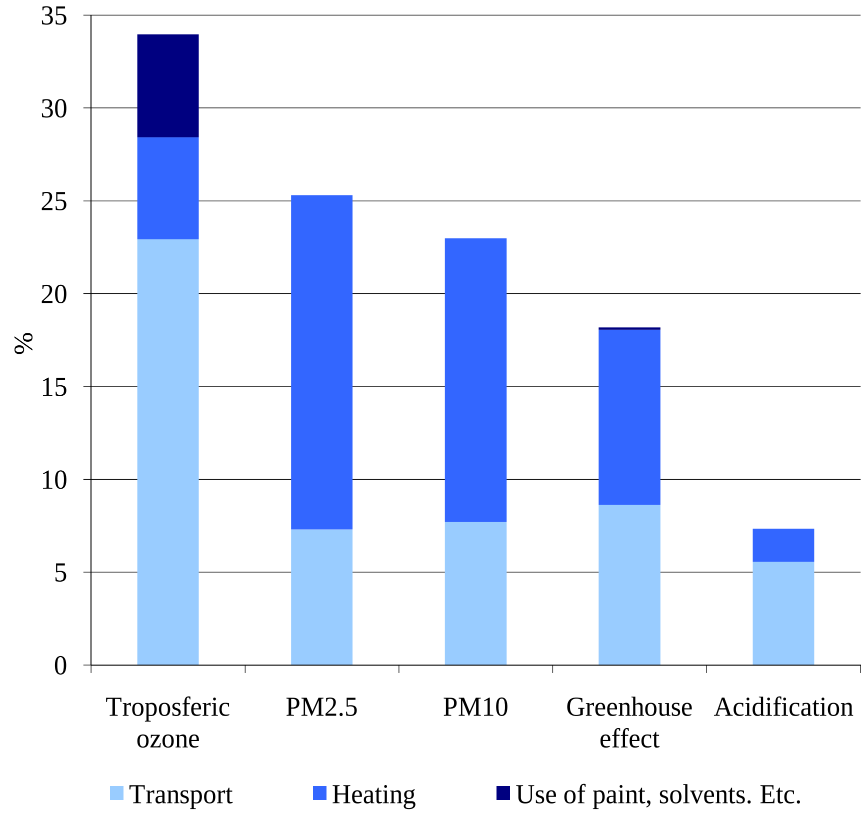
On the contrary, the emissions of particulate matter are primarily due to domestic heating (70%) and only by 30% to private vehicles.

GHG emissions are caused by private transport and domestic heating in almost equal measure (47.5% and 52%, respectively), while emissions generating acidifying pollutants are primarily caused by private transport (76%) and, to a lesser extent, domestic heating (24%) (Figure IV.10).

In 2008, final consumption by households generated 34% of the emissions generating tropospheric ozone. In this case, the contribution by households is primarily the result of the use of fuel for private vehicles (67.5%), while the remainder is down to domestic heating (16.1%) and the use of paints and solvents (16.4%).

[32] Source: Eurostat data (env_ac_ainacehh) processed by the ISPRA

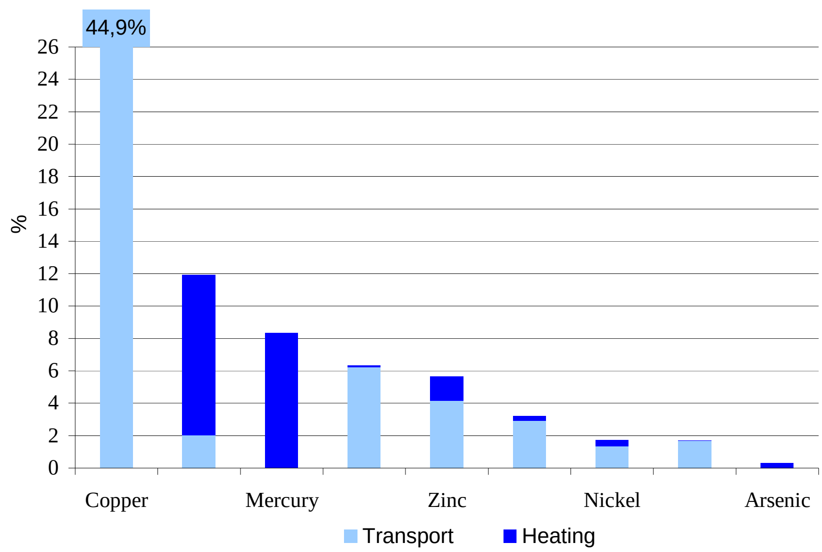
[33] ISTAT – *Atmospheric emissions caused by industry and households.* 1990-2008



In 2008, final consumption by households generated 34% of the emissions generating tropospheric ozone, 25.3% of PM2,5, 23% of PM10, 18.2% of GHG emissions and 7.3 of emissions contributing to the formation of acid rain.

Figure IV.10: Atmospheric emissions from households, by type of pollutant and source (2008)[34] (incidence on total emissions from industry and households)

Regarding heavy metals, final energy consumption by households primarily generated copper emissions (44.9%), almost entirely from private transport (99%).
Also significant are cadmium emissions, 11.9% of which are generated by households, due to heating (83%) (Figure IV.11).



In 2008, regarding heavy metals, final energy consumption by households primarily generated copper emissions (44.9%), almost entirely from private transport (99%).

Figure IV.11: Emissions of heavy metals from households, by type

[34] Source: ISTAT data processed by the ISPRA, *Atmospheric emissions caused by industry and households*. 1990-2008

of pollutant and source (2008)[35] (incidence on total emissions from industry and households)

To reduce GHG emissions, among other things, the European Union is fostering sustainable urban mobility (e.g. the increased use of electrical vehicles), energy saving and energy-efficient building policies (see paragraph IV.2.2), along with the development of an alternative fuel - called biodiesel - obtained from vegetable oils, generally colza oil, but also soy and palm oil and biomass waste, such as straw.

Biodiesel*: the arguments for and against.*

If generated sustainably, biodiesel could effectively reduce CO_2 emissions, otherwise it too would strongly impact the environment. The significant increase of biofuel production from extensive single crops could, in fact, threaten food crops, harm biodiversity and contribute to the deterioration of peat bogs.
Moreover, the production of biofuels would eventually increase the GHG levels, through deforestation.
Despite the improvements introduced in terms of the relative efficiency of motor vehicles and fuels, there has been a sharp increase of CO_2 emissions from transport over the last decade, due to such decisive factors as increased transport demand and changing trends, with respect to both the choice and manner of use of motor vehicles.

IV.2.7 Households use of water

Water is a limited natural resource, a basic and essential necessity for surviving on the Earth.
Although the figures vary, it can safely be said that each European citizen uses about 200 litres of water per day (equal to 20 10-liter buckers).
Although some households use rainwater or groundwater for certain purposes, such as gardening, the largest use by far is of drinking or tap water.

The amount of water abstracted from the water mains for urban use by households and services (including certain industries) varies considerably from country to country, in the EU.

The amount of water abstracted from the water mains for urban use by households and services (including certain industries) varies considerably from country to country, in the EU, ranging from 2% to 10% in Croatia, Hungary, Portugal, Lithuania, Latvia, Germany and Turkey, to over 60% in Luxembourg, Denmark, the UK, Ireland and Malta.
Compared to the previous decades, there has been an increase in the following uses of this precious resource: washing clothes, personal hygiene, washing cars, irrigating gardens, filling in swimming pools.
Improved standards of living are behind the changes in the water demand patterns. Over 90% of the European population use showers and/or baths for personal hygiene[36].
Moreover, most households own a washing-machine; in many western member States no less than 90% or even more[37].
The use of this resource is not evenly spread out over time, because

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[35] Source: *Ibidem*

[36] *Freshwater in Europe— Facts, figures and maps,* Division of Early Warning and Assessment, Office for Europe (DEWA~Europe), of the United Nations Environment Programme (UNEP), 2004

[37] Eurostat – Table: Enforced lack of a washing machine (Source: SILC) [ilc_mddu04], http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_mddu04&lang=en

demand increases in the warmer and drier months, with seasonal variations due to tourism (primarily in Summer in the Mediterranean region).
Population distribution and density are further key factors affecting availability.
Moreover, increased urbanization concentrates demand and can lead to the overexploitation of the local sources.
European households rely significantly on public water supplies. In almost all the EU15 countries, from the 90s, nearly 100% of the population is served by public water systems.
Based on the analysis of the evolution of household expenditure for water supply, a 4% drop was observed between 1998 and 2009, in Italy, while in the EU27 and EU15 expenditure for water increased by 9% and 14%, respectively.

Wastewater production is one of the impacts descending from the use of water by households.

Wastewater production is one of the impacts descending from the use of water by households. To reduce its environmental pressure, wastewater from houses should be treated before being discharged into the sea.
In the last few decades considerable developments have been made in wastewater treatment systems, albeit with significant regional differences.
In 2007, about three-quarters of the European population was connected to a public sewer.
The collected wastewater is not necessarily channelled to a treatment plant, but are in part released directly into the surface waters flowing into the sea or into rivers or around the cities.

IV.2.8 Household waste

In Europe, the waste treatment options are summed up in the so-called "waste hierarchy pyramid", with the most favoured options featured at the top.

The "waste hierarchy pyramid".

Moving from the top downwards, prevention, minimization and reuse can help cut down the amount of waste to be treated.

Recycling recovers materials using them to create new goods. This can entail the conversion of the old materials into either a new version of the same product or an entirely different product.

Incineration can take place with or without heat recovery.

In the former case, it is considered a form of reconditioning, while in the latter it is similar to disposal, like landfill sites.

Although the waste generated by households accounts for only 7% of total waste in the EU27[38], a high percentage is disposed of at landfills and the recycling rates are low in many countries.

In Italy, in 2010, the landfill disposal of municipal waste accounted for about 46% of all managed waste.

Compared to 2009, the amount of waste disposed of at landfills dropped by 3.4%.

Waste has different impacts on the environment, including outdoor air pollution, surface water and groundwater.

Moreover, it should be highlighted that landfill sites occupy precious ground and that inadequate waste treatment processes can be a hazard for public health.

Therefore, it is necessary to properly manage waste and to curb the production and disposal of waste and the related loss of natural resources.

On average, each household member in the EU27 countries produces about 1.2 kg of waste per day.

In 2006, households in the EU27 generated about 215 million tons of waste, equal to 438 kg per person[39].

This means that, on average, each household member produces about 1.2 kg each day.

The total annual amount of biodegradable waste[40], such as organic waste (including food and garden waste), paper and cardboard, included in solid municipal waste, is estimated at between 76.5 and 102 million tons[41].

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[38] Eurostat – Table: Generation of waste (tonnes, kg per person) [env_wasgen], http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_wasgen&lang=en

[39] Eurostat – Table: Generation of waste (tonnes, kg per person) [env_wasgen], http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_wasgen&lang=en

[40] The biodegradable component of household waste includes mainly kitchen, food and garden waste, paper, card and wood

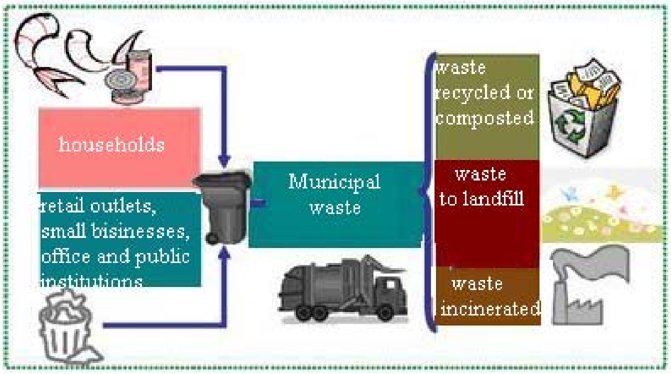
[41] *Green paper on the management of bio-waste in the European Union* (COM(2008) 811 final)

Decomposed biodegradable waste produces biogas and leachate.
On a tonne of biodegradable waste can generate between 200 and 400 m^3 of landfill gas.
According to the IPCC, this landfill gas, if not captured, can significantly increase the greenhouse effect, because it is 23 times more powerful than carbon dioxide, for its impact on climate change, for a time horizon of 100 years.

Hazardous waste contains substances that can be irritating, toxic, inflammable or otherwise harmful, even in small quantities. About 2.7 million tons of hazardous municipal waste are generated every year in the EU27, accounting for 1.2% of total municipal waste[42].
They primarily consist of chemical waste from the production of paints, detergents, solvents, insecticides, medicines and cosmetics, or spent batteries, which contain particularly harmful heavy metals.
Only a small portion of hazardous waste is recycles, most of it is incinerated.
Hazardous waste should be separately collected, for environmental reasons, to prevent it from being disposed of at landfills.

About 2.7 million tons of hazardous municipal waste are generated every year in the EU27, accounting for 1.2% of total municipal waste.

Municipal waste, which is generally collected by the local authorities, consists of the waste generated by household, retail outlets, small businesses, offices and public institutions.
The largest portion of municipal waste is generated by households.



The waste cycle.

The local authorities have adopted a range of actions to facilitate disposal, introducing separate collection systems for recyclable and hazardous waste, or organizing a bulky waste collection service. The collection arrangements can affect both the quality and quantity of the waste and public involvement in the recycling programs. The most widespread methods include curbside collection services, for both recyclable and non-recyclable waste, and neighbourhood recycling drop-off sites.
In the EU27, the percentage of recycled municipal waste grew progressively from 10% in 1995 to 22% in 2008.

A family of European directives identifies the objectives and procedures for collecting and recovering waste from specific products, such as packaging materials, electronic equipment, machines, batteries and construction/demolition waste. The materials

[42] Eurostat – Table: Generation of waste (tonnes, kg per person) [env_wasgen], http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_wasgen&lang=en

for recycling must be clean and uncontaminated and, therefore, should not be mixed with other waste. In fact, the amount of recyclable waste can diminish considerably when the wrong items are thrown into the recycling bin. Contamination can spoil the entire contents of the bin.

Incineration is the most widespread municipal disposal method in Western Europe, while landfills predominate in the new Member States.

Incineration is the most widespread municipal disposal method in Western Europe, while landfills predominate in the new Member States.

In terms of volume, in 2008, 40% of the waste collected by local authorities in Europe were sent to landfills (for burial), 40% was recycled or composted (transformed into an organic fertilizer), and 20% incinerated. In 2008, the percentage of recycled/composted waste in the EU27 had gradually increased from 16% in 1995 to 40%, while the amount of landfilling waste dropped from 62% to 40%.

Increased recycling has greatly reduced the amount of waste for disposal, although it has not reduced the overall amount of waste generated.

In most European states, municipal waste collection and disposal is paid for through levying waste tax[43].

Measures for encouraging separate waste collection.

Several countries levy the tax based on the weight or volume of the waste, or a combination of both. Differing rates, based on the quality and quantity of the waste, in fact, can greatly affect the behaviour of households, with respect to recycling and minimizing waste (see Chapter III – The Environmental Aspects of Daily Family Life). Moreover, to increase recycling various European local authorities have put a fines system in place for failing to drop off specific waste at recycling points and have introduced separate collection systems with labeled and monitored bins and containers.

IV.3 The influence of urbanization on consumption patterns

Recent European trends in landuse of land for urban development highlight the increased use of land by each person and the decrease in urban density.

This is called "urban and suburban expansion" and concerns cities and their suburbs, which are increasingly encroaching on the surrounding outskirts.

The advantages and disadvantages of urban expansion.

Urban expansion gives rise to many disadvantages for residents, such as: the long distances people need to travel to reach their workplace, school or do shopping; dependence on cars for transportation; increased per capita costs for infrastructure.

Moreover, this also creates considerable pressures on the environment, such as the shrinking of farmland, the reduction of habitats for wild flora and fauna (loss of biodiversity), smog and air pollution, due to increased traffic, and the per capita increase of energy and water consumption.

In 2005, the distribution of households in densely, medium-density and sparsely populated areas was, respectively, 50%, 23% and 27% in the EU27, 52%, 24.5% and 23.5% in the EU15 and 47.9%, 39.6% and

[43] *Financing and incentive schemes for municipal waste management case studies*, Final report to the Directorate-General for the Environment, European Commission

12.5% in Italy[44].

Several examples of consumption patterns related to the (urban or non-urban) area of residence.

Following are several examples of consumption patterns related to the (urban or non-urban) area of residence.

For example, households living in rural areas and on the outskirts of urban areas tend to consume more energy than those living in urban areas, especially for heating and transportation.

On the contrary, urban residents live in smaller homes and travel more by foot or public transport.

In urban areas, car dependency is not just a consequence of one's lifestyle or consumption choices, it also depends on the land-use patterns, the development of transport infrastructure and of alternative systems of transport.

Densely populated urban areas can exploit the presence of more efficient services, with regard, for instance, to the number of apartments per building, heating, mass transit and waste collection and treatment.

On the other hand, the demand for transport may be high in expanding areas and the supply of collective services may be difficult to organize.

IV.4 Towards the reduced environmental pressures of products

As already observed, through the analysis of the impact of households on overall energy consumption and climate change, household consumption requires substantially more energy than that used in the homes.

Indirect energy consumption is generally higher that the energy consumed directly by households.

Account must be taken, in fact, of the overall energy used to produce, distribute and use products by households, ranging from household appliances, to food and cars.

The energy "embodied" in consumer goods is called "indirect energy consumption" and is generally higher than the energy directly consumed by households.

The relatively small proportion of national energy consumption not associated with household consumption is due to the many state or public activities (military industry, schools, hospitals, street lighting, heating and climatization of public buildings, public transport).

It should be highlighted that, due to indirect energy consumption, including the energy embodied in imported goods, total consumption could be even higher that the national energy procurement, if the energy costs of imported goods and services are higher than those incurred for the exported ones.

Indirect energy consumption by households, and the associated emissions, increase constantly with higher incomes and with the energy embodied in the goods and services, thus determining the highest proportion of national consumption.

[44] *Household characteristics by urbanisation degree* [hbs_car_t315], http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=hbs_car_t315&lang=en

Households may, therefore, play a significant role in cutting back on this type of consumption by chosing, for example, eco-compatible goods and services and recycling their waste. Starting in Germany, in 1978, over the last 30 years, a growing number of European countries and regions have introduced "environmental quality marks".

The Ecolabel mark

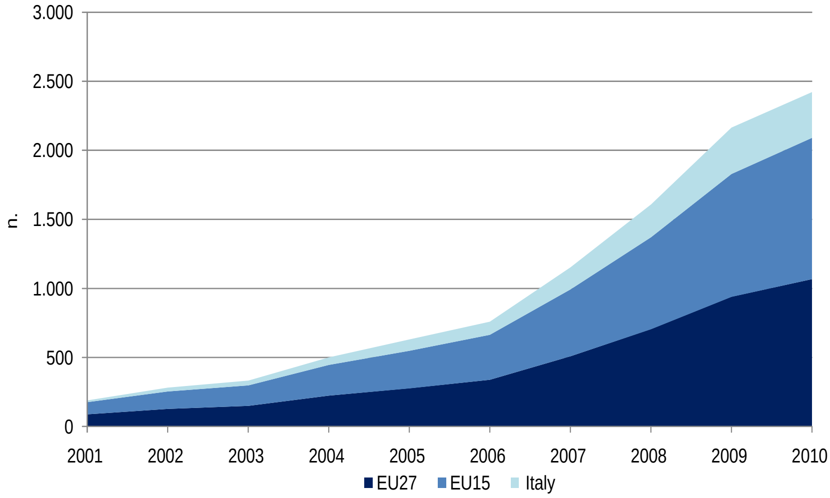
In 1992, the Ecolabel was introduced at Europea level (EU Ecolabel). This is a voluntary certification tool that serves to identify goods and services manufactured and delivered in accordance with certain environmental criteria and requisites, defined based on the entire life-cycle of the product/service[45]: from the extraction of the raw materials out of which it is made, to its production, distribution (including its packaging), use by consumers and, last but not least, disposal (the so-called "from the cradle to the grave" approach). This assessment takes into account all the possible impacts it may create throughout its life-cycle, including water and energy consumption, the toxicity of the substances it contains and the necessary use of resources. The set of criteria is defined by a panel of experts representing the Member States, manufacturers, consumers and environmental NGOs.

The Ecolabel is awarded only after an assessment of the required high environmental performance standards, by the competent independent body set up in each Member State of the European Union.

The Ecolabel logo, depicting a flower, enables consumers to easily identify "green" products, through an environmental quality mark.

The EU Ecolabel currently covers about 25 types of products and services, including: cleaning products, household appliances, electronic equipment, textiles, home and gardening products, lubricants, tourist accommodation services. The mark is recognized in all EU Member States and in Norway, Liechtenstein and Iceland. In 2010, 1,067 EU Ecolabels were awarded in the EU27, no less than 331 in Italy alone.

[45] For further information visit: http://ec.europa.eu/environment/ecolabel/index_en.htm



In 2010, 1,067 EU Ecolabels were awarded in the EU27, no less than 331 in Italy alone.

Figure IV.12: EU Ecolabel licenses awarded in the EU27, EU15 and Italy[46]

The EU Ecolabel, besides helping consumers identify eco-compatible products, also serves the purpose of promoting those companies and manufacturers that respect the environment, singling them out from the competition.

IV.5 Conclusions

European households can influence the environment through their everyday actions and choices, regarding which products and services to buy and how to use them, where to live, where to work, how to use their leisure time and travel. These decisions are made within confines that are conditioned by urban planning, transport infrastructures and the availability of housing. For instance, increased transportation costs affect the use of energy, the quality of the air and climate change. Transportation and domestic heating are direct sources of carbon dioxide. Households, however, contribute indirectly as well to GHG pollution, by purchasing goods and services whose emissions are embodied in the relevant production, distribution and disposal phases.

Households affect the environment through their daily decisions.

The population statistics show how European households are becoming increasingly smaller, and therefore each member uses more space, more goods and services, more energy and and water, producing increasing amounts of waste and emissions.

Moreover, most European households are buying larger and larger amounts of different food products from all over the world, as well as increasing amounts of motor vehicles and household appliances. The statistics also show increased numbers of private motor vehicles and the growing use and ownership of second homes, electronic consumer goods, highly processed and packaged foodstuffs and waste generation.

Household expenditure on food and beverages have increased, albeit not at the same rate as the overall budget, which means that the

[46] Source: Eurostat data (tsdpc420) processed by the ISPRA

percentage spending for food by households has dropped. Household spending, in fact, has shifted from the basic necessities, such as food, to other sectors, such as leisure activities or communication.

Food choices (diet) can significantly affect the use of resources and the environmental effects of the various stages of the life-cycle of a product, such as production, wholesale and retail sales. For example, consumers can choose to eat organically, to adopt a less meat-intensive diet or prefer locally-sourced fruit and seasonal vegetables. By going for food products with a low environmental impact (for example, “zero-mile” fruit and vegetables), consumers can help reduce the indirect effects of food consumption.

The energy efficiency of European homes has gradually increased over the years.

The energy efficiency of European houses has increased, primarily as a result of the improved use of isolation and the energy efficiency of heating systems and conventional equipment. However, Europeans also live in larger homes and they buy and use an increasing amount of electronic equipment and gadgets. This means that the final consumption of energy by households has remained substantially stable, even though the use of electricity has increased. Private motor vehicles and airplanes are the most widely used means of transport, and those that consume the most energy too. The introduction of regulations promoting technological improvements and greater fuel efficiency has successfully reduced the amount of emissions into the air of certain pollutants, such as acidifying substances, but a lot can still be done to direct mobility-related behaviour towards a greater degree of sustainability.

Obviously, households do not have full control over the environmental pressures they directly or indirectly generate.

Obviously, households do not have full control over the environmental pressures they directly or indirectly generate. For example, the energy required for heating essentially depends on how the house has been built and on the temperature at which the rooms are kept. The capacity of private citizens have of influencing these problems is variable. Moreover, consumption for private travel and the resulting CO_2 emissions depends on the fuel, the vehicle, the distance travelled and the number of passengers.

Transportation.

The amount of fuel used also depends on the manner of driving, which, in turn, depends on urban planning, infrastructures and alternative transport systems. Very often, people have few or no alternative options to the use of private vehicles, when they need to do some shopping, visit friends or relatives or run errands.

In the case of long-distance travel, energy consumption depends, first and foremost, on the destination (distance), and secondly on the means of transport used: motor vehicle (direct household consumption) or airplane (indirect).

Lighting.

In the case of lighting, the number of lamps, kilowatts, efficiency and time for which the lights are on are decisive factors at household level. Moreover, the electricity consumed by a refrigerator, for example, is primary determined by the efficiency of the appliance and not how it is used. In any case, when purchasing, consumers should be able to consider the energy efficiency of the product, by means of the energy efficiency label, along with its other characteristics. Examples of controlable energy conservation and emission reduction measures include the heat isolation of buildings, purchasing low-consumption vehicles or using public transport, chosing more efficient lamps, using wood for heating and reducing consumption by not leaving equipment in standby mode.

Wastewater.

Wastewater from household represents a significant environmental pressure. In northern and western Europe, most of the population is now connected to wastewater treatment plants and many have tertiary treatments, which remove the nutrients and organic matter. The percentage of the population connected to wastewater treatment, is still relatively low in central and eastern Europe, although the trend is increasing.

In conclusion, consumption by European households can be deemed one of the principal causes for the increased pressures on the environment, through the use of natural resources and the production of undesired byproducts, such as GHG emissions, household waste or wastewater. In the EU15, increased income levels and household expenditure have led to an overall increase in the impact of household consumption on the environment. Nevertheless, household consumption can also offer opportunities for the development of more “eco-compatible” goods and services (such as, for example, Ecolabel certified products, more energy-efficient equipment and reduced packaging).

GLOSSARY

Biogas:

a gas mixture primarily comprising methane (40-70%) and carbon dioxide (30-60%). It is obtained through anaerobic fermentation in the presence of micro-organisms (acidogens, acetogens and methanogens) of livestock manure, the organic fraction of municipal waste, industrial and agricultural waste or sewage treatment sludge.

Co-incineration:

the joint combustion of conventional and alternative fuels.

Energy efficiency:

the energy efficiency of a system – whether industrial or civil and residential – is the capacity to best exploit the energy made available to the system itself, as “efficiently” as possible.

Final energy:

the energy used by the consumer is called final or useful energy. Examples of this are the petrol in the tank or the electricity in the socket.

Leachate:

the liquid produced during the anaerobic decomposition of the organic substances present in municipal waste.

CHAPTER 1

CLIMATE CHANGE AND ENERGY

Introduction

The United Nations Conference on Climate Change that, starting on 28 November 2011, was scheduled to end by 9 December, went on until 11 December through a long series of plenary sessions.

The outcome of the Conference, which was entrusted with the arduous task of defining an organic set of commitments to curb emissions in both the developed and the developing countries further to the conclusion of the first commitment period of the Kyoto Protocol (2008-2012), has been judged in different ways by different observers.

The United Nations Conference that ended in Durban on 11 December 2011 was entrusted with the task of defining an organic set of commitments to curb emissions in both the developed and developing countries further to the conclusion of the first Kyoto Protocol commitment period (2008-2012).

This difficulty is comprehensible if one keeps into account both the complexity of the negotiations, which took place at six parallel negotiation tables, and the multiplicity and variety of the issues being debated, which ranged from the transition to low-carbon energy sources, to the fight against deforestation and the financing of measure to adapt to the impact of climate change in extremely vulnerable countries, with the involvement of colossal geopolitical and strategic interests.

The intensive negotiations in Durban have led to several results that should not be underestimated, in particular insofar as it concerns two decisions relating to the limitation of the emissions that, as a whole, prefigure an ambitious global system to mitigate climate changes.

The negotiations in Durban have led to several results that should not be underestimated, including two decisions relating to the reduction of emissions.

1st Decision – The Conference decided to continue with a second commitment period of the Kyoto Protocol, setting legally binding targets for the reduction of the emissions for just a few Annex I Parties[1].

This second commitment period shall begin in January 2013 and shall most likely continue until 2017. Not all the Annex I Parties are going to participate in the Kyoto-2 commitment: Canada, Japan, Russia and the United States have already given up for a variety of reasons.

The only ones left are Europe, Australia, New Zealand, Switzerland, Norway and a few more countries. The reductions by 2020 of the overall emissions currently being debated by the participating countries oscillate between 15% and 25% with respect to 1990.

The quantification of the actual commitments of the various countries shall be determined at a later date, based on the information on the reduction objectives that the countries are required to submit by May 2012.

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[1] There are 39 Annex I Parties, namely: Australia, Austria, Belgium, Bulgaria, Canada, European Community, Croatia, Denmark, Estonia, Russian Federation, Finland, France, Germany, Japan, Greece, Ireland, Iceland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Norway, New Zealand, Netherlands, Poland, Portugal, United Kingdom of Great Britain and Northern Ireland, Czech Republic, Rumania, Slovakia, Slovenia, Spain, United States of America, Sweden, Switzerland, Ukraine, Hungary.

The European Union has already committed itself to reducing overall emission by 20% by 2020 with respect to 1990 values.
In any event, it is willing to consider more ambitious targets if other countries undertake to make similar efforts.
Considering that the countries that are now participating in the second commitment period of the Kyoto Protocol account for no more than 15% of the global emissions, this decision should not be assessed based on its numerical (little more than symbolic) significance. Indeed, this decision has a definite political significance: to convince developing countries to accept the so-called "Durban Platform".

The European Union has already committed itself to reducing its overall emission by 20% by 2020 with respect to the 1990 values. However, it is willing to consider more ambitious targets if other countries undertake to make similar efforts.

It is not going to be a total disengagement for the industrialized countries that are not going to take part in the second commitment period under the Kyoto Protocol. The United States, for instance, have confirmed the offer made in Copenhagen of a 17% voluntary reduction of the emissions by 2020 with respect to 2005.
Even though, for the time being, this is more a good intention than a binding commitment, one should nonetheless appreciate the greater ambition with respect to the past.

2nd Decision – It entails the establishment of an Ad Hoc Working Group on the Durban Platform to develop a "*protocol, another legal instrument or an agreed outcome with legal force under the Convention*" applicable to all Parties. The Working Group will have to deal with such fundamental issues as mitigation, adaptation, finance, technology and capacity building. Hence, this Group shall aim at raising the level of "global ambition", based also on the outcome of Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) that is going to be published between 2013 and 2014. A fundamental aspect is that the "Developing Countries" (i.e., China and India) have finally accepted the idea that they also have "*binding*" objectives (starting from 2020). Even though it is going to be definitely hard to get to an agreement in 2015, and quite a few aspects have still to be untangled (particularly insofar as the nature of an "*instrument having legal force*" is concerned), the Durban Convention has laid the bases for overcoming the dichotomy between rich countries and poor countries that, since time immemorial, has held hostage the entire debate on the reduction commitments, preventing it from stepping forward.
While the compromise that has been reached fails to define any legally binding and immediately effective ambitious objective for the reduction of the emissions, it is quite likely that the failure to reach an agreement would have put strain on the climatic multilateralism causing a further downsizing of the mitigation expectations.

A decisive role for the attainment of this result has been played by the cooperative climate patiently created by the South African Presidency of the Conference, which has also paid specific attention to the negotiation priorities and requirements of the various groups of countries, particularly the least developed ones.
In particular, a number of decisions have promoted a much more positive attitude with respect to the negotiations on the part of the Alliance of Small Island States (AOSIS) and the Least Developed Countries (LDC), as well as important emergent countries such as Brazil. These decisions include the start up of the Green Climate Fund that, with an expected appropriation of USD 100 billion per year by 2020, is to fund the mitigation and adaptation measures in developing Counties, and the definition of the fundamental rules for the operation of the REDD+ (Reducing Emissions from Deforestation and Forest Degradation) mechanism. The latter is to provide technological and financial support to the measures to mitigate the emissions resulting from deforestation and forest degradation and to address forest conservation in tropical countries.

More in general, the success of the Durban Agreement in providing during the forthcoming years an effective answer to the urgent need of reducing global emissions will not be measured exclusively through the involvment – with binding objectives - of all the leading economies of the Planet, as it will also be measured through the introduction of mechanisms promoting a reconversion of the economies and the productive processes towards sustainable development.
In this connection, in June 2012, twenty years after the first Earth Summit, Rio de Janeiro will host the United Nations Conference on Sustainable Development (or "Rio+20"), an extremely important appointment to take stock of and relaunch sustainable development. The debate at Rio+20 is going to address the green economy namely, according to the definition of the European Commission, "*an economy that generates jobs and eradicates poverty by investing in and preserving the natural capital offers upon which the long-term survival of our planet depends*"[2]. The European documents drawn up in preparation for the United Nations Conference have given considerable relevance to the strengthening of the international governance to revive sustainable development. The Communication of the European Commission concerning Rio+20 points to three interlinked policy dimensions that need to be addressed to achieve the transition to a green economy:

- investing in the sustainable management of key resources and natural capital;
- establishing the right market and regulatory conditions;
- improving governance and private sector involvement.

[2] EC, 2011, *Rio+20: towards the green economy and better governance*, COM(2011)363

Quite recently, the UNEP (United Nations Environment Programme)[3] published a report that "*aims to debunk several myths and misconceptions about "greening" the global economy, and provides timely and practical guidance to policy makers on what reforms they need to unlock the productive and employment potential of a green economy*". The UNEP defines a green economy "*as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities*". This means a low-carbon, efficient and socially inclusive economy. The UNEP report shows that the investment of 2% of the global GDP in key sectors of the economy per year, from now until 2050, may initiate the transition towards an efficient and low-carbon economy. The UNEP concludes that the green economy is not inconsistent with economic growth and, indeed, after a six-year period, it is likely to generate a higher GDP growth than would otherwise be possible in the current situation. The transition phase may result in job losses that are going to be subquently offset by the creation of added employment in the new sectors. Therefore, investments are needed in the transitional phase to reorient the competences in the labor world. The UNEP points to the utmost significance of reforming the system of incentives damaging the environment with a view to releasing economic resources to be used in the transition phase and stimulating the sectors of the green economy.

For instance, the elimination of the subsidies to fossil-fuels is a measure that has already been suggested by the International Energy Agency (IEA)[4] that affirms that, "*eradicating subsidies to fossil fuels would enhance energy security, reduce emissions of greenhouse gases and air pollution, and bring economic benefits*". The fossil-fuel sussidies contribute to artificially lowering energy prices that, in their turn, blur market signals and undermine the competitiveness of renewables and more efficient energy technologies. Always according to the IEA[5], "*removing fossil-fuel consumption subsidies could represent an integral building block for tackling climate change: their complete removal could reduce CO_2 emissions by 5.8%, or 2 Gt in 2020*".

As for the incentives provided to the productive sectors in Europe, a recent report of the European Parliament[6] analyzes the various fields of Community expenditure in relation to their environmental sustainability. In the report, the European Parliament acknowledges that several sectors benefit from support given by national governments; while these incentives seek in principle to achieve environmentally compatible objectives, they end up having environmentally harmful side-effects.

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[3] UNEP, 2011, *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*
[4] IEA, 2010, *World Energy Outlook 2010*
[5] IEA, 2010, *World Energy Outlook 2010*
[6] European Parliament, 2011, *EU subsidies for polluting and unsustainable practices*

According to the study, the EU Common Agricultural Policy (CAP) has often favored large and intensive producers. The Structural and Cohesion Funds (344 billion Euro in the period 2007-2013) are for the most part oriented towards the solution of environmental problems, such as the management of household and industrial waste or the rehabilitation of industrial sites and contaminated land (nearly 69% of the financial volume), rather than being oriented towards the prevention and control of pollution. In the transport sector, 12% (41 billion Euro) of the Structural and Cohesion Funds are intended for road-based transport infrastructures. In the energy sector, the annual expenditure of the period 2007-2013 amounts to 2.9 billion Euro, 54% of which managed through the Structural and Cohesion Funds. The fusion energy research has a 13.9% share of the Funds, in addition to 11.6% of the Funds intended for nuclear energy under different titles. Out of the Funds for this sector, a 28.3% share is intended for renewable energies and a 21.4% share for energy efficiency. Although the energy expenditure appears to be more oriented towards sustainability, the European Parliament reccommends caution in the interpretation of the results of the assessment, as several items have been left out due to the uncertainty related to their sustainability (such as nuclear energy and the capture and storage of CO_2).

As stressed by a recent OECD report[7], which suggests a series of indicators to monitor the development of the green growth, a return to business as usual after having come out of the current economic crisis "*would indeed be unwise and ultimately unsustainable, involving risks that could impose human costs and constraints on economic growth and development. It could result in increased water scarcity, resource bottlenecks, air and water pollution, climate change and biodiversity loss which would be irreversible*".

Basic climate trends

Worldwide

The warming of the global climate system currently stands as an undisputed fact, as shown by the observed increases in the global mean atmospheric and oceanic temperatures, as well as the melting of the polar ice caps (especially in the Arctic), the shrinking of glaciers in the middle latitudes (including the snow covering) and the rise in the mean level of the oceans. The increase in the mean temperature observed in recent decades, both globally and in Europe, is unusual in terms of both its extent and its rate of variation.

The increase in temperature observed in recent decades, both globally and in Europe, is unusual.

[7] OECD, 2011, *Towards Green Growth: Monitoring Progress - OECD Indicators*

Based on the Fourth Assessment Report of the IPCC, the overall increase in global mean temperature (the land-ocean system[8]) as at 2005 was 0.7°C compared to pre-industrial levels. During the last century (1905-2005), the mean temperature of the planet rose by 0.74°C, at increasingly higher rates. In the decades before 1950, the mean increase rate was less than 0.06°C per decade, while, over the last 50 years, it has increased to 0.13°C per decade, and more recently (the last few decades), it has reached approximately 0.25°C per decade.

The analyses updated by the National Oceanic and Atmospheric Administration (NOAA) show that 2010, with a +0.62°C anomaly with respect to the mean temperature of the 20th century, has been, together with 2005, the warmest year of the entire series of the land-ocean global mean temperature (Figure 1.1).

The estimates relative to 2010 show an anomaly in the global mean temperature of 0.62°C with respect to the mean value of the 20th century. Keeping into account the margins of uncertainty, this datum causes 2010 to rank first among all the warmest years of the entire series along with 2005.

Starting from 1850, the fourteen highest annual temperature values have been reported in the years from 1997 to 2010.

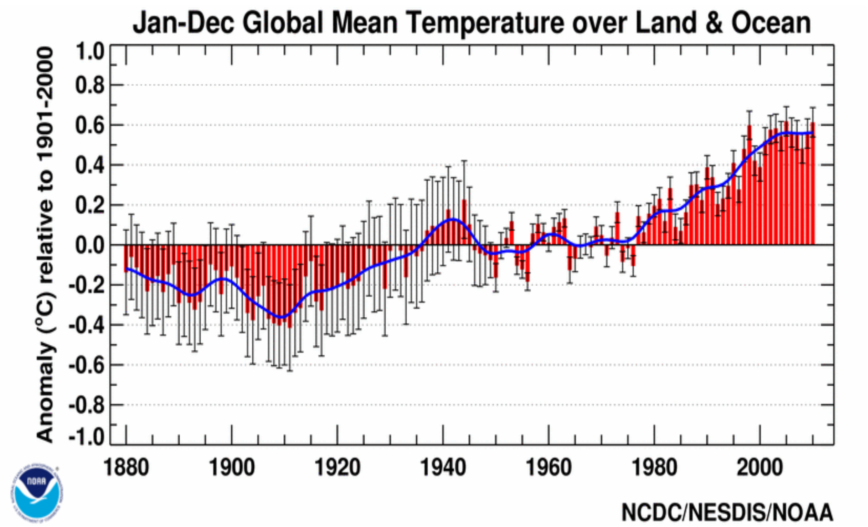


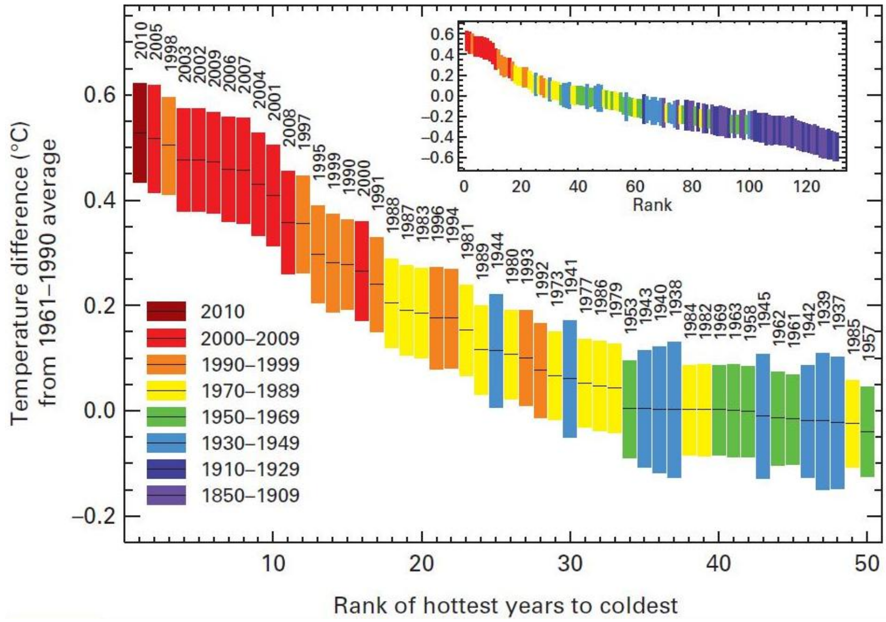
Figure 1.1: Series of the annual anomalies[9] in the global mean temperature (land-ocean system)[10]

The 2001-2010 decade (0.56°C above the average for the 20th century) has been 0.36°C warmer than the period 1991-2000 (0.24°C above the average for 1961-1990). The preliminary data processed by NOAA relative to 2011 show that, with a global mean land-ocean anomaly of 0.51°C with respect to the 20th century mean, it ranks 11th in the entire series. With 2011, the number of consecutive years with a positive global temperature anomaly gets to 35. The ranking of the 50 highest years in terms of global mean surface temperature, as illustrated in Figure 1.2 published by the World Meteorological Organization, shows the year 2010 in 10th place, even though the difference with respect to the previous highest years (2005 and 1998) are not statistically significant. However, the ranking of the most recent years, from 1990 to 2010, in the leading positions is generally confirmed.

8 In this document, the term "land-ocean" indicates that the temperature was calculated by taking into account both the temperature of the air on dry land and the surface temperature of the sea, while the phrase "land only" means that the reading refers only to the temperature of the air on dry land

9 Anomalies calculated with respect to the reference period 1961-1990

10 Source: NCDC/NESDIS/NOAA



Legend:
The insert shows the ranking of the global mean surface temperatures starting from 1850.
The dimensions of the bars show a 95% confidence interval.

The ranking of the global mean surface temperature in the 50 warmest years shows that 2010 ranks first.

Figure 1.2: Ranking of the global mean surface temperatures for the 50 warmest years[11]

As for the precipitation trends from 1900 to 2005, a noteworthy increase was observed in the eastern regions of North and South America, in Northern Europe and in Northern and Central Asia, while a reduction was observed in the Sahel region, the Mediterranean, Southern Africa and certain parts of Southern Asia.

Changes in climate variables also lead to increases in the frequency, intensity and duration of extreme events, such as floods, droughts and heat waves.

Changes in climate variables also lead to increases in the frequency, intensity and duration of extreme events, such as floods, droughts and **heat waves**. The frequency of intense precipitation events has risen in most parts of the Earth surface above water, in parallel with the warming trend and the increase in atmospheric water vapor. The IPCC has dealt with the issue of extreme events with particular interest. During the first joint section of the IPCC working groups I and II, the IPCC has recently approved (November 2011) in Kampala (Uganda) the Summary for Policymakers of the Special Report "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation"[12] (SREX).
According to the report, it is quite likely that the greenhouse gas emissions are the cause of a few trends that are being observed in respect of extreme events.
In fact, according to the report, it is highly probable that the increase in climate changing gases in the atmosphere has led to an increase in

[11] Source: World Meteorological Organization (2011), *WMO statement on the status of global climate in 2010. Report* WMO, no. 1074, Geneva 2011

[12] IPCC, 2011: *Summary for Policymakers*. In: *Intergovernmental Panel on Climate Change Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* [Field, C. B., Barros, V., Stocker, T. F., Qin, D., Dokken, D., Ebi, K. L., Mastrandrea, M. D., Mach, K. J., Plattner, G.-K., Allen, S., Tignor, M. and P. M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

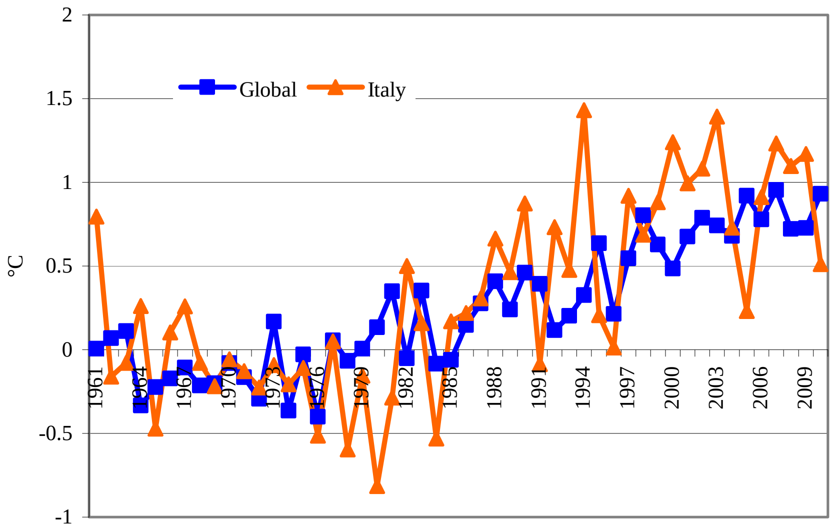
temperature extremes and states with medium confidence that anthropogenic influences have contributed to a worldwide intensification of extreme precipitation events.
These results are quite significant, but not surprising since they are consistent with what science expects in a warmer world. Furthermore, the document describes the costs – in terms of loss of human lives and economic damages – already incurred, in addition to those that are most likely to be borne with the intensification of extreme phenomena and the social implications of a warmer world. An increase in extreme meteo-climatic events has been observed in a few areas of the world, in particular in respect of daily temperature extremes and heat waves. According to the SREX estimates, a further increase should be expected in the 21st century, with greater risks for the livelihood, human health and infrastructures.
It is virtually certain (99-100%) that there is going to be an increase in the frequency of extreme daily temperatures and a decrease in cold extremes worldwide. It is very likely (90-100%) that the length, frequency and intensity of the heat waves will increase in many areas. Besides, it is likely (66-100%) that the frequency of extreme precipitation events will increase in many areas.
There is medium confidence that droughts will intensify in the 21st century in a few specific areas (southern Europe and the Mediterranean region, central Europe, central North America, Mexico, and northeast Brazil). Projected precipitation and temperature changes imply possible changes in flood phenomena, even though the limited evidence and the complexity of the causes reduce the confidence level at global scale.

Italy

Temperatures

The recent climate trends in Italy may be evaluated through data and climate indicators processed through the national system for the collection, processing and diffusion of climatological data of environmental interest (SCIA). This system, implemented by ISPRA and updated on a yearly basis, stores the time series of observations made by the network of the Air Force Meteorological Service, the CRA-CMA, ten ARPA and the agrometeorological services of the Marche and Sicily Regions[13].
The estimate of the mean temperature variation in Italy is based on the longest and most complete time series. Furthermore, the series are subjected to homogeneity tests and, if need be, they are corrected with a view to filtering any non-climatic signal, such as the displacement of the measuring station or a change in the instrumentation.
Figure 1.3 shows the trend of the mean temperature in Italy with respect to the global mean on land, from 1961 to 2010.

[13] Desiato F., Lena F. and Toreti A., 2007, *SCIA: a system for a better knowledge of the Italian climate.* Bollettino di Geofisica Teorica ed Applicata, Vol. 48, no. 3 351-358



2010 has been for Italy the 19th consecutive year with a positive thermal anomaly, but the anomaly of the mean temperature has been lower than the global temperature on land.

Figure 1.3: Time series of the mean temperature anomalies worldwide and in Italy with respect to normal climatological values 1961-1990[14]

The increase in the mean temperature reported in Italy in the last three decades has almost always exceeded the global mean on land. However, in 2010, Italy's temperature anomaly (+0.51°C) has been lower than the global temperature anomaly on land (+0.93°C). The year 2010 has been the nineteenth consecutive year with a positive temperature anomaly, with a value that is the eighteenth of the series since 1961[15]. A detailed seasonal analysis of the trends for northern, central and southern Italy shows that the increase in mean temperature was noteworthy throughout the country in the autumn starting from 1970 and in the summer from 1980. On the other hand, throughout the period 1961-2006, there were significant increases in the north in the winter and in the central-southern regions in the spring[16].

Extreme temperature events

The warming trend may also be inferred from the analysis of a few indicators relative to extreme temperature values. In the last 14 years, the "summer days" and the "tropical nights" have always been higher than the respective

The warming trend may also be inferred from the analysis of a few indicators relative to extreme temperature values. In the last 14 years, the "summer days"[17] (Figure 1.4) and the "tropical nights" [18] (Figure 1.5) have always been higher than the respective climatologic means. In particular, in 2010, the number of tropical nights ranks seventh in the entire series since 1961. Finally, due consideration is given to the "heat waves", which represent events lasting at least 3 days where the maximum daily temperature exceeds the 95th percentile of the distribution of the maximum daily temperatures of the thirty-year

[14] Source: ISPRA and NCDC/NOAA

[15] ISPRA, *Gli indicatori del clima in Italia nel 2010*, Report from the State of the Environment Series, no. 9/2011, Year VI

[16] Toreti A., Desiato F., Fioravanti G. and Perconti W., 2009, *Seasonal temperatures over Italy and their relationship with low-frequency atmospheric circulation patterns, Climatic Change*, doi 10.1007/s10584-009-9640-0

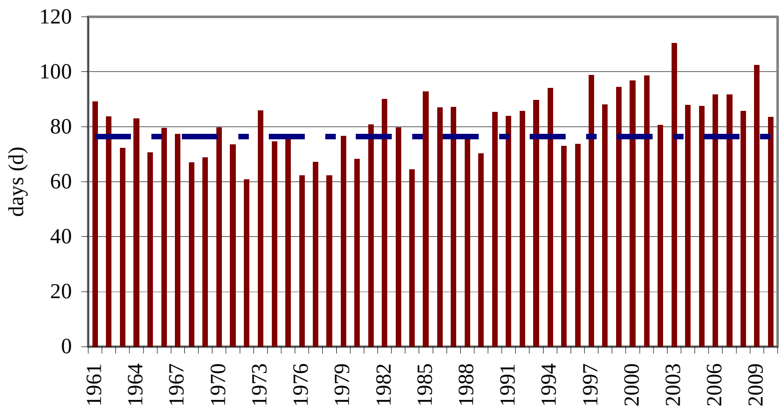
[17] Number of days with a maximum air temperature over 25 °C

[18] Number of days with a minimum air temperature over 20 °C

climatological period going from 1961 to 1990.

Figure 1.6 shows the mean trend in Italy of the "heat wave intensity" index, which represents the mean value (in °C) of the temperature peaks over the threshold, cumulated in the course of the events. Over the last 30 years, the trend is definitely on the increase and the heat wave intensity in the summer of 2003 is undoubtedly exceptional.

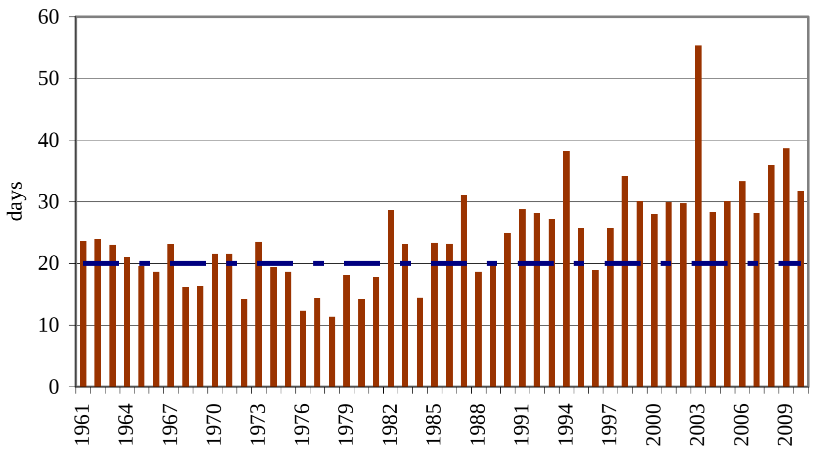
climatologic means.



In the last 14 years, the "summer days", that is days with a maximum air temperature over 25 °C, have always been higher that the climatological average.

Legend:
The dotted line indicates the normal mean value calculated for the reference period 1961-1990
Note:
Homogenized time series of 50 stations

Figure 1.4: Annual series of the mean number of summer days (maximum temperature > 25°C)[19]

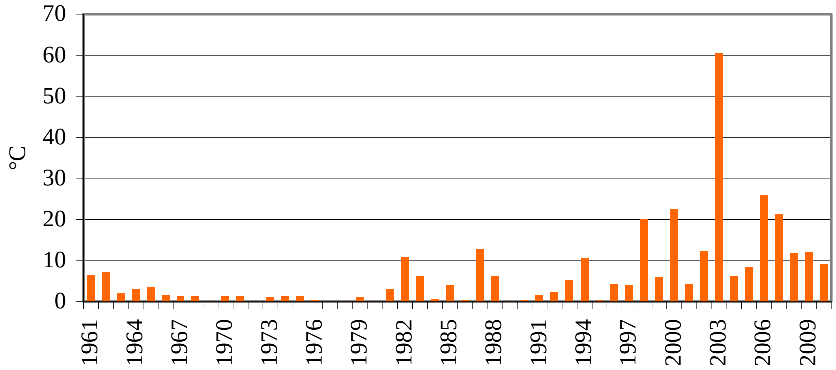


In the last 14 years, the "tropical nights", that is nights with a minimum air temperature over 20 °C, have always been higher that the climatological average

Legend:
The dotted line indicates the normal mean value calculated for the reference period 1961-1990
Note:
Homogenized time series of 50 stations

Figure 1.5: Annual series of the mean number of tropical nights (minimum temperature > 20°C)[20]

[19] Source: ISPRA processing of data collected by the synoptic and regional network stations
[20] Source: ISPRA processing of data collected by the synoptic and regional network stations



The "heat wave intensity" index represents the mean value of the maximum daily temperature peaks with respect to a threshold value.

Note:
Homogenized time series of 50 stations

Figure 1.6: Mean intensity of the heat waves from 1961 to 2010[21]

Insofar as the long-term precipitation trends are concerned, CNR studies have shown that, trends are in general negative, though only to a slight extent, and often have little statistical significance.

Precipitations

In terms of long-term precipitation trends, studies of the Italian National Research Council (CNR)[22] indicate that, "trends are in general negative, though only to a slight extent, and often have little statistical significance.

The magnitude of the reduction in precipitation is in the order of 5% per century; it would appear to be traceable primarily to the spring, the season when the precipitation reduction approximates 10% per century"[23].

Even though the precipitation series from 1951 to the present, processed through the SCIA system, are characterized by a rather inhomogeneous spatial and temporal coverage, they allow nonetheless to calculate with the Thiessen (or Voronoi) polygons technique[24] the annual cumulated precipitation series referred to a given geographical area.

Figure 1.7 shows the annual series of anomalies of the mean cumulated precipitation throughout the Italian territory with respect to the normal value calculated in the climatological period 1961-1990.

In the last thirty years, the precipitation has been mostly lower than the 1961-1990 climatological mean.

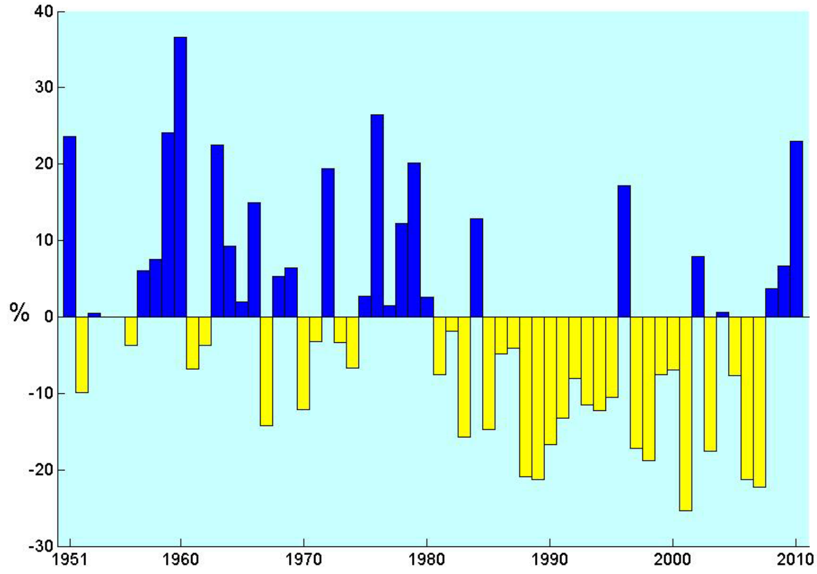
In fact, since 1981, the precipitation events have been heavier than the mean value for just seven years, three of which are the most recent years (2008, 2009 and 2010). In 2010, the precipitation events in Italy have exceeded the 1961-1990 climatological mean by nearly 23%.

[21] Source: ISPRA processing of data collected by the synoptic and regional network stations

[22] Brunetti M. et al., 2006, *Temperature and precipitation variability in Italy in the last two centuries from homogenized instrumental time series*, International Journal of Climatology, vol. 26:345-381

[23] Nanni T. and Prodi F., 2008, Energia, no. 1, 2008, pp. 66-71

[24] Antonio Mestre Barcelò, 718 WG1., *Report on rainfall spatialisation*, 2002 – Cost 718 Meteorological Applications for Agriculture



In the last thirty years, the precipitation events have been mostly below the climatological average for the period 1961-1990. In fact, since 1981, they have exceeded the mean value for just seven years, three of which are the most recent years (2008, 2009 and 2010).

Figure 1.7: Series of the mean cumulated precipitation anomalies throughout the national territory with respect to the 1961-1990 reference period (percentage values)[25]

Extreme precipitation events

The analysis of extreme precipitation events, as well as the evaluation of the signs, if any, of the variations of the intensity and frequency of heavy precipitation, requires long and sufficiently continuous time series.

Starting from the maximum daily precipitation value, a map of this indicator over the entire national territory may be reconstructed thanks to the good spatial coverage and high density of the available time series that refer for the most part to the pluviographic network of the former National Hydrographic and Marigraphic Service.

Figure 1.8 shows the spatial distribution of the maximum daily precipitation during the reference period 1951-1980, which is similar to that of the period 1961-1990.

It should be understood that "maximum daily" precipitation means the maximum cumulated precipitation at fixed 24-hour intervals rather than at 24-hour intervals at variable times.

The strongest maximum daily precipitation events are reported in Liguria, Val d'Ossola, Carnic Alps and Pre-alps, Calabria and Ionian side of Sicily; the highest values exceed 400 mm/day, while the most frequent values over the entire national territory range from 50 to 200 mm/day.

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[25] Source: ISPRA processing of data collected by the synoptic and regional network stations

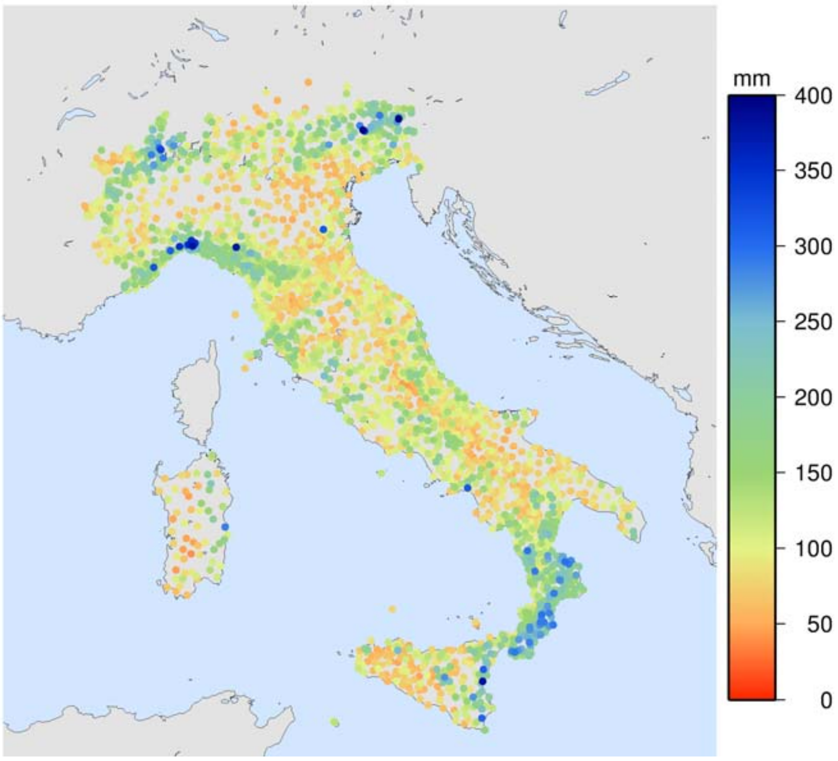

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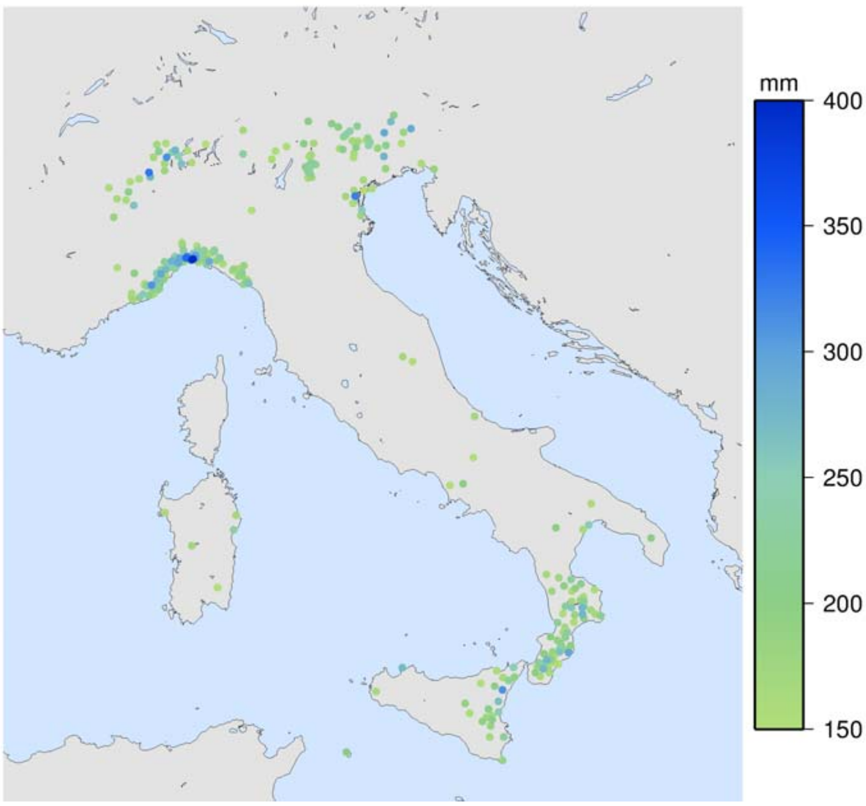
Figure 1.8: Maximum daily precipitation in the 1951-1980 climatological reference period[26]



Considering the 150 highest values, the maximum daily precipitation events in the ten-year period 2001-2010 are reported in Liguria.

Figure 1.9: Maximum daily precipitation in the period 2001-2010 in the stations with the highest values[27]

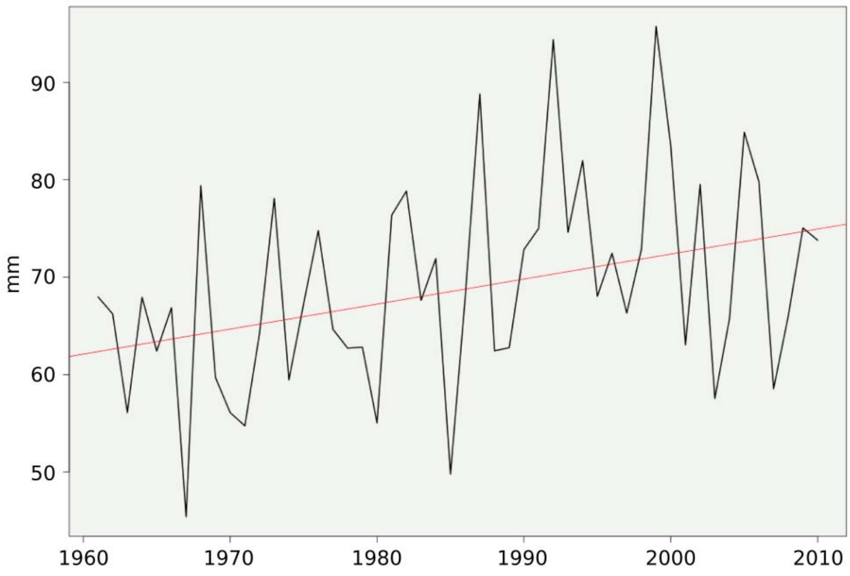
[26] Source: ISPRA
[27] Source: ISPRA

With reference to the latest period, the density and spatial coverage of the available data are definitely lower.
However, starting from a data set that is nonetheless deemed significant, highest maximum daily precipitation values may be extracted and represented as a graph.
The 150 highest values recorded in the 2001-2010 decade are shown in Figure 1.9. The maximum values are recorded in Liguria, in particular: 411 mm at the Santuario Monte Gazzo station; 377 mm at Genova Pegli; and 337 mm at Fiorino.
Furthermore, the maximum 24-hour precipitation measure recorded at Brugnato during the downpour that hit the La Spezia Province in October 2011 is definitely noteworthy: 539 mm[28].

In order to evaluate the long-term trend of the maximum daily precipitation, the analysis is necessarily limited to the most complete, uninterrupted and updated time series.
After having selected nearly 40 stations meeting these requirements and having defined three clusters of stations relative to as many geo-climatic areas (Northern Italy-low altitude, Tyrrhenian basin, Southern Italy and Sicily), the mean values of the maximum daily precipitation for each area have been calculated for each year during the period 1951-2010.
The results show the existence of a positive trend (at a 5% significance level) for the stations in northern Italy, with a mean increase of 26 mm/100 years (Figure 1.10).
No statistically significant trends were found for the other two areas.

The analysis to assess the long-term trend of the maximum daily precipitation shows the existence of a positive trend for the stations in northern Italy.

[28] Arpa Liguria



The analysis to assess the long-term trend of the maximum daily precipitation shows the existence of a positive trend for the stations in northern Italy, with an mean increase of 26 mm/100 years.

Figure 1.10: Trend of the maximum daily precipitation over the last 50 years. Mean value in 12 stations at low altitude in northern Italy[29]

Considering the maximum precipitation at shorter time intervals (one hour, six hours and twelve hours), Tables 1.1, 1.2 and 1.3 show the 50 maximum values reported in the 2001-2010 decade, starting from a database that covers in an adequate manner the following Regions: Aosta Valley, Piedmont, Lombardy, Liguria, Veneto, Friuli-Venezia Giulia, Emilia-Romagna, Marche, and Sicily.
The heaviest precipitation values taken from this database are approximately 165 mm/hour, 321 mm/6 hours and 337 mm/12 hours.
Even in this case, a few figures stand out, including the one-hour maximum precipitation measure reported at Vicomorasso (GE) on 4 November 2011 (181 mm) and the one-hour, 6-hour, and 12-hour maximum precipitation measures reported at Brugnato (SP) in October 2011: 153 mm, 472 mm and 511 mm, respectively[30].

[29] Source: ISPRA
[30] Arpa Liguria

Table 1.1: One-hour maximum cumulated precipitation (2001-2010)[31]

Region	Station	Value mm	Year
PIEDMONT			
	Pallanza	92.2	2009
LOMBARDY			
	Funivia Bernina - Chiesa Valma	161.2	2001
	Ponte Briolo - Valbrembo	88.8	2008
VENETO			
	Rosolina Po di Tramontana	98.2	2008
	Valle Averto	95.4	2007
	Agna	85.0	2009
	Feltre	79.0	2009
LIGURIA			
	Polanesi	146.0	2007
	Santuario Monte Gazzo	123.8	2010
	Lavagnola	117.6	2005
	Santuario di Savona	102.6	2005
	Madonna delle Grazie	100.2	2004
	Altare	99.4	2006
	Fiorino	99.0	2009
	Mele	96.8	2005
	Pero	96.2	2010
	Ellera (Ponte Poggi)	95.4	2005
	Romito Magra	95.0	2004
	Vicomorasso	92.8	2006
	Lerca	91.6	2010
	Genova-Pegli	90.8	2010
	Mele	90.8	2006
	Fiorino	90.6	2006
	Bargagli	90.0	2010
	Colonia Arnaldi	89.2	2010
	Righi	87.8	2008
	Colle Melogno	87.4	2005
	Sanda	85.2	2006
	Nasceto	84.4	2010
	Lerca	82.6	2005
	Piana Battolla	82.2	2009
	Passo del Turchino	82.2	2006
	Polanesi	80.0	2008
	Mele	79.8	2007
	Ceriana	79.6	2006
	Fiorino	79.2	2005
	Righi	78.4	2010
	Ranzo	78.4	2006
SARDINIA			
	Orosei	87.8	2008
MARCHE			
	Visso	165.6	2008
	Montelupone	81.6	2006
BASILICATA			
	Terranova di Pollino	148.4	2007
	Tramutola	139.4	2007
	Grumento-Ponte La Marmora	106.2	2007
	S.Giuliano	105.8	2007
	Stigliano	98.4	2003
	Potenza	96.4	2003
	Potenza	92.2	2003
	Grassano Scalo	92.2	2003
SICILY			
	Linguaglossa	86.0	2005

The one-hour maximum cumulated precipitation value shown in a database that covers the Aosta Valley, Piedmont, Lombardy, Liguria, Veneto, Friuli Venezia Giulia, Emilia-Romagna, Marche and Sicily Regions, amounting to 165.6 mm/hour, has been reported in the Marche Region in 2008.

[31] Source: ISPRA

Table 1.2: 6-hour maximum cumulated precipitation (2001-2010)[32]

Region	Station	Value mm	Year
PIEDMONT			
	Pallanza	203.8	2009
	Oropa	174.0	2002
	Piedicavallo	166.4	2002
	Cicogna	161.8	2004
LOMBARDY			
	Funivia Bernina - Chiesa Valma	166.6	2001
VENETO			
	Valle Averto	264.0	2007
	Feltre	205.0	2009
LIGURIA			
	Fiorino	321.2	2006
	Mele	283.4	2006
	Santuario Monte Gazzo	271.6	2010
	Genova-Pegli	269.4	2010
	Passo del Turchino	268.2	2006
	Ranzo	229.4	2006
	Pero	223.6	2006
	Bolzaneto-Trasta	216.2	2010
	Pontedecimo	213.6	2010
	Bargagli	203.2	2010
	Sanda	194.2	2006
	Passo del Turchino	191.4	2007
	Fiorino	188.6	2009
	Polanesi	187.4	2007
	Ellera (Ponte Poggi)	183.4	2005
	Mele	182.2	2007
	Montalto	182.0	2006
	Piampaludo	180.0	2006
	Santuario di Savona	179.4	2005
	Isoverde	179.4	2006
	Romito Magra	178.8	2004
	Busalla	177.2	2006
	Osiglia	173.4	2005
	Lerca	170.8	2010
	Colonia Arnaldi	170.4	2010
	Vicomorasso	169.4	2006
	Viganego	169.4	2010
	Pero	168.8	2010
	Isoverde	164.2	2010
	Valleregia	163.8	2010
	Colle Melogno	163.0	2005
	Mignanego	161.6	2010
	Castelvecchio di R. B.	159.8	2006
	Alpicella	157.0	2006
	Madonna delle Grazie	155.8	2004
SARDINIA			
	Orosei	233.6	2008
	Siniscola	162.0	2008
MARCHE			
	Visso	167.2	2008
APULIA			
	Marina di Ginosa	207.0	2004
SICILY			
	Linguaglossa	209.2	2005
	Linguaglossa	193.8	2008
	Fiumedinisi	185.4	2006
	Torregrotta	166.8	2010

The maximum 6-hour cumulated precipitation value shown in a database that covers the Aosta Valley, Piedmont, Lombardy, Liguria, Veneto, Friuli Venezia Giulia, Emilia-Romagna, Marche and Sicily Regions, amounting to 321.2 mm/6 hours, has been reported in the Liguria Region in 2006.

[32] Source: ISPRA

Table 1.3: 12-hour maximum cumulated precipitation (2001-2010)[33]

The 12-hour maximum cumulated precipitation value shown in a database that covers the Aosta Valley, Piedmont, Lombardy, Liguria, Veneto, Friuli Venezia Giulia, Emilia-Romagna, Marche and Sicily Regions, amounting to 337.4 mm/12 hours, has been reported in the Liguria Region in 2006.

Region	Station	Value mm	Year
PIEDMONT			
	Sambughetto	240.0	2002
	Pallanza	218.8	2009
	Cicogna	192.2	2004
LOMBARDY			
	Ispra	238.6	2002
VENETO			
	Valle Averto	321.2	2007
	Feltre	211.0	2009
FRIULI-VENEZIA GIULIA			
	Chievolis	207.6	2010
	Enemonzo	203.8	2006
	Musi	195.3	2008
	Chievolis	187.7	2009
LIGURIA			
	Fiorino	337.4	2006
	Mele	318.6	2006
	Passo del Turchino	299.2	2006
	Santuario Monte Gazzo	271.6	2010
	Ranzo	270.2	2006
	Genova-Pegli	269.4	2010
	Pero	268.8	2010
	Passo del Turchino	261.2	2007
	Vicomorasso	249.2	2006
	Polanesi	228.4	2007
	Giacopiane Lago	227.4	2005
	Montalto	227.2	2006
	Pero	223.6	2006
	Busalla	223.4	2006
	Alpe di Vobbia	221.8	2002
	Loco Carchelli	219.4	2010
	Bolzaneto-Trasta	216.2	2010
	Fiorino	215.8	2009
	Pontedecimo	213.6	2010
	Piampaludo	209.8	2010
	Loco Carchelli	209.0	2009
	Osiglia	207.2	2005
	Mele	206.4	2007
	Castelvecchio di R. B.	206.4	2006
	Bargagli	204.4	2010
	Vicomorasso	201.8	2002
	Colle Melogno	197.6	2005
	Romito Magra	196.6	2004
	Sanda	194.2	2006
	Isoverde	194.0	2006
	Colle Melogno	191.0	2006
	Rovegno	187.2	2009
	Ceriana	186.6	2006
SARDINIA			
	Orosei	233.6	2008
BASILICATA			
	Stigliano	196.8	2003
APULIA			
	Marina di Ginosa	245.0	2004
SICILY			
	Torregrotta	251.2	2010
	Linguaglossa	209.4	2005
	Linguaglossa	202.4	2008
	Fiumedinisi	185.6	2006

[33] Source: ISPRA

Climate scenarios

The projections based on the six emission scenarios of the IPCC for the end of the 21st century point to an increase in global temperature ranging from 1.8 to 4.0°C by the period 2090-2099, as compared to the period 1980-1999[34].

The projections of the climate changes in the different emission scenarios developed by IPCC are obtained through global and regional climate models.

As a rule, the boundary conditions for regional climate simulations are provided by the global dynamical downscaling model. In particular, the simulations produced by the Euro-Mediterranean Center for Climate Change (CMCC) through its system of models (CMCC-MED and CMCC-CLM) have attained a high horizontal resolution for specific areas in our peninsula.

The simulation of the future climate scenario for the 21st century, carried out with the CMCC-MED climate model following the A1B protocol of the IPCC[35], shows that, for the period 2021-2050, the temperature variations at two meters above ground level range around 2°C with respect to the period 1971-2000 (Figure 1.13) with a positive gradient moving towards the North and peaks over 5°C in the wintertime in Norway.

In summer, the model shows slighter temperature variations with peaks not exceeding 3°C in the northern area of Norway.

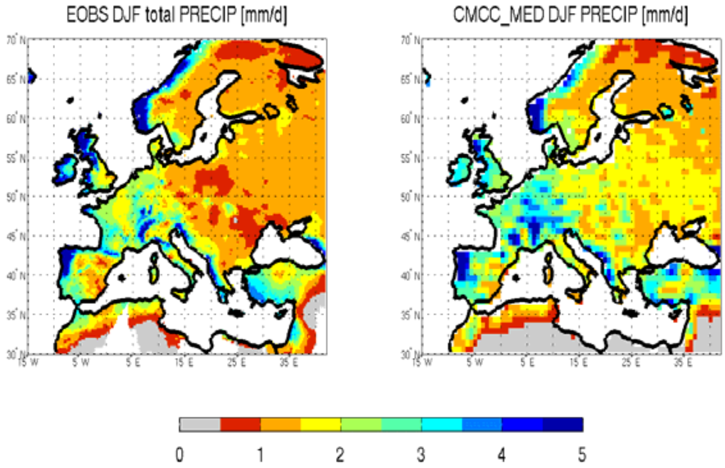
With reference to the estimated precipitation variations in the future climate scenario, the maximum increase is expected in Norway in winter (Figure 1.11), while a considerable percentage variation – with basically positive patterns – is expected in the summertime in the southern sector where, in any event, precipitations are scarce during the reference period (Figure 1.12).

The results of the A1B scenario simulation show an average 2°C increase in Italy, with a maximum of up to a 3°C on the Alps in winter. On the other hand, no precipitation variations worthy of note are reported on the Italian peninsula.

The projections based on the six emissions scenarios of the IPCC for the end of the 21st century point to an increase in global temperature ranging from 1.8 to 4.0°C by the period 2090-2099, as compared to the period 1980-1999.

[34] IPCC, 2007, *Climate Change 2007 – Fourth Assessment Report-WGI*

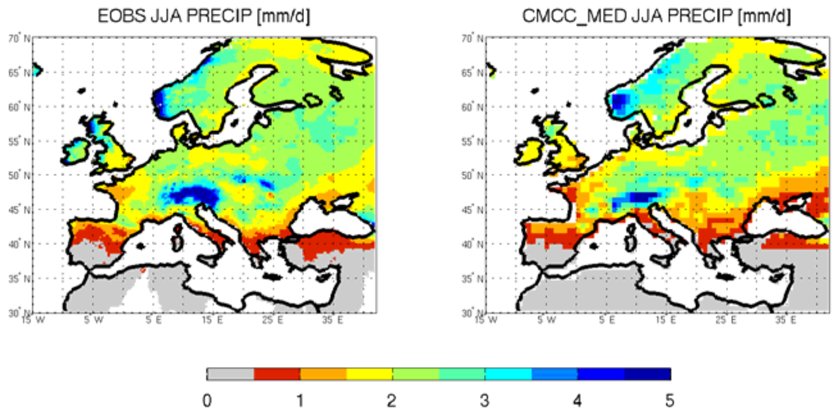
[35] http://www-pcmdi. llnl.gov/ipcc/about_ipcc.php



Legend:
DJF: December, January, February – Wintertime
mm/d: millimeters/day

Figure 1.11: Total precipitation in winter as represented by the model (right-hand panel) and the observations (left-hand panel). The climatology is calculated for the period 1971-2000[36]

Insofar as it concerns the estimated precipitation variations in the future climate scenario, the maximum increase is expected in Norway during the winter.



Legend:
JJA: June, July, August - Summertime
mm/d: millimeters/day (unit of measurement)

Figure 1.12: Total precipitation in summer as represented by the model (right-hand panel) and the observations (left-hand panel). The climatology is calculated for the period 1971-2000[37]

Insofar as it concerns the estimated precipitation variations in the future climate scenario, a considerable percentage variation, with basically positive patterns, is expected for the summertime in the southern domain where, in any event, the precipitation is scarce during the reference period.

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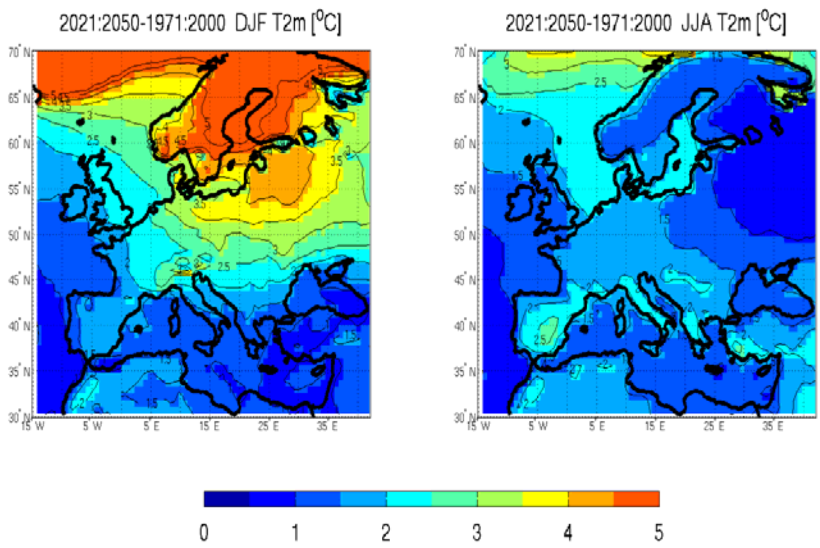
[36] Source: CMCC
[37] Source: CMCC



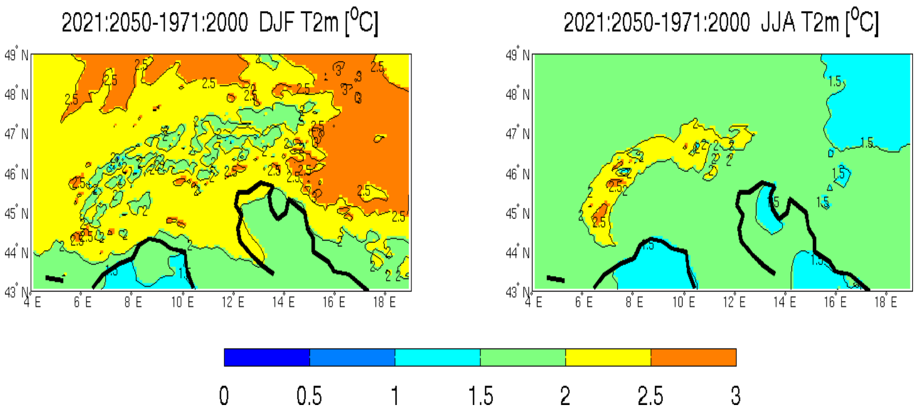
Legend:
DJF: December, January, February – Wintertime
JJA: June, July, August - Summertime
°C: degrees Celsius
Note:
The future climate reference period is 2021-2050
The present climate reference period is 1971- 2000

Figure 1.13: Air temperature variation, at two meters above ground level, in a future climate scenario (A1B) as represented by the winter model (left-hand panel) and the summer model (right-hand panel)[38]

The simulation of the future climate scenario for the 21st century shows that, compared with the period 1971-2000, the temperature variations two meters above ground level for the period 2021-2050 range around 2°C with a positive gradient moving North and peaks over 5°C in Norway during the winter. With reference to the summer season, the model shows slighter temperature variations with peaks not exceeding 3°C in the northern area of Norway.

The CMCC-CLM[39] regional climate model is the climatological version of the Lokal Model, a limited-area meteorological model developed by the international Consortium for Small-Scale Modeling (COSMO). CMCC-CLM has been used with an 8-km resolution to produce a climatology of the present climate (from 1971 to 2000) and for the same scenario simulation made through the CMCC-MED global model (A1B, period 2021-2050).

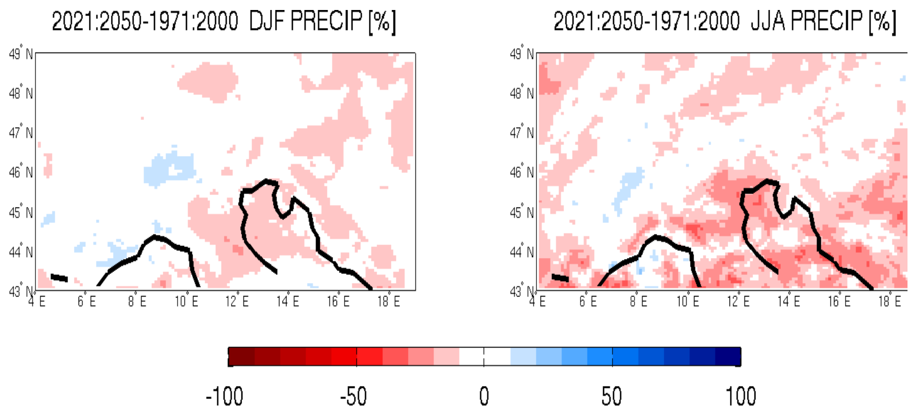
[38] Source: CMCC
[39] Rockel, B., A. Will, and A. Hense, 2008: *The Regional Climate Model COSMO-CLM (CCLM)*. Meteor. Z, 17, 347–348; http://www.cosmo-model.org



The climate change signal expressed in terms of difference among the climatological averages for the temperature at two meters is characterized by an increase in both the summer season and the winter season.

Legend:
DJF: December, January, February – Wintertime
JJA: June, July, August - Summertime
°C: degrees Celsius (unit of measurement)

Figure 1.14: Climate change signal- expressed in terms of difference among the climatological averages for the temperature at two meters – between the periods 2021-2050 and 1971-2000 in winter (left-hand panel) and in summer (right-hand panel) - Northern Italy, Alpine arc[40]



The climate change signal in winter - expressed in terms of percentage difference in daily cumulated precipitation – is characterized by extremely limited percentage variations ranging between 10 and 20% that may be quantified in no more than 0.3-0.4 mm/d., while the summer precipitation seems even less responsive to the change of the atmosphere composition in the future climate.

Legend:
DJF: December, January, February – Wintertime
JJA: June, July, August - Summertime

Figure 1.15: Climate change signal – expressed in terms of percentage difference of the daily cumulated precipitation between the periods 2021-2050 and 1971-2000 in winter (left-hand panel) and in summer (right-hand panel) – Northern Italy, Alpine arc [41]

[40] Source: COSMO
[41] Source: COSMO

The climate change signal is assessed by comparing the present climate simulation with the simulation of the A1B scenario and is expressed in terms of difference among the climatological averages at 2 meters above ground level and in terms of percentage difference in the cumulated daily precipitation.

As for the temperature at 2 meters (Figure 1.14), the climate change signal is characterized by an increase in both summer (right-hand panel) and winter (left-hand panel), but it is much more marked in the latter, with values ranging on average between 2 and 3°C in flat areas and between 1.5°C and 2°C in the highest mountain areas.

Climate change signal - expressed in terms of difference among the climatological averages for the temperature at two meters above ground - is characterized by an increase in both the summer and the winter season. On the other hand, the climate change signal in winter – expressed in terms of percentage difference for the cumulated daily precipitation – is characterized by extremely limited percentage variations.

The area most sensitive to climate change in the winter season is the eastern part of the domain, corresponding to Hungary, Slovenia, Croatia and part of Bosnia Herzegovina, with values that reach or exceed 3°C.

This signal is less intense in summer, when it is more marked along the Alpine arc (ranging on average around 2.5°C, probably linked to the melting of the glaciers) and less marked in the flat regions (an mean value included between 1.5 and 2°C).

As for winter precipitation (Figure 1.15 - left-hand panel), the climate change signal is characterized by extremely limited variations in terms of percentages, which are included between 10 and 20% and quantifiable in no more than 0.3-0.4 mm/d.

The summer precipitation (right-hand panel) seems even less sensitive to changes in the composition of the atmosphere in the future climate represented by the A1B scenario.

Most of the domain seems to be characterized by a precipitation decrease, with percentage variations that may even get to 30% in areas where, in any event, its reference value is quite limited.

Impacts and vulnerability

Worldwide

The overall picture of the climate change impacts observed worldwide until now, as it may be elaborated he most recent literature, does not differ to any significant extent from the overall picture described in the 2009 edition of this report that, in its turn, is based on the conclusions of the Fourth Assessment Report of the IPCC (2007).

This year, with the publication of the SREX report, the IPCC has emphasized the issue of extreme events and their consequences[42]. As shown by the recent floods in Thailand, the drought in the Horn of Africa and the floodings of the Mississippi and Missouri rivers, the consequences of extreme events are extremely costly in terms of both losses of human lives and economic damages. These losses change from year to year and from place to place. However, it may be stated with a high confidence level that, on the whole, they have increased even in consequence of the growing number of persons and infrastructures that are being exposed. The developing countries are the most affected: from 1970 to 2008, over 95% of the deaths due to natural disasters have been reported in those areas. Adaptation and risk management may improve the resilience of the systems with respect to climate change. In fact, a number of measures may be adopted to manage the risks associated with extreme events. When developing these measures, due consideration should be paid to the aspects related to the exposure and vulnerability of the systems to climate change, since extreme events are not going to have the same impacts everywhere. In fact, a cyclone that hits Australia will not have the same impact as a cyclone having a similar force that hits Bangladesh.

The consequences of extreme events are extremely costly in terms of both losses of human lives and economic damages. The developing countries are the hardest hit.

Italy

The outcome of the latest IPCC report shows that the Mediterranean region – and, therefore, our country - is one of the zones most sensitive to climate changes. In fact, there are already unequivocal signs of the effects produced in this area by climate change that, coupled with the consequences of anthropic stresses on the territory and its resources, make this region one of the most vulnerable in Europe.

The Mediterranean region – and, therefore, our country - proves to be one of the zones most sensitive to climate changes.

In particular, as described in the SREX report of the IPCC, extreme events have lately become a recurring presence in our country, with consequences that in some cases are extremely dramatic, as shown by the tragic events that occurred from Genoa to Lunigiana and from Cinque Terre to Messina.

In fact, between the end of October and the beginning of November 2011, heavy precipitation events exceeding 450 mm in just a few hours have been reported at first on the eastern coast of Liguria (Vara basin and Cinque Terre) and in Lunigiana (Magra basin), and then in Genoa (Bisagno and Fereggiano basins), with flooding events that, on the whole, have resulted in the loss of a good 19 human lives and an estimated damage amounting to nearly 640 million euro. On the other hand, the complex landslides triggered by the intense rainfall events that have affected the Messina area and the Calabria Region have caused four victims.

[42] IPCC, 2011: *Summary for Policymakers*. In: *Intergovernmental Panel on Climate Change Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* [Field, C. B., Barros, V., Stocker, T.F., Qin, D., Dokken, D., Ebi, K.L., Mastrandrea, M. D., Mach, K. J., Plattner, G.-K., Allen, S., Tignor, M. and P. M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

The data relative to the victims of the flood events in the period 1951-2011 show an increasing trend in 2008, 2009 and 2011, with respect compared to the previous period (2001-2007) characterized by a decreasing trend[43].

Heavy rainfalls may give rise to considerable landslide events to which our territory proves to be particularly exposed. In fact, in Italy, landslides represent the most frequent type of natural disaster responsible, after earthquakes, for the highest number of victims.

During 2011, 70 major landslides were recorded; they caused 18 victims, the evacuation of over a thousand people and huge damages to the highway, road and railway networks. The Regions that have been affected the most are Liguria, Calabria and Sicily[44].

Although for the time being it is quite hard to evaluate the trends of flood and landslide events, it may be nonetheless affirmed that our country's hydrogeologic risk represents one of the major problems connected with population security and the damages to residential areas and infrastructures.

Increasing relevance is going to be attributed to adaptation and risk management in a changing climate that, as shown in the IPCC reports and highlighted by the projections of the climate models, will likely to cause the Mediterranean area to deal increasingly more often with heat waves, a reduction in the snow and ice reserves, an increased risk of extreme events such as floods and drought, and a loss of terrestrial and marine biodiversity, with socio-economic consequences in sectors such as energy, agriculture, tourism and transport.

If in the past the lack of suitable technologies caused the effects of these events, and their economic costs, to be considered unavoidable, nowadays it is a definite duty for us to enhance our ability to anticipate their intensity and their current and future trends, as well as to develop suitable measures to improve the resilience of the systems with respect to climate changes. This would allow achieving the much-desired objective of ensuring the sustainable development of our territory and avoiding having to pay an excessively high price in terms of environmental damages, loss of human lives and economic costs.

[43] For further details refer to the Chapter "Natural hazards"

[44] For further details refer to the Chapter "Natural hazards"

Pressures on the climate system

The greenhouse gas emissions in Italy

Without meaning to overlook the effects of natural phenomena, such as the variability of solar radiation intensity, the vast majority of the scientific community is convinced that "*there are new and even more meaningful elements*"[45] for holding that "*most of the observed warming over the last 50 years is likely to have been due to human activities*". These results receive ample confirmation in the Fourth Assessment Report on Climate Change of the IPCC, which reiterated that, "warming of the climate system is unequivocal", and that human activities can be considered as the causes for this warming with a "very high confidence"[46].

Much of the warming observed in the last 50 years can be traced to human activities.

With regard to CO_2, the main greenhouse gas, the mean global atmospheric concentration of carbon dioxide has risen from 280 ppm during the period 1000-1750 to 389 ppm in 2010[47]. From the pre-industrial period to 2009, the carbon dioxide emissions have grown from roughly zero to 30.8 billion tons, taking into account just emissions from the use of fossil fuels in combustion processes and in cement production[48]. According to the IPCC assessments of the carbon cycle, between 1750 and 2000 an amount of fossil fuels equal to approximately 390 billion tons of carbon was extracted from under ground and burned, producing, approximately 1400 billion tons of carbon dioxide. Of this quantity, 57% was absorbed by the oceans (in part dissolved in the water and in part absorbed by the phytoplankton) and by the vegetation on land (through chlorophyll photosynthesis and forest sinks), while the remaining 43% remained in the atmosphere, raising the concentration of carbon dioxide to a level that is the highest in the last 650 thousand years, and probably in the last 20 million years as well. The other greenhouse gases, such as methane, nitrous dioxide and fluorocarbons, have shown similar if not even higher rates of growth. The global economic crisis that, since 2008, has played havoc with the economic and energy markets, in 2009 has had limited effects on the worldwide trend of the greenhouse gas emissions. In fact, if it is true that the CO_2 emissions due to the use of fossil fuels have decreased in a number of industrialized countries (-6.9% in the United States, -8.6% in the United Kingdom, -7% in Germany, -11.8% in Japan, -8.4% in Russia), it is just as true that they have kept on growing in the emerging countries (+8% in China, +6.2% in India, +1.4% in South Korea). Therefore, although a 1.3% worldwide drop of emissions have been registered with respect to 2008, the average annual increase starting from 2000 has approximated 2.5% and the expected increase in 2010 should exceed 3%.

[45] IPCC, 2007, *Climate Change 2007 – WG-I, WG-II, WG-III, Technical summary*

[46] IPCC, 2007, *Climate Change 2007 – WG-I, WG-II, WG-III, Technical summary*

[47] http://oco.jpl.nasa.gov/science/

[48] Global Carbon Project, 2010, *Carbon budget and trends 2009*.

In Italy, the greenhouse gas emissions are in line with the trend observed in other industrialized countries.
The emissions 2009 have decreased by 9.2%[49] with respect to the preceding year, but the figure has increased once again in 2010.
The data of the National Greenhouse Gas Emissions Inventory show that the emissions have dropped from 519.25 to 501.32 million tons of CO_2eq in the period 1990-2010, with a 3.5% decrease. On the other hand, under the Kyoto Protocol, Italy should have reduced emissions, in the period 2008-2012, to levels 6.5% lower than emissions in 1990, meaning to 483.26 Mt CO_2eq.
Globally, Italy is responsible for no more than 1.34% of overall emissions generated by the use of fossil fuels in 2009, meaning that it ranks fourteenth among the countries with the highest levels of greenhouse gas emissions[50].

From 1990 to 2007, greenhouse gas emissions in Italy went from 516.3 to 552.8 Mt CO_2eq, with a 7.1% increase. Under the Kyoto Protocol, Italy should have reduced its emissions, in the period 2008-2012, to levels 6.5% lower than its emissions in 1990, that is 483.3 Mt CO_2eq.

Between 1990 and 2010, greenhouse gas emissions in Italy have decreased by 17.93 million tons of carbon dioxide equivalent (Mt CO_2eq). During this period, reductions of the emissions have been reported in nearly all the sectors, except for the transport sector and the household and services sectors where emissions have increased by 15.32 Mt CO_2eq and 15.81 Mt CO_2eq, respectively. There were reductions in fugitive emissions, those due to accidental losses during the extraction and distribution of hydrocarbons (3.35 Mt CO_2eq), as well as in the emissions by manufacturing industry (25.95 Mt CO_2eq), agricultural sector (7 Mt CO_2eq), the use of solvents (0.80 Mt CO_2eq), industrial processes (6.43 Mt CO_2eq), and wastes sector (1.60 Mt CO_2eq). Finally, the emissions by energy industries have decreased by 3.96 Mt CO_2eq. Starting from 1990, the national emissions have been increased until 2005, when there has been a reversal of trend accelerated by the economic crisis, followed by a new increase in emissions in 2010 with respect to the preceding year.

Table 1.4: Greenhouse gas emissions by sector[51]

Sector	**2008**	**2009**	**2010**	**2009-2010**
	Mt CO_2eq			**% variation**
Energy industries	156.92	131.78	133.25	1.12%
Fugitive emissions	7.35	7.13	7.43	4.16%
Manufacturing industry	72.44	55.97	61.37	9.65%
Transport	124.62	120.30	119.52	-0.65%
Households and services	88.00	90.33	94.15	4.23%
Industrial processes	35.64	30.87	31.96	3.54%
Use of solvents	1.95	1.81	1.66	-8.62%
Agriculture	36.01	34.78	33.74	-2.97%
Wastes	18.66	18.56	18.23	-1.77%
TOTAL	**541.59**	**491.53**	**501.32**	**1.99%**

In 2010, the emissions have increased with respect to the preceding year by 9.79 Mt CO_2eq (+1.99%) with trends that differed depending on the various sectors.

[49] ISPRA, 2012, *Italian Greenhouse Gas Inventory 1990-2010*. National Inventory Report 2012
[50] IEA, 2011, *CO_2 emissions from fuel combustion. Highlights.* (1971-2009 data)
[51] Source: ISPRA

In 2010, total emissions have increased with respect to the preceding year by 9.79 Mt CO_2eq (+1.99%) with different sign patterns for the sectors (Figure 1.16).

An increase in the emissions from the households and services sector and, to an even greater extent, from transport was observed in the period 1990-2010.

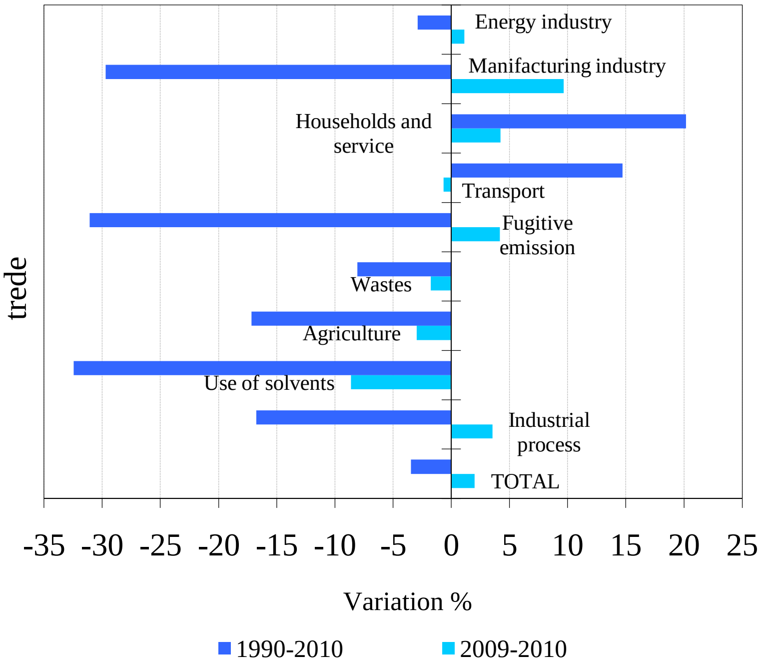


Figure 1.16: Percentage variation in emissions of greenhouse gases by SNAP (Selected Nomenclature for Air Pollution) sector for 2010, compared with the previous year and with 1990[52]

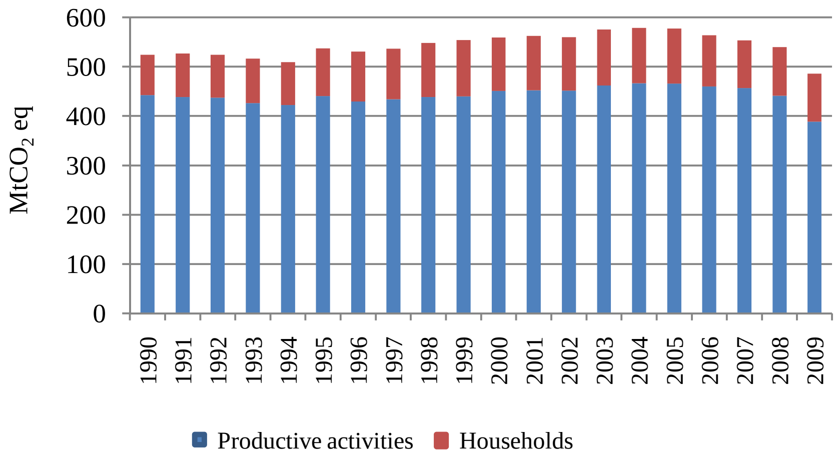
[52] Source: ISPRA

Emissions of greenhouse gases generated by the Italian economy in relation to production and consumption

In order to provide policy relevant information, production and consumption – driving forces in the DPSIR terminology – and the relevant environmental pressures have to be presented in a statistically consistent manner. For this reason the analyses presented in this part of the chapter use greenhouse gas emissions data from Italy's economic activities resulting from the NAMEA (*National Accounting Matrix Including Environmental Accounts*) satellite-accounting matrix[53]. While these data, owing to their construction, allow a comparison between the economic aggregates and the pressures exerted by the economic system on the natural environment, they may not be directly compared with the data estimated within the UNFCCC (*United Nations Framework Convention on Climate Change*).

In 2009, productive activities generated 80% of the greenhouse gas emissions, equal to 388.3 Mt CO_2eq (Figure 1.17). The remaining emissions (97.9 Mt CO_2eq) result from household consumption activities, with special regard to fuels for private transport and heating[54].

In 2009, productive activities generated 80% of the greenhouse gas emissions. The rest of the emissions are generated by household consumption activities.



From 1990 to 2009, the greenhouse gas emissions due to households have increased by 20%, while those due to production activities have decreased by 12%.

Figure 1.17: Greenhouse gas emissions due to productive activities and households in Italy[55]

[53] For an overview of the Namea accounting matrix and its latest developments, refer to: Tudini A., Vetrella G. (2011) *From Pioneer Work to Regulation and Beyond*, in Hybrid Economic-Environmental Accounts, edited by V. Costantini, M. Mazzanti, A. Montini. Routledge

[54] Households generate atmospheric emissions through the use of fuel for private transport and gardening, home heating and kitchen uses, and through the use of solvents and paints

[55] Source: ISTAT

From 1990 to 2009, greenhouse gas emissions generated by households have increased by 20%, while those generated by production activities have decreased by 12%.

The household emissions are characterized by different trends of their two main components (heating and transport).

Figure 1.18 shows that greenhouse gas emissions due to household private transport have doubled in the 1990s, have remained stable until 2003 and, from then onwards, have reversed their trend, dropping by 23% in the period 2003-2009. Over the entire period, their overall growth has been by 59%.

On the other hand, heating has remained substantially constant in the period 1990-2009 (with an mean share for the period by 52%).

The greenhouse gas emissions due to household private transport have doubled in the 1990s, have remained stable until 2003 and, from then onwards, have reversed their trend. On the other hand, heating has remained substantially constant in the period 1990-2009.

The greenhouse gas emissions due to household private transport have doubled throughout the 1990s, have remained stable until 2003 and, starting from that year, have reversed their growth trend. On the other hand, heating remains substantially stable in the period 1990-2009.

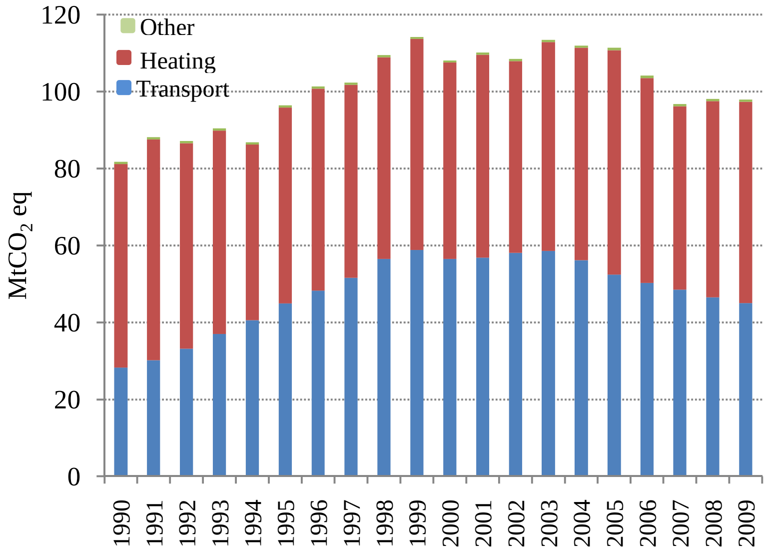


Figure 1.18: Greenhouse gas emissions due to households by type of consumption in Italy[56]

The greenhouse gas emissions due to productive activities reached in 2004 and 2005 the highest values in the entire period 1990-2009.

Emissions have then started decreasing, at first slowly (2005-2007) and then progressively faster. Indeed, a 3% and a 12% reduction are reported in 2007-2008 and 2008-2009 owing to the concomitant production drop (-2 and -8 percentage points in 2007-2008 and 2008-2009 respectively).

Based on this data, the indicator of the emission intensity of the productive system should be interpreted with some caution, particularly in respect of the short-term period.

In general, from 1990 to 2009, Italy witnessed a clear and constant decreasing trend in the intensity of the greenhouse gas emissions per euro produced.

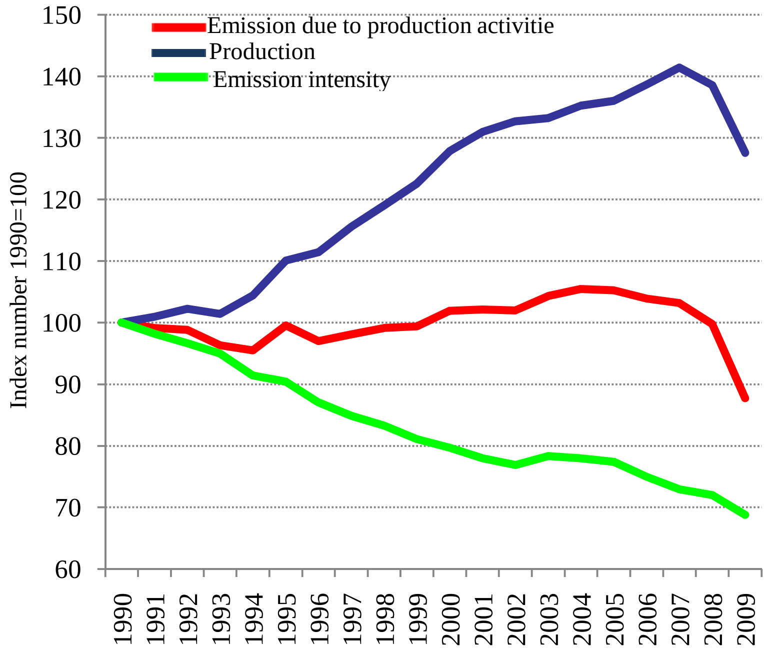
The efficiency increases over the last twenty years may be explained

The greenhouse gas emissions due to productive activities have reached in 2004 and 2005 the highest values in the entire period (1990-2009).

[56] Source: ISTAT

by the use of more technically advanced electric power generating plants that use less polluting fuels, the simultaneous growth of services[57] (the production share of which increased by 7 percentage points over the period, getting in 2009 to 36% of the total Italian production) and the delocalization of part of the heavy industry.

From 1990 to 2009, Italy witnessed a clear and constant decreasing trend in the intensity of the greenhouse gas emissions per euro produced.



Legend:
basic price production, interlinked values

Figure 1.19: Production and greenhouse gas emissions due to productive activities in Italy[58]

The analysis presented in Table 1.5 shows the individual contribution to the greenhouse gas emissions of the ten most polluting production activities and compares their economic and environmental profiles.

The ten most polluting production activities generate 83% of the greenhouse gas emissions of Italy's productive system, even though they represent a mere 33% of the value of the overall production.

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The "Electricity, gas and steam" activity, which is directly responsible for the production of all the electricity distributed in the country and used by productive activities and households, accounts for over 30% of the emissions. The relevant emissions-related contribution of this activity, despite a 3% share of total production, is due to the Italian electricity production system, which still makes prevalent use to fossil fuels. In the period 2000-2008, the emission intensity of this activity has decreased by 16%.

Both the "Manufacture of non-metallic mineral products" and the "Agriculture, hunting and related services" activities account for a share of the total greenhouse gas emissions approximating 10% and a share of production approximating 1.5%. The emission intensity of

[57] They relate to the activities dealing with "Monetary and financial intermediation; real estate and entrepreneurial activities" and "Other services activities"

[58] Source: ISTAT

these activities has decreased from 2000 to 2008 to a different extent: -3% for the "Manufacture of non-metallic mineral products" and -8% for the agricultural activities.

Table 1.5: Contribution to Italy's greenhouse gas emissions of the ten major production activities and corresponding contribution to the production and intensity of the emissions (2008)[59]

The ten most polluting productive activities generate 83% of the greenhouse gas emissions of the Italian productive system even though they represent a mere 33% of the value of the overall production. The "Generation and distribution of electric power and gas" produces over 30% of the emissions despite a 3% share of production. This activity is directly accountable for the entire electric energy generation distributed in the country and used by both production activities and households.

Ranking	2002 Ateco Code	Description of the activity	Share of emissions	Share of production	Emission intensity	
					2000	2008
			%		tCO2 eq per million Euro	
3	01	Agriculture, hunting and related services	10.1	1.6	1.81	994
10	15	Manufacture of food products and beverages	2.4	3.8	89	108
4	23	Manufacture of coke, oil refineries, nuclear fuels	6.0	2.0	892	880
9	24	Manufacture of chemical products and synthetic and artificial fibers	3.7	2.5	378	244
2	26	Manufacture of non-metallic mineral products	10.7	1.4	1,334	1,292
7	27	Metallurgy	4.5	1.9	493	542
1	40	Generation and distribution of electric power, gas, heat	31.0	3.0	2,687	2,256
8	50-52	Commerce	4.0	12.5	56	54
5	60	Land transport and transport via pipelines	5.8	3.7	249	279
6	90	Waste disposal, sewerage and similar services	4.7	0.6	1,698	1,404
		Other activities	17.1	67.1		

Note:
The economic aggregate is estimated at chained values with 2000 as the reference year.
The emission shares of the ten activities shown in the table remain substantially unchanged from 1990 to 2009. The year 2008 has been selected owing to the availability of economic data at a higher level of disaggregation than those available for 2009.

The other manufacturing activities that account for a relevant share of the total greenhouse gas emissions are "Manufacture of coke, oil refineries, nuclear fuels", "Metallurgy", "Manufacture of chemical products and synthetic and artificial fibers" and "Manufacture of food products and beverages" (16.6%).
The emission intensity of production decreases in respect of just two activities, namely "Manufacture of chemical products and synthetic and artificial fibers" (-35.3%) and, to a much lower extent, "Manufacture of coke, oil refineries, nuclear fuels" (-1.4%). The group is completed by "Land transport and transport via pipelines", "Waste disposal, sewerage and similar services" and wholesale and retail trade activities, which account for a further 14.5% of the emissions in 2008.
In economic terms, commerce and transport are extremely important sectors that account for 12.5% and 3.7%, respectively, of the total production.
Commercial and waste disposal activities reported a lower emission intensity at the end of the period 2000-2008 (-4% and -17%, respectively).

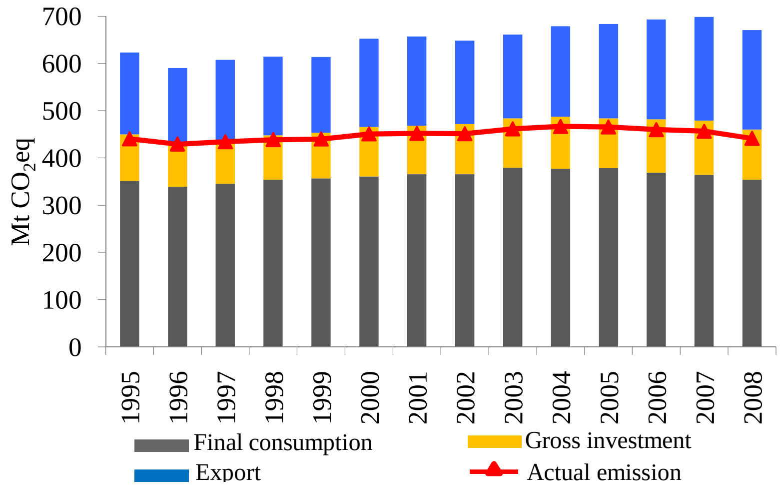
[59] Source: ISTAT

It should be noted that the greenhouse gas emissions relative to the activities shown in Table 1.5 are represented for the most part by carbon dioxide. The exceptions are represented by the emissions generated by agricultural activities – half of which are caused by nitrous oxide (from growing activities with and without fertilizers) and over one third of which by methane (from livestock breeding activities) – and "Waste disposal, sewerage and similar services", where methane prevails.
The environmental extension of the economic input-output model permits to attribute to final users the environmental pressures of the production activities based on the interdependences of those activities that transmit the impulse of the final demand to the entire economic system.
In the analysis of the interdependences, the production chain – that ends with the final production of a given activity - is traced backwards considering all the activities that (either directly or indirectly) have participated in this process, each in respect of its quota. The environmental extension of the model allows cumulating all the environmental pressures (in our case, the greenhouse emissions) generated along that production chain.
Whenever the productive system does not have domestic access to all the inputs and needs to import a few of them, the adoption of this approach ("responsibility of the final user") extends the analysis to the open economic system, including also the environmental pressures that have been avoided thanks to imports.

In 2008, the total emissions – actual emissions and emissions that have been avoided thanks to imports – of the Italian productive activities released by the three categories of final uses have reached 670.7 million tons of CO_2 equivalent, with an increase with respect to 1995 close to 8 percentage points.

In 2008, the total emissions – actual emissions and emissions that have been avoided thanks to imports – of the Italian production activities[60] released by the three categories of final uses reached 670.7 million tons of CO_2 equivalent, with an increase with respect to 1995 close to 8 percentage points.
Figure 1.20 shows that, in the period 1995-2008, the final demand aimed at the expenditure for the final consumption of goods and services accounts for over half of the total emissions. Considering the latter category of final uses together with gross investments, the share of the final domestic uses represents nearly 70% in that period.
Hence, nearly 30% of the total emissions due to the Italian production activities may be traced back to the demand from the rest of the world**.**

[60] This type of analysis, which does not include the emissions due to households, may be carried out for the years 1995-2008, since the supply and use tables are available for that period (refer to: Il sistema delle tavole input-output, ISTAT, available on line at http://www.istat.it/it/archivio/3646)



In the period 1995-2008, the demand aimed at the expenditure for the final consumption of goods and services accounts for over half of the total emissions. Considering the latter category of final uses together with gross investments, the share of final domestic uses represents nearly 70% in that period.

Figure 1.20: Italy's total greenhouse gas emissions (actual and avoided thanks to imports) by category of final demand[61]

The difference between total emissions and actual emissions represents the share of total emissions that has been avoided thanks to imports.

Until 1998, this share nearly coincided with the total emissions that could be traced back to exports; since 1999, the international trade balance in terms of global greenhouse gas emissions has grown owing to a faster increase in the emissions that have been avoided thanks to imports with respect to those that have been exported.

Figure 1.21 compares the results corresponding to the approach of the responsibility of the final user with those relative to the origin of those emissions (domestic and imported)[62].

[61] Source: ISPRA/ISTAT processing of ISTAT data

[62] For the data relative to the European Union (per capita emissions of carbon dioxide), refer to: Eurostat, *Statistics in focus* 22/2011, at http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-11-022/EN/KS-SF-11-022-EN.PDF

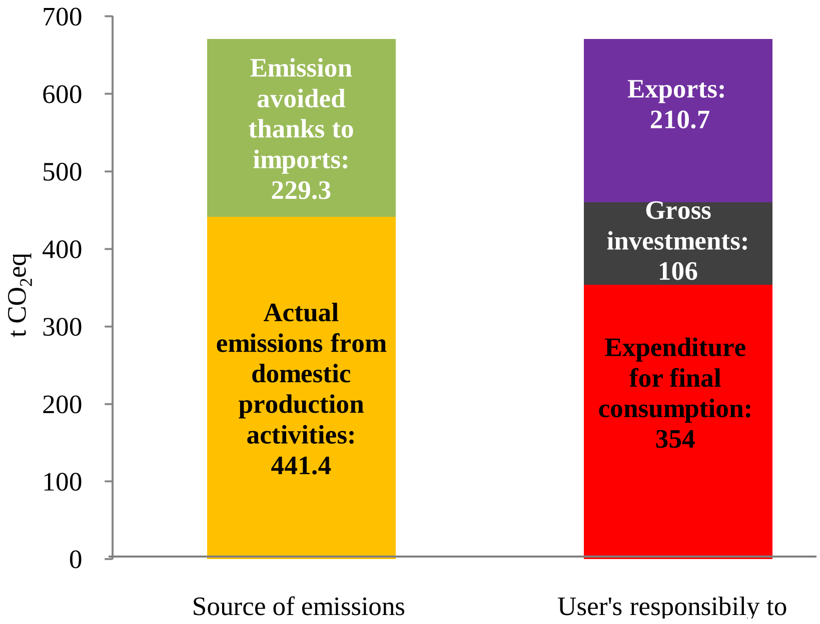


Figure 1.21: Italy's greenhouse gas emissions: total emissions, actual emissions, emissions avoided thanks to imports, and emissions according to the final user perspective (2008)[63]

In 2008, the pressures affecting Italy's environment in terms of total greenhouse gas emissions totaled 670.7 Mt CO_2eq. Two thirds of this amount has been generated by domestic production activities. The residual amount has been avoided through imports. The Italian final users of national and imported products are responsible for nearly 70% of this "total emissions requirement", while the final users who reside in the countries that import goods and services from Italy are responsible for the residual share.

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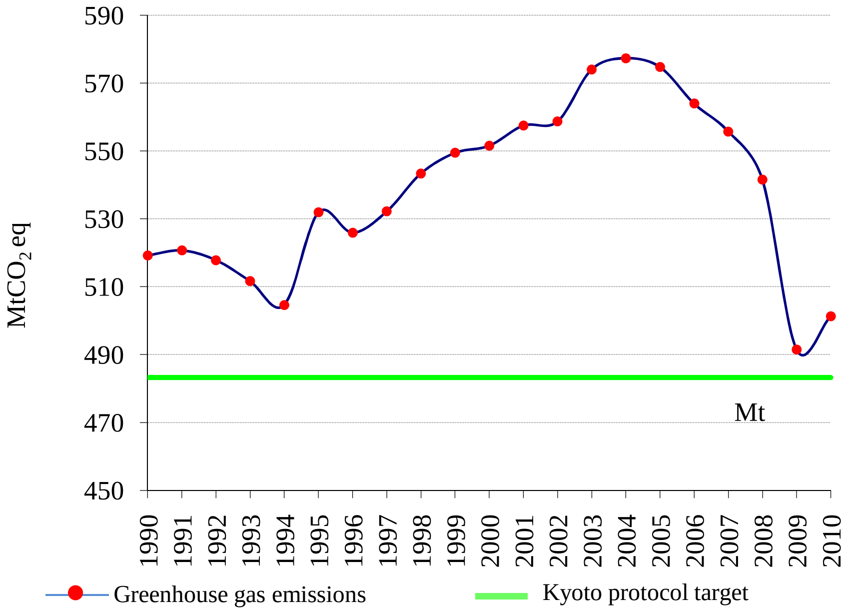
Greenhouse gas emissions and Kyoto target

In 2010, greenhouse gas emissions in Italy exceeded the Kyoto target by 18.1 Mt CO_2 eq.

In 2010, the greenhouse gas emissions in Italy exceeded by 18.1 Mt CO_2eq the Kyoto target (+3.7%). The emissions have decreased by 3.5% with respect to 1990. After the drop in the emissions due to the economic crises, a 2% increase with respect to the preceding year has been reported in 2010. Whether the target under the Kyoto Protocol have been reached is to be assessed in the period going from 2008 to 2012. Until 2010, the country has an emissions debt amounting to 84.7 Mt CO_2eq (Figure 1.22).

[63] Source: ISTAT



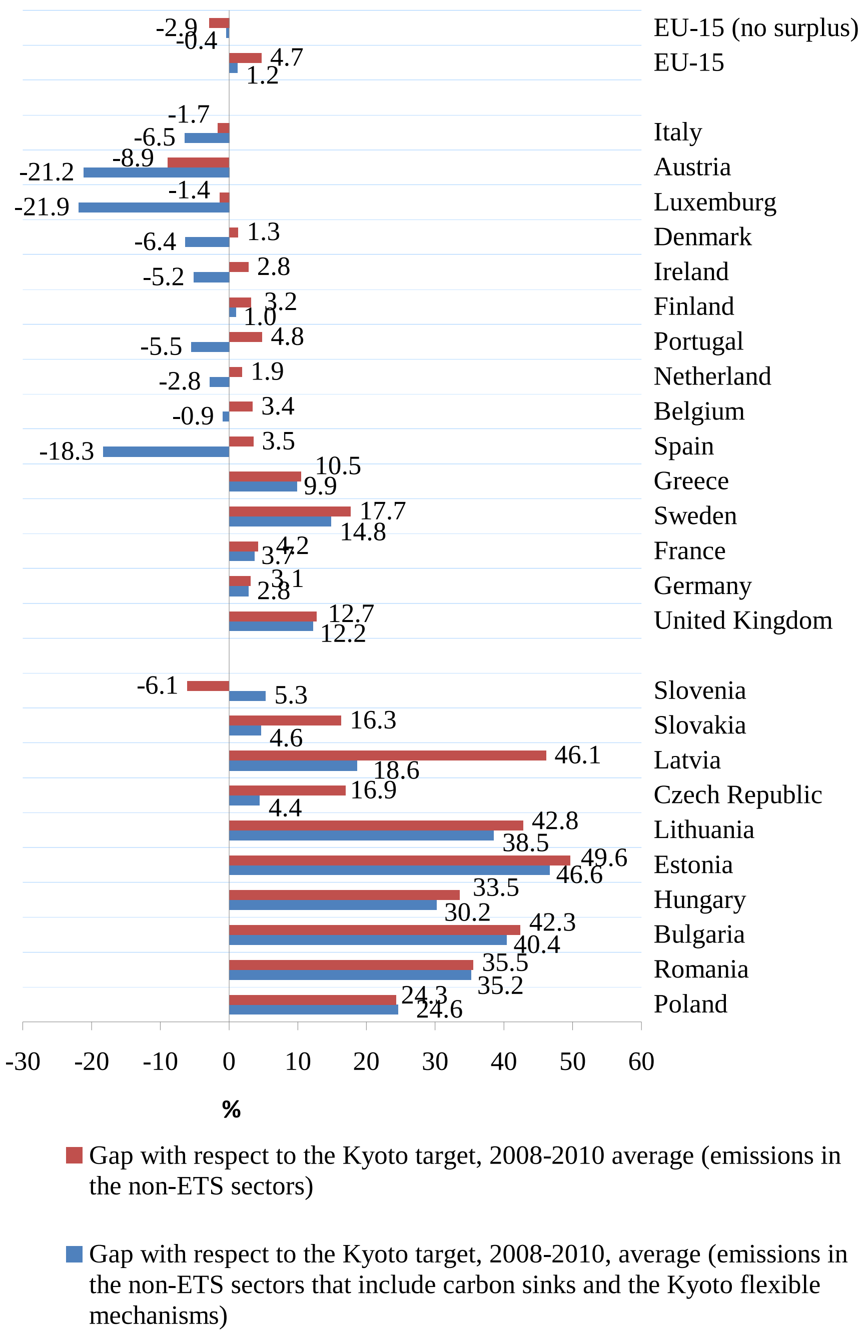
Under the Kyoto Protocol, in the period 2008-2012 Italy should have lowered its emissions by 6.5% with respect to the 1990 levels, bringing them down to 482.76 Mt CO_2eq. In 2010, Italy's greenhouse gas emissions exceeded the Kyoto target by 18.1 Mt CO_2eq. Starting from 2008, the country has an emissions debt amounting to 84.7 Mt CO_2 equivalent.

Figure 1.22: Total emissions of greenhouse gases and target level under the Kyoto Protocol[64]

According to the assessments of the report "*Greenhouse gas emission trends and projections in Europe 2011 - Tracking progress towards Kyoto and 2020 targets in Europe*" of the European Environment Agency (EEA), the 2009 emissions and the preliminary estimates for the 2010 emissions show that Italy, Austria and Luxembourg are not likely to achieve the annual reduction objectives under the Kyoto Protocol unless these countries have further reduction of domestic emissions before 2012, or increase recourse to the flexible mechanisms and the emission credits resulting from the LULUCF (*Land Use, Land Use Change and Forestry*) activities. The preliminary estimates of emissions in 2010 are lower than the actual emissions (-7.72 CO_2eq), thereby confirming the EEA conclusions. The failure of any Member State to achieve its objectives represents a risk for the compliance with the Kyoto Protocol of the EU-15, since there is no guarantee that the Member States with an emission reduction surplus will make their emission credits available to Member States that have not achieved their reduction objective.

According to the assessments of the European Environment Agency (EEA) Italy, Austria and Luxembourg will not reach their targets under the Kyoto Protocol unless they have further reduction of domestic emissions or increase recourse to the flexible mechanisms and the emission credits resulting from the LULUCF activities as defined by Kyoto Protocol.

[64]Source: ISPRA



According to the EEA assessments, Italy, Austria and Luxembourg will not reach their targets under the Kyoto Protocol unless they have further reduction of domestic emissions by 2012, or increase recourse to the flexible mechanisms and the emission credits resulting from the LULUCF activities.

Notes:
After the allocation of allowances to the EU ETS, the targets for the EU Member States are those of the sectors not affected by the exchange of CO_2 allowances.
A positive value indicates emissions that are lower than the target.
The EU-15 datum relates to the Member States with a burden sharing agreement.
The Member States with a surplus of reductions with respect to the targets may use the CO_2 allowances for their own purposes and not necessarily make them available to compensate for Member States that fail to achieve their target. As regards this subject, the EU-15 value is considered in case the surplus is used or not for the European targets.

Figure 1.23: Gap between EU emissions Kyoto Protocol target, with and without the recourse to the carbon credits resulting from the flexible mechanisms and the LULUCF activities (average 2008-2010)[65]

[65] Source: EEA, *Greenhouse gas emission trends and projections in Europe 2011 - Tracking progress towards Kyoto and 2020 targets in Europe, Report 4/2011*

Insofar as the EU-27 target is concerned (reducing by 2020 the greenhouse gas emissions by at least 20% with respect to 1990), the 2010 preliminary estimates have shown a pickup in the emissions after a noteworthy fall in 2009 due to the economic recession. In 2010, the quantity of the emissions has been 15.5% lower than in 1990 and, should the emissions coming from the international aviation sector be considered, the percentage would stand at about 14%[66]. The European emissions in 2010 are lower than those reported in 2008, pointing to the fact that the effects of the economic crisis have not been completely absorbed. The projections made by the European Environment Agency have shown that the total EU-27 emissions are not going to drop to any significant extent by 2020 and that the current domestic measure are going to allow the attainment of a 19% reduction of the emissions by 2020. The 1% gap with respect to the 20% target can be bridged and be exceeded by 5 points if Member States will implement all the currently planned additional measures, particularly in respect of the household and transport sectors.

Considering the 2020 target of reducing the greenhouse gas emissions by at least 20% with respect to the 1990 levels, the preliminary estimates of the 2010 emissions show that the EU-27 can achieve and over-achieve its target provided that Member States implement all the currently planned additional measures.

Energy production and consumption

The energy price trend is one of the causes of the ongoing changes affecting energy supplies. A noteworthy strengthening of the role played by natural gas with respect to other oil products has been reported since 1990, together with a tendential increase in the contribution of renewable sources and cogeneration. In 2010, the renewables keep on being characterized by extremely limited percentages (4.3%) and a resumption of fuel consumption has been evident since 2001.

The energy price trend is one of the causes of the ongoing changes affecting energy supplies.

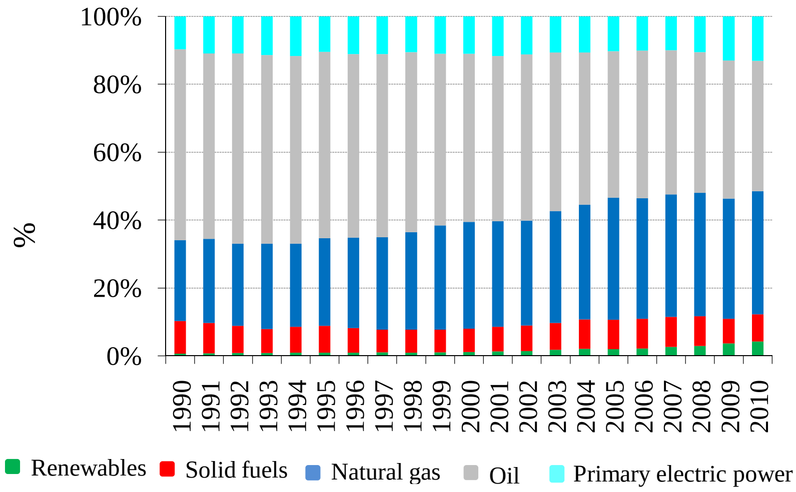


Figure 1.24: Total consumption of energy by primary sources[67]

The energy sector is undergoing major changes in the supply of primary sources. In fact, it is witnessing an increase in the consumption of natural gas with respect to oil products and a greater contribution from renewable sources and cogeneration. Furthermore, since 2001, the consumption of solid fuels has increased.

[66] EEA, 2011, *Greenhouse gas emission trends and projections in Europe 2011 - Tracking progress towards Kyoto and 2020 targets in Europe, Report 4/2011*

[67] Source: ENEA processing of data of the Ministry of Economic Development

The modifications in the mix of primary sources do not reduce the high energy dependence of our country, characterized by considerable fluctuations around an average value of 82.7%.

The modifications in the mix of primary sources do not reduce the high energy dependence of our country.

In 2010, the energy dependence stands at 82.1%. Starting from 1990, Italy has reported an upward trend in the gross inland energy consumption, with a peak reached in 2005 (+21% compared to 1990). A reversal of this trend, reported since 2006, has been accelerated by the economic crisis that, in 2009, has led to an 8.8% drop in consumption with respect to 2005.

Anyway, 2010 has been characterized by a new upward trend in consumption, with a 4.1% increase with respect to the preceding year. Altogether, the gross inland consumption in 2010 has increased by 14.9% with respect to 1990.

The gross inland consumption in 2010 has increased by 14.9% with respect to 1990.

The upward trend reported in 2010 concerns mainly industry (+7.3% compared to 2009), the household and services sectors (+5.9%) and non-energy uses (+11.1%).

The agricultural and fishing sector keeps on reducing its share of consumption, with a further 7.6% decrease.

After the consumption drop reported in 2008 and 2009, the transport sector shows nearly the same figure as in 2009 (-0.1%).

With regard to the break-down of energy for final consumption (not including non-energy uses or bunker fuels), the household and services sector accounts for 38.5% of consumption, followed by the transport and industrial sectors, at 33.8% and 25.4%, respectively.

The agriculture and fishing sector accounts for the remaining 2.4% of final consumption.

The decrease in Italy's total energy consumption in recent years, together with the limited growth of its GDP, explains the significant energy intensity reduction between 2005 and 2010 (-3.2%).

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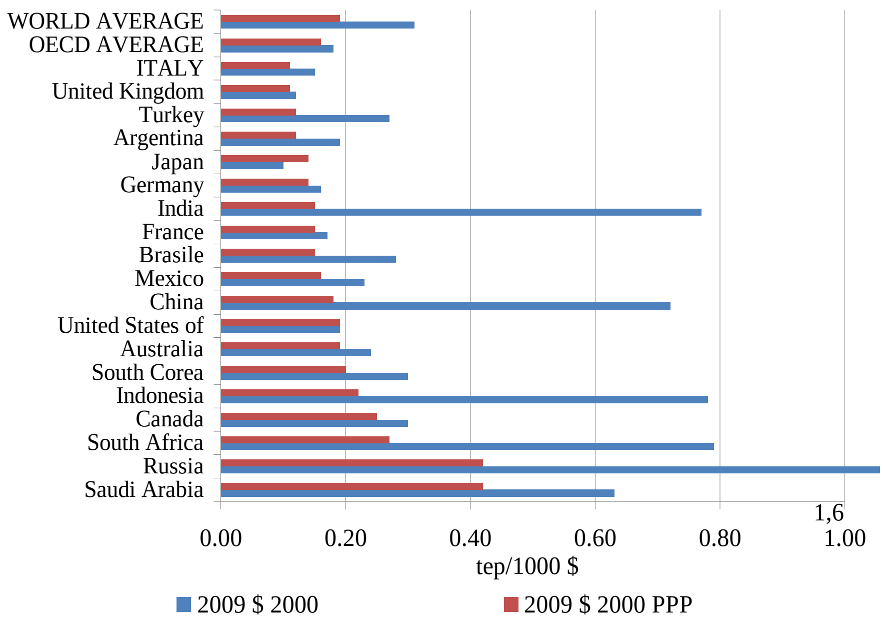
Despite a slight growth with respect to the preceding year, the value reported in 2010, amounting to 153.8 toe per million Euro, keeps on being lower than a series of rather high values reported between 1990 and 2006.

The analysis of the total energy intensity of the G20 Countries has shown that, in 2009, Italy - together with the United Kingdom - featured the lowest total energy intensity in terms of values corrected for purchasing power parity, rating below the worldwide and the OECD average.

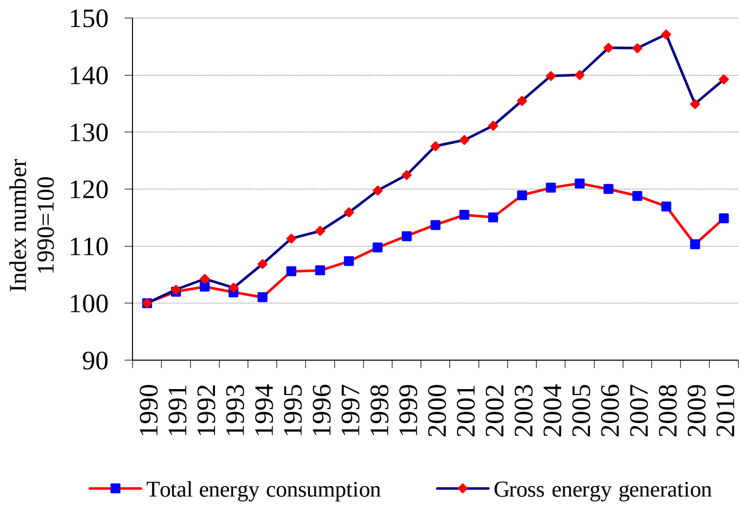


In 2009, Italy – together with the United Kingdom – was the G20 Country with the lowest total energy intensity in terms of values corrected for purchasing power parity, rating below the worldwide and the OECD average.

Figure 1.25: Total energy intensity of the G20 Countries referred to $ 2000 and corrected for purchasing power parity (PPP) (2009)[68]

Between 1994 and 2010, the rate of growth of electricity generation has been considerably higher than the rate of growth of the total energy consumption.
This result points to the growing role of electricity as an energy vector in the national energy system.
A slight pickup in energy consumption and electric power generation has been reported in 2010, compared to 2009 (+4.1% and +3.2%, respectively), after the drastic drop due to the economic crisis.

Between 1994 and 2010, the rate of growth of electricity generation has been considerably higher than the rate of growth of the total energy consumption.



Between 1994 and 2010, the electricity generation rate of growth has been higher than the total energy consumption rate of growth.. This result points to the growing role of electricity as a vector in the national energy system.

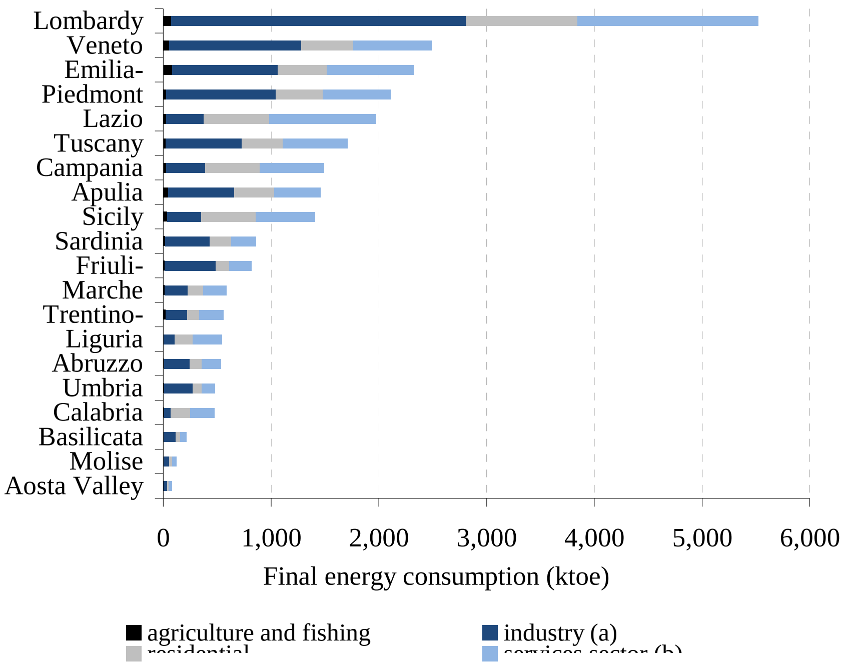
Figure 1.26: Total energy consumption and electric power generation (1990 = 100)[69]

[68] Source: International Energy Agency (IEA)
[69] Source: ISPRA processing of data of the Ministry of Economic Development and TERNA S.p.A.

The regional breakdown of the final energy consumption reveals a highly heterogeneous structure within the national territory.

Looking at the regional level, final energy consumption varies considerably within the national territory. The figures for 2010 show that Lombardy consumes 21.5% of the national final energy, followed by Veneto at 9.7%, while Emilia Romagna and Piedmont account for 9% and 8.4%, respectively, and other regions, such as Lazio, Tuscany, Apulia, Campania and Sicily report an mean value approximating 6.2%. Taken as a whole, these nine regions consume 79.6% of the Italian final energy consumption (Figure 1.27).

The regional consumption of electricity reveals a highly heterogeneous structure within the national territory. Lombardy consumes 21.56% of the national final energy. Nine regions (Lombardy, Veneto, Emilia Romagna, Piedmont, Lazio, Tuscany, Apulia, Campania and Sicily) account for 79.65% of total Italian consumption.



Legend:
(a) The "Energy and water" sector is not included
(b) "Aqueducts" and "Transport" are included

Figure 1.27: Final electric power consumption at a regional level by sector (2010)[70]

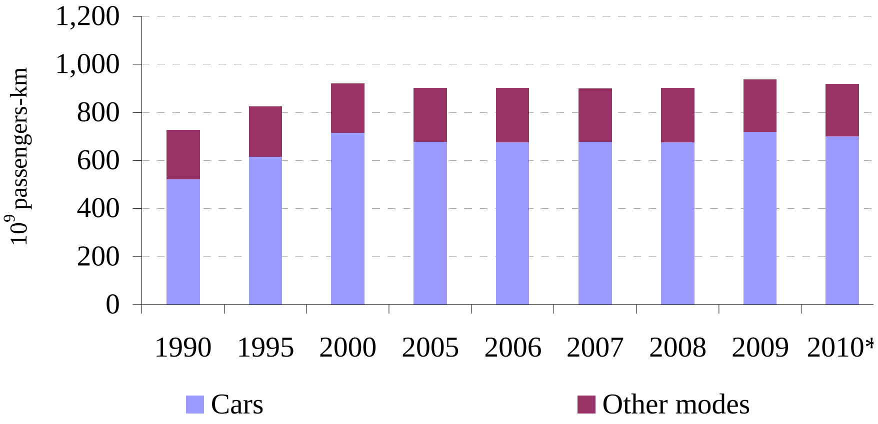
The transportation system must respond to sharp rises in the demand for mobility. During the period 1990-2010, the demand for passenger transport increased by 26.2%, while the demand for domestic freight transport has grown by 14.5% over the same

The transport system must respond to sharp rises in the demand for mobility. During the period 1990-2010, the demand for passenger transport has increased by 26.2%, while the demand for domestic freight transport has grown by 14.5% over the same period.
Growth in passenger demand has remained constant during the period 2005-2008, followed by an increase in 2009 and a subsequent drop in 2010 (-2.1% in 2010 compared to 2009) (Figure 1.28).
The demand for passenger transport has kept on being met primarily by road transport, the least efficient mode from an economic and environmental perspective. In particular, in 2010, car, motorcycle and scooter traffic covered 80.6% of the demand for passenger transport.
In Europe, Italy ranks after Luxembourg and Malta in terms of the ratio of cars in circulation to the resident population, but it is first when motorcycles, scooters and commercial vehicles are taken into

[70] Source: ENEA processing of TERNA S.p.A. data

consideration; worldwide, only the USA have a higher rate of motorization in terms of vehicles per inhabitant.

period.



During the period 1990-2010, the demand for passenger transport has increased by 26.2%. In 2010, road transport (cars, motorcycles and scooters) has met 80.6% of the demand for passenger transport (cars alone 76.2%).

Legend :
* Provisional data

Figure 1.28: Demand for passenger transport[71]

From 1990 to date, the demand for freight transport has increased by 14.5% and has shown to be closely linked to the economic development dynamics.

A drastic reduction started from 2007, in consequences of the economic and financial crisis (-8.9% in 2009 compared to 2007), while it has reported a slight increase (+3% compared to 2009) in 2010.

Freight transport takes place primarily by truck, with a share that has remained fairly constant since 1990, ranging around 70% (69.5% in 2010).

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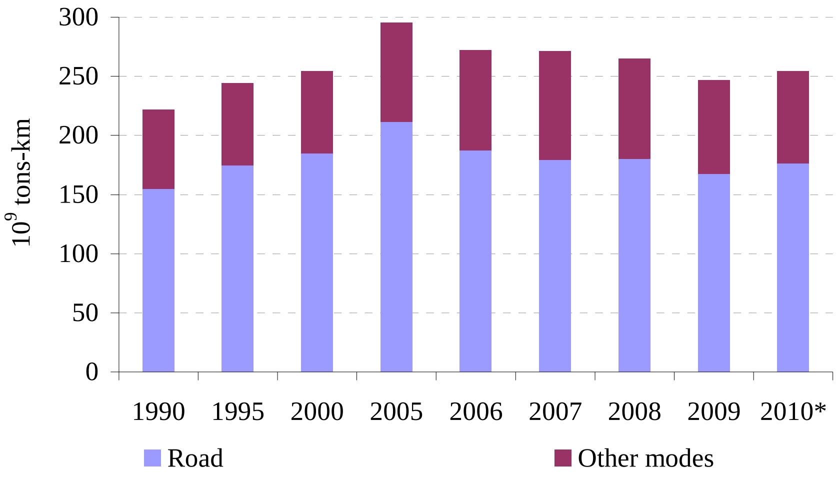
In 2010, domestic freight transport by sea and by railway has stood at 19.2% and 6.9%, respectively, while air transport has represented a marginal 0.4% of total transport.

The demand for freight transport has shown a noteworthy growth during the period 2000-2005, followed by decrease in the subsequent years; on the other hand, has been observed in 2010 a slight recovery determined mainly by an increase in road transport.

In 2010, the freight transport by road has increased by 5.4% with respect to the preceding year, while a decrease (-2.1%) has been reported for the “other modes”.

[71] Source: ISPRA processing of Ministry of Infrastructures and Transport (MIT) data



Legend:
* Provisional data

Figure 1.29: Demand for freight transport[72]

From 1990 to 2010, the demand for transport has shown a 14.5% increase. Furthermore, estimates for 2010 have shown that freight transport within the national territory occurs primarily by road (69.5%) while other modes, such as freight transport by sea and by rail, account for 19.2% and 6.9%, respectively, of total transport.

Response measures: mitigation and adaptation

The main response measures involve mitigation (reducing greenhouse gas emissions) and adaptation to the climate changes.

The main measures to respond to climate change involve mitigation, which means reducing greenhouse gas emissions, as well as adaptation, which aims at minimizing the potential negative consequences of climate change while preventing any related damage. Mitigation and adaptation are complementary measures.
The recourse to nuclear energy and renewable sources represents an option for reducing greenhouse gas emissions.
Insofar as the energy policies are concerned, the debate has been dominated by the nuclear accident that occurred in Japan at the Fukushima nuclear plant on 11 March 2011. The accident, occasioned by a strong earthquake followed by a seaquake, is one of the most serious disasters in the history of the sector after the Chernobyl accident in 1986.

As concern the energy from renewable sources, special relevance should be given to the IPCC and IEA publications that are fully devoted to the role of the renewable sources and their potential for the development of an economy with low greenhouse gas emissions.

IPCC has considered 164 global energy scenarios and their respective consequences on greenhouse gas emissions and climate. Most of the scenarios show a significant increase in the share of renewable energy in 2030 and 2050. The scenario with the highest share estimates that, by 2030, 43% of the world energy requirements is going to be met by renewables, while their share is going to be 77% in 2050.

[72] Source: ISPRA processing of MIT data

In 2008, the renewable energies worldwide accounted for a 12.9% share, mostly represented by biomass (10.2%). The achievement of the objectives that are deemed feasible by the IPCC calls for the adoption of measures addressing the competitiveness of renewable sources with respect to fossil sources. These include the monetization of the external energy costs, the removal of institutional and regulatory obstacles that prevent or slow down the development of the renewables, as well as investments in new technologies and infrastructures. The IEA report lays emphasis on the considerable growth reported worldwide in the sector of renewable sources – with special reference to wind and solar energy. Nonetheless, it stresses that these energy sources are exceeded by far by fossil sources and that the use of all the renewable energy sources must be doubled by 2020 if we are to achieve our sustainability objectives. According to the IEA, the development of an ecocompatible economy requires more "aggressive" environmental policies, including the elimination of the fossil fuel subsidies and a transparent and predictable program of incentives for cleaner and more efficient options. In the last decade, coal has met 47% of the new demand for electricity worldwide. Hence, in order to achieve the objectives of reducing the emissions, extensive recourse to the CO_2 capture and storage technology should be achieved. The application of this technology requires adequate policies and support programs. In the transport sector, IEA stresses the relevance of electric vehicles for reducing the atmospheric emission of greenhouse gases, but this sector requires incentives and the development of suitable infrastructures. The current sales of electric vehicles are at extremely low levels and the achievement of the objective of 20 million electric vehicles in circulation by 2020 in the most advanced countries would represent 2% of the vehicle fleet.

As for the mitigation measures, in February 2011, the European Council has reaffirmed its target of reducing the greenhouse gas emissions of the European Countries to 80-95% below the 1990 levels by 2050 with a view to keeping global mean temperature increase below 2 degrees Celsius compared to pre-industrial levels.
The achievement of thistargetrequires a transition of the economic system towards a nearly total decarbonization of the energy sector[73].
The 2050 objectives can hardly be achieved if the initiatives required to start up this necessary transitions are not implemented in the next five years[74].
In March 2011, the European Commission has published three key communication that provide a general framework for the actions needed to cope with this transition:

In 2011, the European Council has reaffirmed its target of reducing the greenhouse gas emissions of the European Countries to 80-95% below the 1990 levels by 2050 with a view to maintaining the increase in the global mean temperature below 2°C compared to pre-industrial levels.

[73] EC, 2011, *A Roadmap for moving to a competitive low carbon economy in 2050*.
[74] ECF (*European Climate Foundation*), 2010, *Roadmap 2050 – A practical guide to a prosperous, low-carbon Europe*.

- The communication COM(2011)112 “A Roadmap for moving to a competitive low-carbon economy in 2050” proposes a series of actions that would allow the European Union to achieve the objective of reducing greenhouse gas emissions by 80-95% by 2050 compared to 1990. The document outlines milestones that are to show whether the EU is on course for reaching its target, policy challenges, investment needs and opportunities in different sectors, bearing in mind that the reduction objective in the EU will largely need to be met internally. In particular, the achievement of the objective of reducing the emissions by 2050 requires to met a series of intermediate objective, namely, emission reductions of 25% in 2020, 40% in 2030 and 60% in 2040. Besides, it stresses the need to implement the measures designed to increase the energy efficiency and to reduce the emissions in the electricity sectors through the recourse to renewable sources.

COM(2011)112 proposes a series of actions that would allow the European Union to achieve the object of reducing greenhouse gas emissions by 80-95% by 2050 compared to 1990.

- The communication COM(2011)109 “Energy Efficiency Plan 2011” considers the key role played by energy efficiency to enhance security of energy supply, and to reduce emissions of greenhouse gases and other pollutants. The document stresses that “*in many ways, energy efficiency can be seen as Europe’s biggest resource*”. The household sector is the segment with the greatest energy saving potential, followed by transport and industry. With reference to the household sector, the plan proposes that public spending should stimulate the process for refurbishing and renovating both public and private buildings and for improving the energy performance of the components and appliances used in them. The public sector plays a leading role to increase the efficiency of the buildings. With this view in mind, the document proposes a number of measures, including the acceleration of the renovation rate of public buildings with binding objectives and the introduction of energy efficiency criteria in public spending. The energy efficiency in industry should be tackled through energy efficiency requirements for industrial equipment and measures for the introduction of energy audits and energy management systems.

COM(2011)109 considers the key role played by energy efficiency to enhance security of energy supply, and to reduce emissions of greenhouse gases and other pollutants.

- The communication COM(2011)144 “White Paper – Roadmap to a Single European Transport Area – towards a competitive and resource-efficient transport system” proposes the transformation of the European transport sector with a view to reducing by 60% the greenhouse gas emissions of the sector by 2050 with respect to 1990. The measures that have been identified in order to achieve this target include the elimination of conventionally-fueled cars from the cities by 2050, the use of low-carbon sustainable fuels (up to 40%) in aviation, the reduction of the CO_2 emissions from maritime bunker fuels by 40-50% by 2050 with respect to the 2005 levels, the shift of road freight to rail and waterborne transport, a considerable development of public transport and rail transport for

COM(2011)144 proposes the transformation of the European transport sector with a view to reducing by 60% the greenhouse gas emissions of the sector by 2050 with respect to 1990.

passengers through the realization of high-speed rail networks among the European Countries and the maintenance of a dense railway network in all Member States. Furthermore, it provides for measures to improve the efficiency of the transport systems and the use of infrastructures through information systems and market incentives, as well as the full application of the "user pays" and "polluter pays" principles by restructuring transport charges and taxes. The 2030targetprovides for a 20% reduction of the CO_2 emissions due to transport with respect to the 2008 levels, and this means that the transport emissions will still be 8% above the 1990 level.

The implementation of the current EU-27 commitments, namely a 20% share of energy from renewable sources in final consumption and a 20% energy saving to be attained through energy efficiency measures by 2020, would allow over-achieving the 20% reductiontargetand achieving the 25% greenhouse gas emissions reduction objective. However, the commitments provided for reducing the EU emissions do not consider efficiency a binding objective. Hence, a few binding measures are required to increase the energy efficiency. As regards this subject, in June 2011, the European Commission published a proposal for a Directive (COM(2011)370) to transforms a few aspects of the 2011 Energy Efficiency Plan into binding measures.

Considering the national context, reference should be made to a few regulatory provisions having considerable relevance.

- Legislative Decree no. 28/2011, for the implementation of Directive 2009/28/EC on the promotion of the use of energy from renewable sources, lays down criteria for the development of renewable sources that are mostly based on the creation of a system of incentives and the simplification of the authorization procedures. The Decree introduces a number of measures, including the obligation to integrate renewable sources in new buildings and in existing buildings subject to renovation, and the promotion of the development of infrastructures for district heating and district cooling. Besides, it lays down the priority of the absorption of the energy from renewable sources by the current (electric and natural gas) network while promoting the use of biofuels.
- Ministerial Decree of 05/05/2011 ("Fourth Energy Account") lays down the parameters for promoting the generation of electricity from solar photovoltaic plants and the development of innovative photovoltaic conversion technologies. The so-called "fourth energy account" cuts down the incentive rates of the "third energy account" and introduces a few limits for ground-based plants favoring those installed on buildings.
- Legislative Decree no. 162/2011, for the implementation of Directive 2009/31/EC on the geological storage of carbon dioxide, lays down a series of measures to ensure the geological

storage of CO_2 in suitable geological formations. The decree sets out the criteria to authorize the exploration and the storage underground of CO_2 and determines the technical authorities entrusted with the supervision and control of the exploration activities, the implementation of the plants, the CO_2 injections and the management of the sites.

- The second Energy Efficiency Action Plan (EEAP 2011), approved by the State-Regions Conference of 27 July 2011, takes into consideration the new normative framework for the achievement of the energy saving objectives under Directive 2006/32/EC and makes a projection of the energy saving as at 2020.
- The Interministerial Decree of 4 August 2011 on the promotion of cogeneration defines the new calculation methodologies – to be implemented since 1 January 2011, for qualifying the cogeneration process as High Efficiency Cogeneration. The Ministerial Decree of 5 September 2011 defines the new incentive scheme for high efficiency cogeneration. Furthermore, the cogeneration units that meet the high efficiency cogeneration requirements are entitled to the issue of White Certificates in a number proportionate to the primary energy saving attained during the year.
- The Ministerial Decree of 15 March 2012 concerns the so-called burden sharing as established by Law no.13/2009. The Decree assigns the regional commitments for achieving by 2020 the national object of a 17% share of energy produced from renewable sources with respect to the gross final consumption. For the time being, the object set to the Regions is 14.3%, while the remaining part depends on State instruments. There are a number of items that contribute to the achievement of the object of the regional gross final consumption of energy from renewable sources (electricity, thermal power and biofuels). However, the regional breakdown has only concerned the national target defined by the NAP (National Action Plan) of the national generation of electricity from renewable sources and the consumption of thermal renewable sources. The consumption of biofuels for transport and the imports of renewable energies from Member States and non-EU Countries do not contribute to the determination of the share of energy from renewable sources to be divided among the Regions and Autonomous Provinces. Anyway, the Regions "are entitled to enter into agreements with the territorial bodies of another Member State as well as with other Member States for statistical transfers", as set out in Legislative Decree no. 28 of 3 March 2011. The Ministerial Decree provides for a system for the yearly monitoring of the regional objectives to be achieved. Besides, until the monitoring methodology is defined, it provides that "without prejudice to the national objective, the methodological criteria and the parameters used for the breakdown of the intermediate and final objectives among

Regions and Autonomous Provinces may be reviewed" with a consequent redefinition of the regional objectives.

Within the European context, in April 2009, the European Commission presented a White Paper entitled: "Adapting to climate change: Towards a European framework for action", with the goal of making the EU less vulnerable to the impact of climate change.

With reference to the adaptation measures, in April 2009, the European Commission presented a White Paper entitled: "Adapting to climate change: Towards a European framework for action", with the goal of making the EU less vulnerable to the impact of climate change. The White Paper stressed the need to integrate adaptation into all the key policies of the EU, to develop the knowledge base through further research efforts, to support developing countries in increasing their resilience and ability to adapt to climate changes and to implement a clearinghouse mechanism.

In order to do so, the document outlined over thirty concrete actions to be implemented through a variety of policies ranging from awareness raising to the development of an information system in the matter of adaptation.

During 2010, the European Commission has established a special Directorate General devoted to climate (DG Clima), with a view to coordinating the European policies addressing both climate change and adaptation. This shows the central role that climate change plays in the EU policies, particularly in respect of such vulnerable sectors as energy, civil defense and regional policies. Starting from the White Paper, the European Commission, supported by experts coming from different Countries and sectors, has set going the activities needed to develop a European adaptation strategy for after 2013.

The European Climate Adaptation Platform (CLIMATE ADAPT), an interactive web-based tool on adaptation to climate change available in the web site of the European Environment Agency (http://climate-adapt.eea.europa.eu**)** has been launched in March of last year.

The European Platform is designed to support policy-makers at EU, national, regional and local levels in the development of climate change adaptation measures and policies. CLIMATE ADAPT will help users to access, disseminate and integrate information on climate changes in Europe and their impact, the vulnerability of socio-economic systems and natural sectors, adaptation activities and strategies, case studies of adaptation and potential future adaptation options, and the available tools that support adaptation planning.

It is unquestionable that a sound knowledge base is the main presupposition for stimulating and motivating Member States to develop those national and regional adaptation strategies and plans that, in all probability, the Commission intends to make binding starting from 2012. To date, quite a number of countries (Finland, France, Spain, Netherlands, Denmark, United Kingdom, Germany, Hungary, Norway, Sweden, Ireland, Latvia, Portugal and Belgium, still with the exception of Italy) have initiated processes for the development and implementation of national climate-change adaptation strategies and plans, as well as policies and programs that are to ensure a sustainable development in their territories and to avoid paying an excessive costs in terms of environmental damages, losses of human lives and economic costs,

The European Emission Trading System (ETS)

In the context of the mitigation strategies, the EU Countries have given the utmost relevance to the implementation of the European emissions trading system established under Directive 2003/87/EC.

In the context of the mitigation strategies (meaning the prevention of climate change through a reduction of greenhouse gas emissions and an increase in the carbon dioxide absorption), the EU Countries have given the utmost relevance to the implementation of the European emissions trading system established under Directive 2003/87/EC.

This system entails the setting of a maximum limit (cap) on the greenhouse gas emissions of industrial plants falling under the Directive.

Emissions allowances are assigned to each eligible plant under a National Allocation Plan (NAP). Each allowance (an EAU or European Allowances Unit) entitles the holder to emit a ton of carbon dioxide during the year in question.

CO_2 emissions allowances that are allocated but not used may be exchanged among operators on the European market.

This system should give rise to a competitive market mechanism leading to a reduction in emissions by industrial plants.

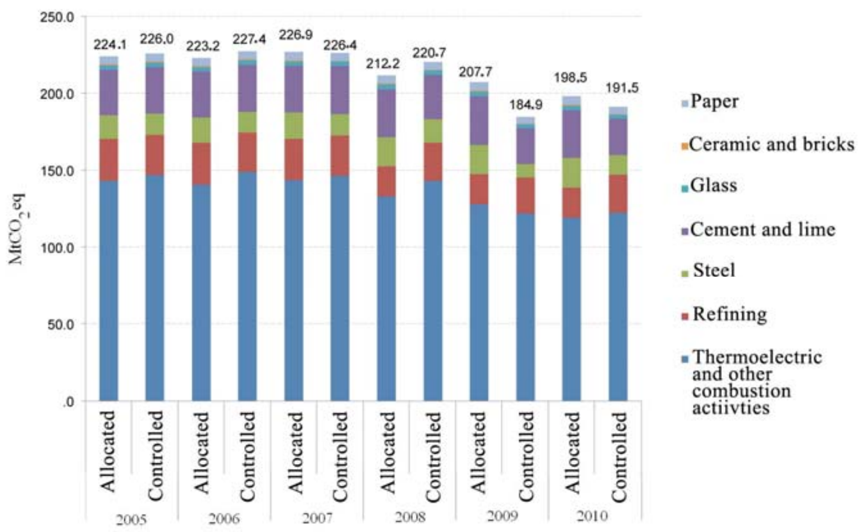
From this point of view, the price at which emissions permits are traded on the European market shall provide a useful indicator of the effectiveness of the system and its capacity to signal to operators when allowances are in short supply.

The period of implementation of the emissions trading system (ETS) began on 1 January 2005 and ended on 31 December 2007.

In Italy, the allowances for the first period were assigned with the Decree DEC/RAS/74/2006 of the Ministry of the Environment, Land and Sea.

The National Committee for the Management and Implementation of Directive 2003/87/EC, consisting of representatives of the Ministry of the Environment, Land and Sea and of the Ministry of Economic Development, assigned the quotas for the second period (2008-2012) with the Decision dated 20 February 2008.

The final figures of allocated and verified CO_2 emissions are available for the period 2005-2010 (Figure 1.30).



The first period (2005-2007) ended with CO_2 emissions exceeding the allocations (+5.6 Mt CO_2).
From 2008 to 2010, the emissions that have been verified were lower than the allowed emissions (-21,3 Mt CO_2), in consequence of the economic crisis that is particularly evident in the last two years.

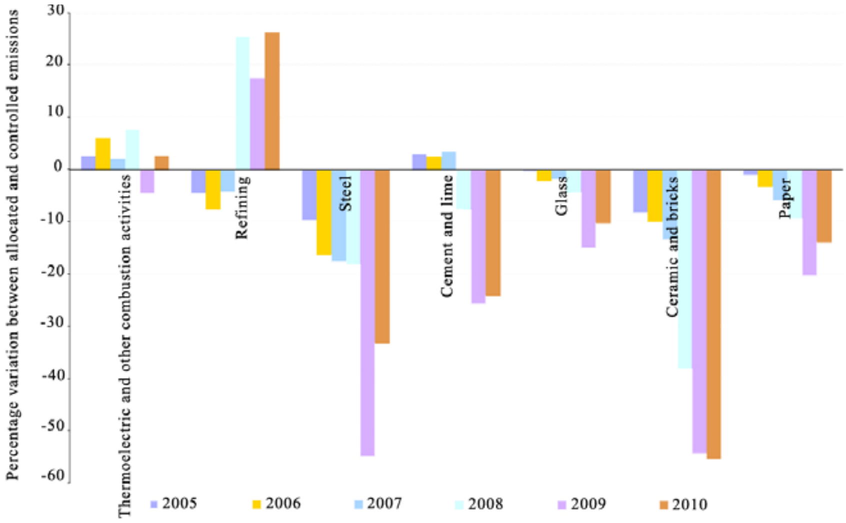
Legend:
Allocated: CO_2 emission quotas assigned to the plants
Verified: CO_2 quantities actually emitted by the plants

Figure 1.30: Comparison between allocated emissions and verified emissions by industrial sectors[75]

The first period ended with CO_2 emissions exceeding the allocations (+5,6 Mt CO_2).
In 2008, the first year of the second period (2008-2012), total CO_2 emissions exceeded the assigned quotas by 8.5 Mt CO_2. Emissions were found to be higher than the assigned thresholds in the thermoelectric sector (+15.6%) and for refineries (+9.1%), while the other sectors recorded emissions lower than their respective allocations.
In the two-year period 2009-2010 , the reduction of the emissions due to the economic crisis became quite evident, even though 2010 allowed observing a lower difference between allocated and verified emissions as compared to the previous year (22.8 Mt CO_2 in 2009 and 7 Mt CO_2 in 2010).
This reduction has affected all the sectors, the only exception being the refining sector that, for three years in a row, reported emissions that were higher than those allowed (Figure 1.31).
In 2010, a slight emission surplus with respect to the allocated quantity (+2.7%) has also been reported in the thermoelectric sector.

The first period (2005-2007) ended with CO_2 emissions exceeding the allocations (+5.6 Mt CO_2).
In 2008, the first year of the second period, the verified emissions exceeded by 8.5 Mt CO_2 the allowed emissions, while the reduction of the emissions has become definitely evident during the two subsequent years in consequence of the economic crisis.

[75] Source: ISPRA



The reduction of the emissions observed in the second period (2008-2012) in consequence of the economic crisis has involved all the sectors, except for the oil-refining sector that, for three years in a row, reported higher emissions than those allowed. A slight surplus with respect to the allocated emissions (+2.7%) is also reported in 2010 with respect to the thermoelectric sector.

Figure 1.31: Percentage variation of the allocated CO_2 emissions with respected to the verified emissions in the industrial sectors[76]

The emission drop consequent to the economic crisis make hard the assessment of the environmental effectiveness of the emissions trading system in the period after 2012.

The emissions drop make hard the assessment of the environmental effectiveness of the emissions trading system in the period after 2012. In fact, the allocated emissions that have not been actually emitted represent emissions allowances that the operators may sell or use in the next years, when the industrial sectors will recover from the crisis. The surplus of allowances, already detected for a few sectors within Europe[77], has become even more noticeable further to the economic crisis and could represent an obstacle to investments in the sectors with lower carbon content.
With Decision dated 22 October 2010, the European Commission has approved the quantity of emissions to be allocated at a European level for 2013 (2,039.15 Mt CO_2). The emission allowances that have become available in consequence of the economic crisis may indeed represent an increase in the emission threshold after 2012 if they are not used to offset the emissions exceeding the allocations in the period before the economic crisis.

Energy efficiency and saving

As concern the electricity generation is worthy of note nationally is the growing role played by cogeneration, which increase the

As concern the electricity generation is worthy of note is the growing role played by cogeneration, which increase the efficiency of the conversion of the energy available from primary sources. The electric generation data show that, since 1997, the new requirement for electric power generated through thermal power stations has been met almost entirely through cogeneration (Figure 1.32). In 2010 a slight recovery of the thermoelectric generation was observed (+2%) after a rapid drop reported in 2009 (-13.5% with respect to the preceding

[76] Source: ISPRA

[77] Gaudioso D., Caputo A., Arcarese C., "*A preliminary assessment of CO_2 emissions abatement resulting from the implementation of the EU ETS in Italy*", proceedings of the workshop "eceee 2009 Summer Study", 1–6 June 2009, La Colle sur Loup, Côte d'Azur, France, http://www.eceee.org/conference_proceedings/eceee/2009/

year). Last year, the share of the combined generation of electric power and heat amounted to 49.2%, while it was 21% in 1997.

efficiency of the conversion of the energy available from primary sources.

As for the mix of the primary sources, it should be noted that the growing role of natural gas in thermal electricity generation has a positive effect on the trend in greenhouse gas emissions. This is due not only to the low emission factor of natural gas compared to other primary sources, but also to the greater efficiency of the combined cycles fuelled by natural gas, as opposed to traditional steam cycles.

The growing role of natural gas in thermal electricity generation has a positive effect on the trend in greenhouse gas emissions.

The mean annual increase in electric power generation between 1997 and 2010 approximated 5,527 GWh/year for the combined heat and power production through the cogeneration process and 2,410 GWh/year for total thermoelectric power generation. The generation of electric power alone remained almost constant until 2008, when it witnessed a sudden reduction. These figures show that, since 1997, the need for new electric power from thermal power plants has been met nearly entirely through cogeneration.

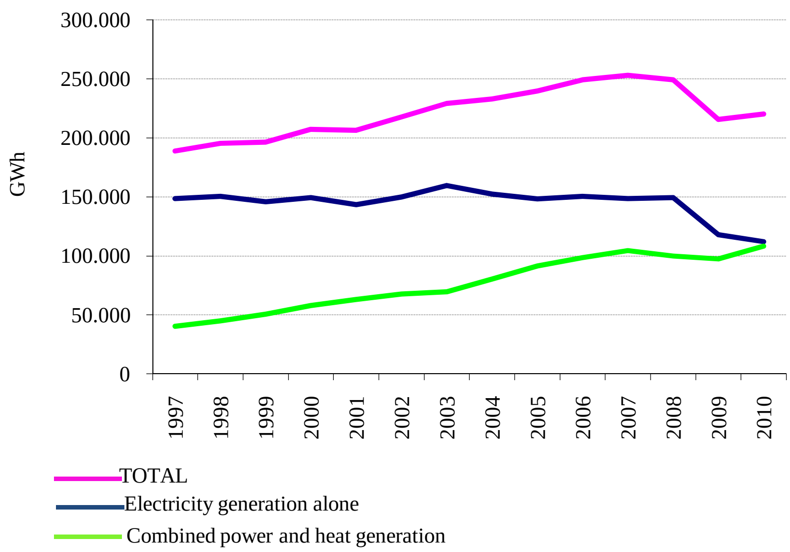


Figure 1.32: Net production of thermoelectric power[78]

During the period 1996-2010, 20.4% decrease was reported in the specific mean consumption of natural gas for net electricity generation. Derivative gases also showed a significant drop in specific consumption in 2010, with a 16.9% decrease with respect to 1996, even though a 2.8% increase has been reported last year with respect to 2009. Taking into consideration all the fuels used for electricity generation, specific mean consumption fell by 13.3%. The specific mean consumption of all fuels for electricity generation is affected by the use of oil products and solid fuel, which are less efficient than gas fuels. In fact, during the period taken into consideration (1996-2010), the mean specific consumption of oil products and solid fuel rose by 7.9% and 5.6%, respectively, while last year was characterized by a marked reduction in the specific

During the period 1996-2010, the specific mean consumption of all fuels used for net electricity generation fell by 13.3% (-0.9% between 2009 and 2010).

[78] Source: ISPRA processing of TERNA S.P.A. data

consumption of both fuels, amounting to -6.6% and -2.2%, respectively (Figure 1.33).

During the period 1996-2010, the mean specific consumption of natural gas decreased by 20.4% and the mean specific consumption of derivative gases decreased by 16.9%. In general, the mean specific consumption for electricity production has dropped by 13.3%. On the other hand, oil products and solid fuel consumption has increased by 7.9% and 5.6%, respectively.

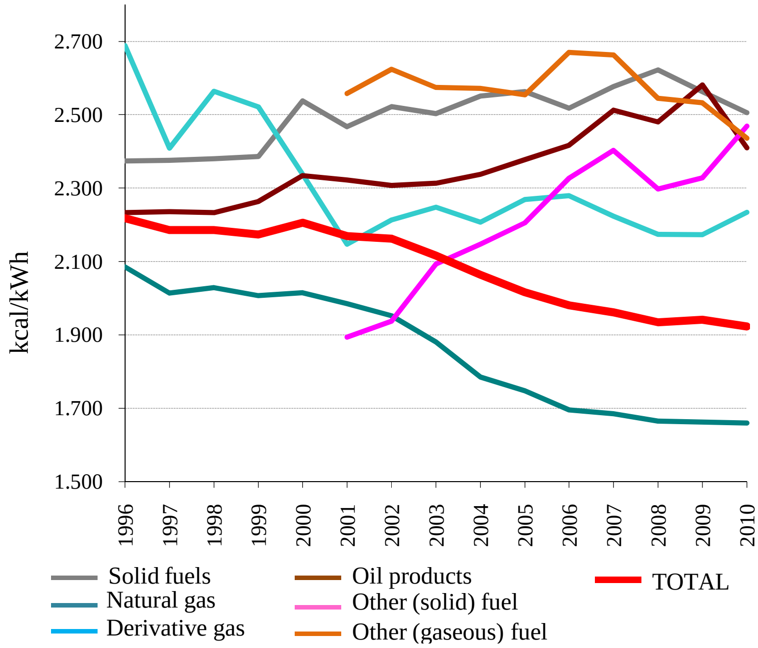


Figure 1.33: Mean specific fuel consumption for production of net electric power from fossil sources[79]

The electricity generation sector is one of the major natural sources of greenhouse gas emissions. In 2010, the emissions of carbon dioxide for electricity generation amounted to 118.4 Mt CO_2, that is 88.9% of the emissions from energy industries and 23.6% of the national GHG emissions. Starting from 1990, the factors of carbon dioxide atmospheric emissions from electricity generation have shown a constant reduction of the emissions per kWh produced. The decrease in the emissions is due to a variety of factors that contribute to a different extent to such a reduction:

- variation of the fuel mix used in the thermoelectric generating plants, with a greater recourse to low-carbon fuels having a greater calorific value, such as natural gas;
- technological improvement of the combustion plants starting from 2001 and greater efficiency of the combined cycles fuelled by natural gas compared to the traditional steam cycles;
- electricity production from renewable sources with net atmospheric emissions of carbon dioxide equal to zero.

As for the emission factors for electricity consumption, at user level, the reduction of the emission factors is also due to the following factors:

- increased ratio of the net electric power generation to the gross electric power;
- reduction of the network losses;

[79] Source: ISPRA processing of TERNA S.p.A. data

- increase in the share of electricity imported from abroad.

Table 1.6: Emission factors (g CO_2/kWh) for thermoelectric production, total electric production and electric consumption[80]

Year	Gross thermoelectric production	Gross electricity production*	Electric consumption
	g CO_2/kWh		
1990	708,35	592,01	577,76
1991	711,36	562,91	550,31
1992	696,85	553,23	539,99
1993	683,52	542,15	520,42
1994	679,63	535,83	518,24
1995	691,93	570,66	556,47
1996	680,57	549,28	534,61
1997	669,72	543,89	528,53
1998	672,01	549,09	533,99
1999	662,34	532,48	516,45
2000	649,24	528,35	510,59
2001	628,05	504,87	480,80
2002	628,26	522,99	497,28
2003	607,86	513,66	490,47
2004	592,86	491,48	477,37
2005	568,16	482,30	462,05
2006	560,53	475,77	460,98
2007	546,22	469,17	453,38
2008	533,77	443,34	435,68
2009	522,60	409,68	393,87
2010	513,80	396,34	382,13

Note:
* net of contributions from pumped storage units

Under Directive 2006/32/EC, the general national target for energy savings is 9% within the ninth year of the implementation of the Directive (2016).

Directive 2006/32/EC has set targets for Member States regarding the efficiency of the final uses of energy and energy services. The general national target for energy savings is 9% within the ninth year of the implementation of the Directive (2016).

On 27 July 2011, in compliance with Law no. 99/2009 that provided for the introduction of Plan for Energy Efficiency and Energy Saving to be transmitted to the European Commission (article 27), the State-Regions Conference has approved the second Energy Efficiency Action Plan (EEAP 2011). In line with the first Plan submitted by Italy in July 2007, the EEAP 2011 maintains its quantitative target of 9.6% (126,540 GWh/year) reduction of consumption by 2016 and presents the results obtained in 2010. An innovative element is represented by the extension of the EEAP estimates from 2016 to 2020, with a view to linking together the policies concerning the renewable energy sources with the energy efficiency policies. The Plan takes into consideration the new legislative framework by making specific reference to a number of new regulations. These include Legislative Decree no. 115/08, which implements Directive 2006/32/EC, the Ministerial Decree of 26 June 2009 concerning the National Guidelines for the energy certification of buildings for the implementation of Legislative Decree no. 192/2005, Law no. 99/2009 and Legislative Decree no. 28/2011, which implements Directive 2009/28/EC on renewable resources. In relation to the targets

[80] Source: ISPRA

achieved in 2010, the Plan shows how the results exceed expectations. Altogether, 47,711 GWh have been saved, and this is 33.8% more that the results expected in the intermediate period shown in the Plan in 2007 (Table 1.7).

Table 1.7: Actual and expected annual energy savings in 2010 and annual energy savings expected in 2016 and 2020[81]

Measures to improve the energy efficiency	Annual energy saving		Variation between attained and expected saving	Expected annual energy saving	
	attained in 2010	expected in 2010		2016	2020
	GWh/year		%	GWh/year	
Household sector	31,427	16,998	84.9%	60,027	77,121
Services sector	5,042	8,130	-38.0%	24,590	29,698
Industry	8,270	7,040	17.5%	20,140	28,678
Transport	2,972	3,490	-14.8%	21,783	49,175
TOTAL	**47,711**	**35,658**	**33.8%**	**126,540**	**184,672**

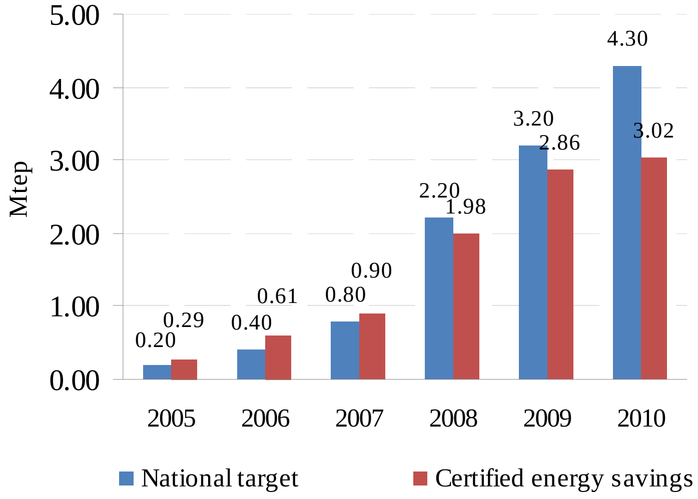
The household sector accounts for 65.9% of the savings achieved in 2010 and, even in the subsequent years, it is the sector with the highest saving potential (47.4% in 2016 and 41.8% in 2020).
In fact, the savings obtained in the household sector exceed expectations by 84.9%.
The industry sector represents 17.3% of the savings attained in 2010 and the reported savings exceed expectations by 17.5%.
On the other hand, a negative result has been reported in 2010 with reference to the services and transport sectors.
Based on the new Plan, the measures singled out in order to achieve the 2016 target will allow 14% energy saving by 2020 with respect to the average energy consumption from 2001 to 2005.
Furthermore, the energy savings expected in 2016 and 2020 will allow avoiding annual emissions amounting to 37.2 Mt CO_2 and 45 Mt CO_2, respectively.

Based on the EEAP 2011, the measures singled out in order to achieve the 2016 target will allow 14% energy saving by 2020 with respect to the average energy consumption from 2001 to 2005. Furthermore, the energy savings expected in 2016 and 2020 will allow avoiding annual emissions amounting to 37.2 Mt CO_2 and 45 Mt CO_2, respectively.

One of the major energy saving measures that has been implemented is the system of White Certificates. This system has been provided for by article 6 of Directive 2006/32/EC, and Italy was the second country to implement it, right after the United Kingdom, through the Ministerial Decrees of 20 July 2004. The objective of the decrees, subsequently supplemented by the Ministerial Decree of 21 December 2007, is to achieve annual energy savings that are to increase year after year, until they reach, by 2012, a level of 6 Mtoe a year through the introduction of mandatory energy saving quantities for distributors of electricity and natural gas.

The objective of the Ministerial Decrees of 20 July 2004 and the Ministerial Decree of 21 December 2007 is to achieve energy savings that are going to increase up to 6 Mtoe per year by 2012.

[81] Source: *Piano d'Azione Italiano per l'Efficienza Energetica*, 2011



During the first three years of operation of the system of White Certificates, the certified energy savings have always exceeded the annual targets set by the decrees, while in the last three years the target has not been achieved.

Legend:
For the "national targets", the reference year is the solar year.
As for the "certified energy savings", the first year (2005) refers to the period going from 1 January 2005 to 31 May 2006, while the reference period for the subsequent years goes from 1 June of the year to 31 May of the subsequent year.

Figure 1.34: Comparison between national energy saving targets and certified energy savings[82]

Figure 1.34 shows that, during the first three years of operation of the system of White Certificates, the certified energy savings have exceeded the annual objectives set by the decrees referred to above, while in the last three years the objectives have not been achieved. From 2008 to 2010, the certified savings have been altogether 18.9% lower than the target. Given the results, it may be inferred that the system of the White Certificates meets with difficulties in the achievement of the targets and deserves to be strengthened to a greater extent. The application of an emission factor allows expressing the certified savings in terms of avoided greenhouse gas emissions. In particular, assuming an emission factor of nearly 2.3 tCO_2/toe (average for natural gas) it turns out that, in 2010, the White Certificate have allowed avoiding 22.2 Mt CO_2.

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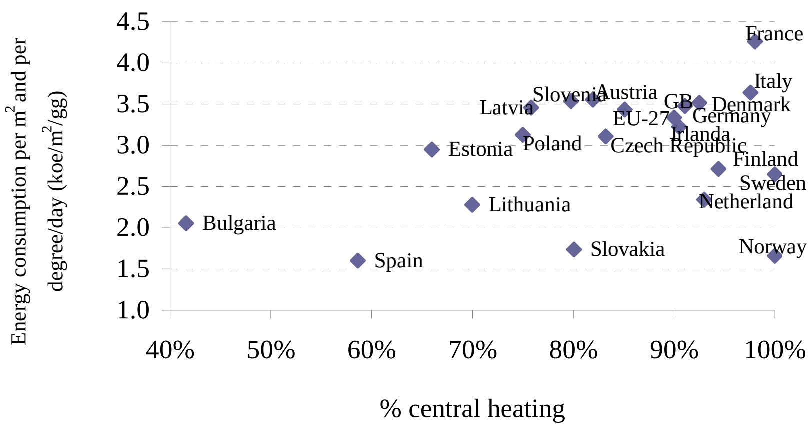
With a purpose to giving new impetus to the White Certificates, the Italian Authority for Electricity and Gas has issued new guidelines for the energy efficiency certificates with the Resolution EEN 9/11 of 27 October 2011. The Resolution provides for a number of measures to facilitate the submission of projects and to increase their number, including the introduction of multiplication coefficients – durability coefficients – that, taking into consideration the technical life of the measures, increase the number of White Certificates issued during their useful life with respect to the past. Furthermore, the minimum project threshold has been reduced, while the time limit for the submission of the projects has been increased. Another significant

[82] Source: ISPRA processing of AEEG (Italian Authority for Electricity and Gas) data, "*Il meccanismo dei Titoli di Efficienza Energetica dal 1°gennaio al 31 maggio 2011*". Second Intermediate Statistical Report on the Mandatory Year 2010, drawn up in accordance with the first paragraph of article 8 of the Ministerial Decree of 21 December 2007

measure is the introduction of energy efficiency credits certifying energy savings in the transport sector.
With respect to the energy uses in buildings, nearly all the EU Member Countries report heating as the major component of the household sector energy consumption (68.4% in 2008). Considering the correction for climate conditions, Italy ranks immediately after France as one of the countries with the highest energy consumption per square meter and per degree/day in the household sector (Figure 1.35).

In 2008 the energy consumption per m², adjusted for the climate conditions, show that Italy is one of the major consumer countries after France.



Note:
Centralised heating (that includes district heating, condominium heating, independent heating and electric heating), implies that the entire building is heated, as against the heating supplied to a single room

Figure 1.35: Energy consumption per m² and per degree/day in buildings (2008)[83]

According to the European Environment Agency, the recent penetration of central heating in buildings and the increase in the mean size of houses has contributed to the increase in the energy demand in the household sector. It has been estimated that the replacement of the devices for heating a single room with centralized heating systems determines a 25% average increase in the energy requirement for heating purposes. The European share of buildings with central heating has increased from 77% in 1990 to 85% in 2008. Therefore, with the increase in the average size of living spaces and in the number of electrical appliances, nearly 70% of the energy efficiency attained through technological progress has been offset by the increase in energy consumption.
As for the efficiency of buildings over the national territory, special significance should be given to the incentives to improve the building efficiency through the mechanism stimulating tax allowances. This mechanism has been introduced by the 2007 Financial Act (Law no. 296 of 27 December 2006) and subsequently amended and extended until 31 December 2010 by the 2008 Financial Act (Law no. 244 of 24 December 2007) with a view to promoting energy saving in the household sector. It entails a 55% IRPEF (Personal Income Tax) or

As for the efficiency of buildings over the national territory, special significance should be given to the incentives to improve the building efficiency through the

[83] Source: ISPRA processing of EEA/ODYSSEE data

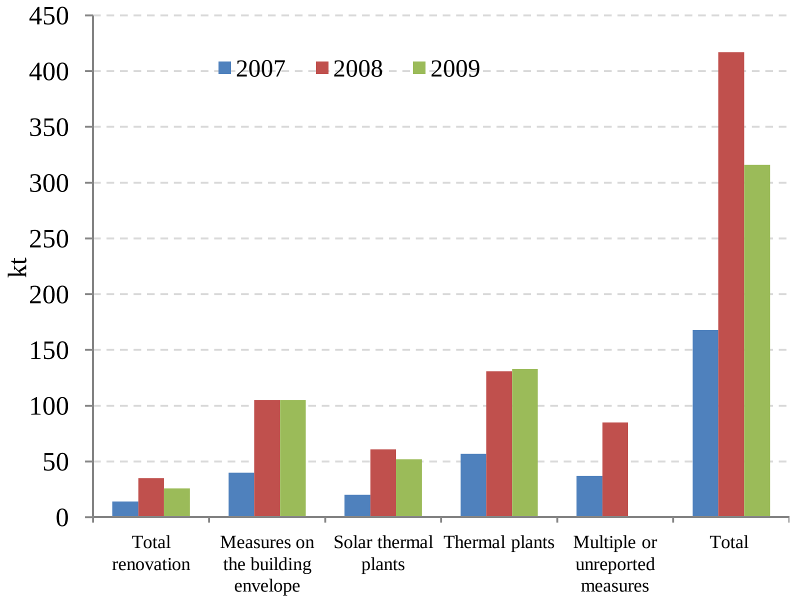
IRES (Corporate Income Tax) allowance for expenses incurred to implement energy saving measures in existing buildings (with the exclusion of new buildings and extension works). In short, the measures eligible for tax allowance concern:

mechanism stimulating tax allowances.

- global energy-oriented requalification of the building;
- measures affecting horizontal opaque structures, vertical opaque structures and windows, including frames;
- installation of solar panels for the production of hot water;
- replacement of wintertime conditioning systems with plants provided with gas condensing boilers or, as an alternative, with high-efficiency heat pumps or with low-temperature geothermal plants.

Based on data processed by ENEA[84], the number of building renovation measures that benefited from this incentive mechanism during the period 2007-2009 has increased to a considerable extent from 2007 to 2008, getting from 106,000 to 247,800 while it has decreased slightly in 2009, getting to 236,700. The energy saving obtained through these measures amounted to 67.7 ktoe in 2007, 168.7 ktoe in 2008 and 127.9 ktoe in 2009. The energy saving is closely connected with the quantity of carbon dioxide not released into the atmosphere, that is 168 kt CO_2 in 2007, 417 kt CO_2 in 2008 and 316 kt CO_2 in 2009. Although the number of renovation measures dropped between 2008 and 2009 by 4.5%, the total energy saving dropped by 24.2%. This may be due to the lower efficiency of the measures implemented in 2009. Considering the average toe saved per measure the resulting value is 0.64 and 0.68 toe/measure, respectively, in 2007 and 2008, while in 2009 it drops to 0.54 toe/measure average. In any event, as stressed in the ENEA report, the procedural and administrative simplifications, as well as the reduction of the technical and formal obligations to be fulfilled by the technicians and the end-users have contributed in the course of the third year to a lower reliability of the data with respect to the past.

[84] MSE-ENEA, 2010, *Le detrazioni fiscali del 55% per la riqualificazione energetica del patrimonio edilizio esistente nel 2009*



The measures for upgrading buildings that have profited from the incentive mechanisms have allowed to avoid the emission of 901 kt CO_2 in the period 2007-2009.

Note:
Data processed based on documents e-mailed to ENEA. The 2009 data do not take into account the paper documentation sent by mail, estimated to be nearly 1%.

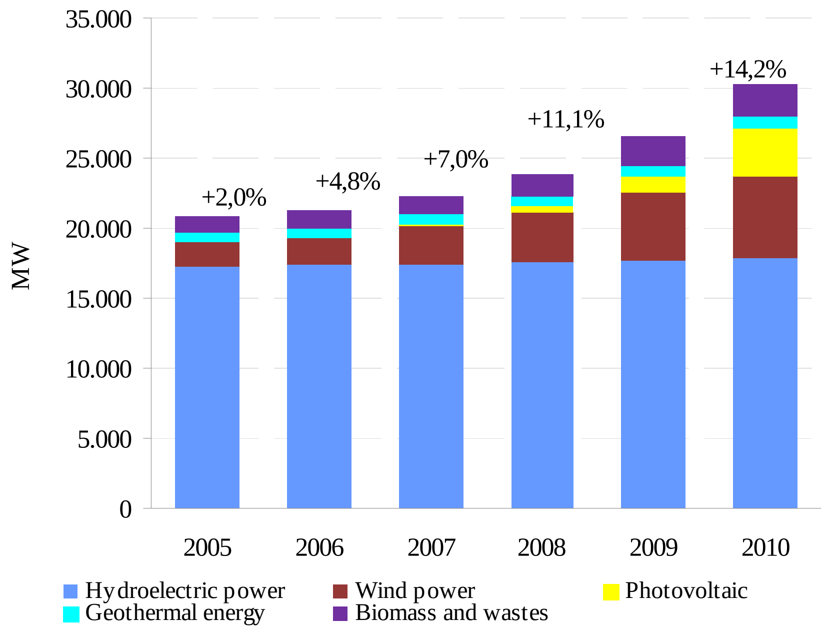
Figure 1.36: CO_2 that has not been released in relation to the type of building renovation measures[85]

Renewable sources

Since 2006, Italy has reported a noteworthy increase in the installed capacity relative to all the renewable energy sources.

Insofar as the electricity generated from renewable sources is concerned, since 2006 Italy has reported a noteworthy increase in the installed capacity with an exponential annual growth.
In 2010, the gross efficient operating capacity reached 30,284 MW, with a 14.2% increase (3,767 MW) compared to the previous year.
The growth of the photovoltaic and wind sectors has been quite rapid: the former got from 7 MW in 2006 to 3,470 MW in 2010, and the latter from 1,908 MW in 2006 to 5,814 in 2009.
The increase in the installed power capacity in the last year is mainly due to the development of photovoltaic (+2,328 MW) and wind (+916 MW) power plants, followed by bioenergy and hydroelectric plants, which account for +333 MW and +155 MW, respectively.

[85] Source: MSE-ENEA



Since 2006, Italy has reported a noteworthy increase in the installed capacity relative to all the renewable energy sources.

Figure 1.37: Gross efficient power of plants produced by renewable sources[86]

The national production of electricity from renewable sources accounts for 25.5% of the total generation of electricity.

In 2010, the production of electricity from renewable sources is about 77 TWh in the face of a total electricity generation of 302.1 TWh. Therefore, the national production of electricity from renewable sources accounts for 25.5% of the total generation of electricity. The significant increase in the share of electricity from renewable sources reported in the last few years is due to the contingent decrease in the total electricity production in consequence of the economic crisis and the intensification of the power generation from a number of renewable sources. The electricity production by renewable sources is characterized by annual fluctuations as concern the effects of meteorological conditions on hydro-electricity, as well as the growing contribution of non-traditional sources (wind power, geothermal energy, biomasses and wastes). In 2010, hydroelectricity has accounted for 66.4% of the electricity generated from renewable sources. Even though this source still provides the greatest contribution, its relative share has dropped significantly compared to preceding years (on average, 79.6% in 2001-2005 and 71% in 2006-2009) due to the increased share of other sources. In recent years, there has been a noticeable increase in the electricity generated from wind (from 117.8 to 9,125.9 GWh in the period 1997-2010) and bioenergies, which include biomasses and wastes (from 694.2 to 9,440.1 GWh). Even the electricity produced from geothermal sources has increased from 3,905.2 to 5,375.9 GWh, in the period 1997-2010, though production from this source has dropped slightly in recent years and has remained substantially unchanged during the last year. The contribution from photovoltaic plants has reached 2.5% of the electricity generation from renewable sources (1,905.7 GWh in 2010) and, in 2010, its production has increased 1.8 times with

[86] Source: ISPRA processing of TERNA S.p.A. data

respect to 2009. The monthly reports by TERNA on the electric power production[87] point to a rapid growth in the photovoltaic production that, in 2010, reached 9,258 GWh.
The objectives set with Directive 2009/28/EC for 2020 on the promotion of the use of energy from renewable sources have been divided by the National Action Plan for renewable resources among the electric sector, thermal sector and transport sector. The 2020 target for the electric sector, calculated as the ratio between normalized electricity production from renewable sources and gross domestic consumption, is 26.4%. Hence the normalized production should reach 98.9 TWh compared to 68.9 TWh in 2010[88].

The national production of electricity from renewable sources accounts for 25.5% of the total generation of electricity. In recent years, there has been an exponential increase in the share of renewables in electricity production.

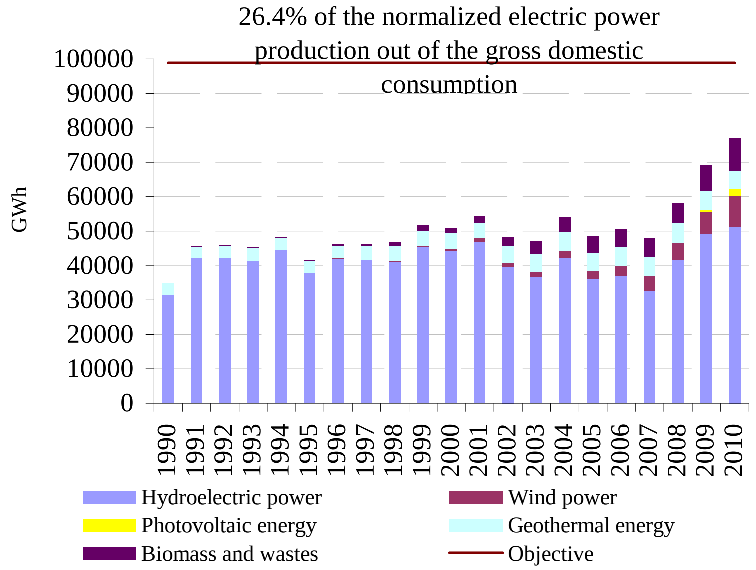


Figure 1.38: Gross domestic production of electricity from renewable sources[89]

Table 1.8: Production of electricity from renewable sources with respect to the gross domestic consumption of electricity in Italy[90]

In 2010, the shares of actual and normalized renewable energy show a significant increase: the former gets to nearly 22.4% and the latter to 20.1%. The causes of it may be traced in the drop in Gross Domestic Consumption and the concomitant increase in the renewable production.

Year	Production of energy from RES[1]		GDC[2]	Percentage share	
	Actual	Normalized		Actual/GDC	Norm./GDC
	TWh		TWh	%	
2005	48.4	56.4	346.0	14.0%	16.3%
2006	50.6	56.2	352.6	14.4%	15.9%
2007	47.7	56.6	354.5	13.5%	16.0%
2008	58.2	58.8	353.6	16.5%	16.6%
2009	69.3	62.7	333.3	20.8%	18.8%
2010	77.0	68.9	342.9	22.4%	20.1%

Legend:
[1] Renewable Energy Sources
[2] Gross Domestic Consumption: Gross national production – Production from pumped storage units + foreign balance

[87] TERNA, 2011, *Rapporto mensile sul Sistema Elettrico – Consuntivo settembre 2011*
[88] GSE, 2011, *Impianti a fonti rinnovabili. Rapporto statistico 2010*
[89] Source: ISPRA processing of TERNA S.p.A. data
[90] Source: GSE, 2011, *Impianti a fonti rinnovabili. Rapporto statistico 2010*

A regional analysis points to noteworthy differences in the renewable energy sources. Hydroelectricity, found primarily in the regions of the Alpine arc, accounts for 66.47% of the electricity generated by renewable sources.

Hydroelectricity, concentrated in the regions of the Alpine arc, accounts for almost 66.4% of the electricity generated from renewable sources.

Geothermal energy generation, found only in the Tuscany Region, accounts for 7% of the electricity produced from renewable sources. The bioenergies account for 12.3% of the total, while wind power and photovoltaic energy account for 11.9% and 2.5%, respectively, of the electricity produced from renewable sources.
Most of the wind power is generated in the southern Regions and on the major islands (98%).

Regionally, noteworthy differences can be observed in the renewable energy sources.

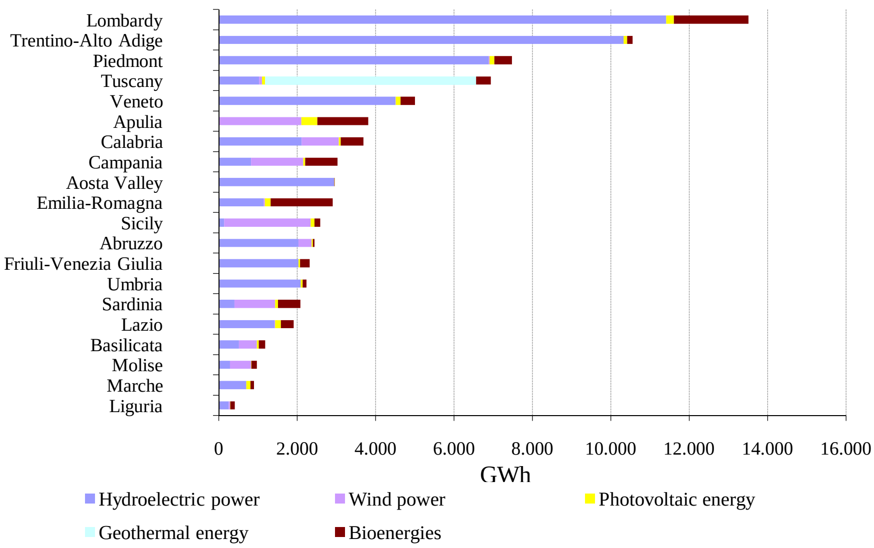
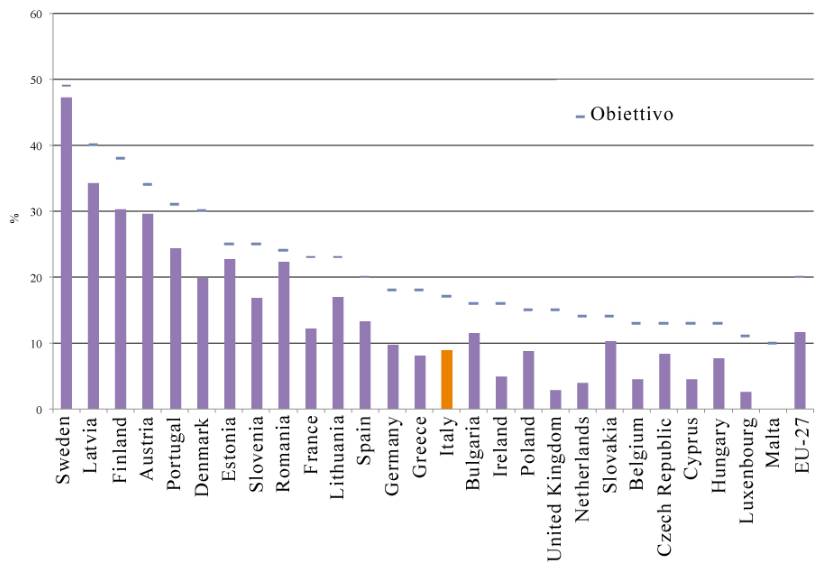


Figure 1.39: Gross electricity production from renewable energy sources at a regional level (2010)[91]

Directive 2009/28/EC set the share of the final domestic energy consumption that has to be produced from renewable energy sources by each country of the European Union in 2020. These shares include not only energy from renewable sources consumed for the production of electricity, but also renewable energy used for heating and transport. Furthermore, the Directive provides also for the possibility for Member States to enter into agreements with other Member States for the statistical transfer of a certain quantity of energy from renewable sources, as well as to cooperate among Member States or with non-EU Countries, in the production of energy from renewable sources. The renewable energy consumption target assigned to Italy is 17% of final domestic consumption. In 2009, the total renewable energy as a percentage of the final consumption was equal to 8.9% (Figure 1.40).

Directive 2009/28/EC set the share of the final domestic energy consumption that has to be produced from renewable energy sources by each country of the European Union in 2020.

[91] Source: ISPRA processing of TERNA S.P.A. data



The renewable energy consumption target assigned to Italy (Directive 2009/28/EC) is 17% of gross final consumption. In 2009, the total renewable energy share as a percentage of final consumption was 8.9%.

Figure 1.40: Share of the energy consumption from renewable sources as a percentage of final consumption in the European Countries (2009)[92]

At a national level, Law no. 13 of 27 February 2009 sets out that the Community targets in the matter of renewable energies must be allocated with shared arrangements among the Italian Regions. As previously pointed out, a Ministerial Decree that has been recently published provides for a regional burden sharing. For the time being, the target set to the Regions is 14.3%, while the remaining part depends on State instruments.

The target set to the Regions is 14.3%, while the remaining part depends on State instruments.

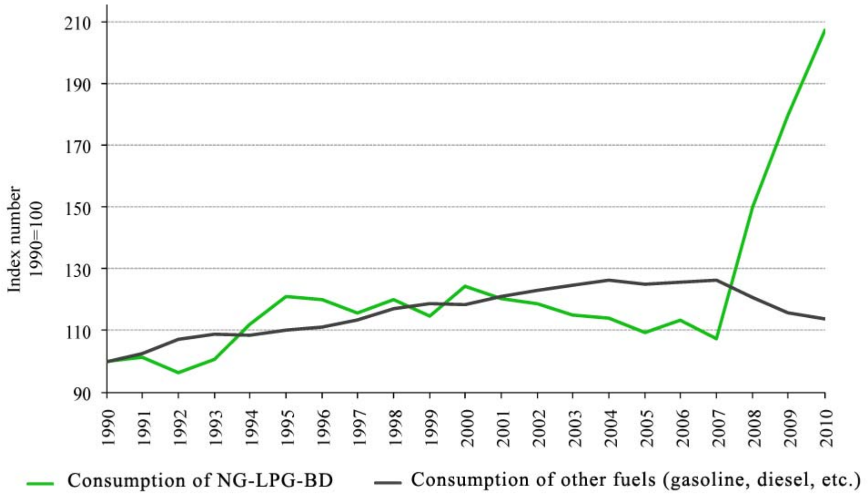
Fuels with a lower environmental impact in the transport sector

Looking at the transport sector, there has been a constant increase in fuel consumption between 1990 and 2007 (+26.4% compared to 1990), followed by a rapid decrease due to the effects of the economic crisis. The consumption of fuel in 2010 exceed by 14% the 1990 level. Consumption levels appear to be characterized by regular periods of stabilization, followed by a resumption of the upward trend. The percentage of fuels with a low environmental impact (natural gas, LPG, bio-diesel) out of total fuels shows irregular results, going from 5.6% in 1990 to 4.8% in 2007, with a peak value of 9.8% in 2010. From 2000 to 2007, the consumption of these fuels has dropped by 13.7% with a sudden rise in the subsequent years mainly due part to the increase in the biodiesel consumption that, in 2010, has grown by 80.6% with respect to 2008, while the consumption of LPG and natural gas has grown by 21.2% and 23.1%, respectively. It is interesting to note that the fall-off in fuel consumption in the period affected by the economic crisis has only concerned such fuels as gasoline and diesel, with 8.7% and 3.7% reductions in 2010 with respect to 2008. Altogether, the low-impact fuels consumed in 2009 with respect to 1990 has increased by 107.3%. Based on the available data, it is clear that the progress made

[92] Source: ISPRA processing of Eurostat data

in the transport sector through the implementation of technological measures involving engine efficiency are offset - and to a greater extent in Italy than in the other European Countries - by growth in the demand for transport, and especially road transport, meaning that the environmental impact of this sector continues to grow. As for the quality of the fuels used, it can be observed that the quantity of low-impact fuels, in addition to being of marginal importance, is often highly irregular, although the last three years have been observed a constant increase of consumption of these fuels.

The effects of technological measures are offset by the growth in the demand for transportation and especially road transport.



The use of low-impact fuels is marginal and subject to considerable irregularities. In recent years, there has been a sudden rise due mostly to biodiesel.

Legend:
NG: natural gas;
LPG: liquefied petroleum gas
BD: biodiesel

Figure 1.41: Fuel consumption for transportation purposes (1990=100)[93]

LULUCF (*Land-use, Land-use change and forestry*)

In the face of the increase in emissions of greenhouse gases resulting from various production activities and deforestation processes, a noteworthy quantity of carbon dioxide, in the order of 0.2 billion tons of carbon during the period 1980-1989 and 0.7 billion tons of carbon during the period 1989-1998, has been removed globally from the atmosphere by the LULUCF sector[94]. In Italy, the LULUCF sector, which encompasses the different existing uses of the land (such as forests, cultivated land, meadows, urban settlements and wetlands), as well as changes in the designated use of land, was responsible for the capture of 34.5 million tons of CO_2 eq in 1990 and 56.5 million tons of CO_2 eq in 2010. However, only the portion removed from managed forests can be included in the accounting for the Kyoto Protocol, as set by articles 3.3 (forestation, reforestation and deforestation) and 3.4 (forest management[95]).

In 2007, the LULUCF sector was responsible for the capture of 56.5 Mt di CO2 eq in Italy. Much of the absorption was due to forests.

[93] Source: ISPRA processing of Ministry of Economic activity data
[94] IPCC, 2000, *Land-use, Land-use change and forestry*, IPCC *Special Report*
[95] Italy chose only forestry management as an additional secondary activity, in accordance with art. 3.4 of the Kyoto Protocol; the other activities are the management of cultivated land, the management of pastureland and re-vegetation

GLOSSARY

Burden Sharing:
Regional breakdown of the minimum share of increase in the energy produced from renewable sources in view of the European objectives set for 2020.

White Certificates:
also referred to as "Energy Efficiency Credits", confirm the claims of energy savings through the application of efficient technologies and systems. They are issued by the Manager of the Electricity Market based on the certifications by the Authority of the savings that have been attained. A certificate is equivalent to the saving of 1 ton of oil equivalent (toe).

Clearinghouse:
information exchange mechanism in the form of an interactive web tool that provides access to geospatial information and multiple information sources. Therefore, the main object of a clearinghouse is to facilitate the collection and circulation of information, data and case studies and to enhance their sharing with a view to creating a comprehensive and updated knowledge base.

Emissions Trading System:
a system established under Directive 2003/87/EC as a mitigation measure that entails the setting of a maximum limit on the greenhouse gas emissions of industrial plants falling under the Directive. Emissions allowances are assigned to each eligible plant under a National Allocation Plan (NAP). Each allowance entitles the holder to emit a ton of carbon dioxide into the air during the reference year. CO_2 emissions allowances that are allocated but not used may be exchanged among operators on the European market. This system should give rise to a competitive market mechanism that leads to a reduction in emissions by industrial plants.

Green Economy:
based on the UN definition, it is an economy that results in improved human well-being and reduces inequalities over the long term, while not exposing future generations to significant environmental risks.

LULUCF (**Land-Use, Land-Use Change and Forestry**):
sector for estimating the absorptions and emissions of the greenhouse gases resulting from land use, land-use change and forestry provided for by the National Inventory of Greenhouse Gas Emissions.

Climate change mitigation measures:
climate change response measures, or else, measures to prevent climate changes through a reduction of the greenhouse gas emissions and an increase in the carbon dioxide absorptions.

Climate change adaptation measures:
climate change response measures that aim at minimizing any negative consequence and at preventing any damage resulting from climate changes.

Heat waves:
a prolonged period of excessively hot weather often associated with high humidity, strong solar irradiation and no ventilation. These climate conditions may represent a risk for the health of the population.

Kyoto Protocol:
it is one of the most important international treaties aimed at fighting global warming. It is a protocol to the United Nations Framework Convention on Climate Change that sets out the commitments of the industrialized countries to reducing the emissions of a few greenhouse gases responsible for the warming of the planet. The total emissions of the developed countries must be reduced by at least 5% in the period 2008-2012 with respect to the 1990 levels and, according to the Kyoto Protocol, Italy should cut its emissions in the period 2008-2012 to levels 6.5% below its 1990 levels, that is, 483.26 Mt CO_2eq.

Ton of oil equivalent (**toe**):
unit of measurement of energy. It is used to compare quantities of different energies. By definition, 1 toe is equivalent to 11,628 kWh.

CASE STUDY

The impacts of climate change on the Ancona cultural heritage

Introduction

It is just in recent years that the international scientific community has started focusing on the effects of climate change on the historical-artistic heritage.

In 2007, the report *Global Climate Change Impact on Built Heritage and Cultural Landscapes,* published within the context of the European Noah's Ark project, has provided estimates of the climate-related parameters in Europe up to 2100, together with "damage maps" that represent the potential impacts of both climate and environment on the materials constituting cultural heritage sites[96].

In 2011, based on this and similar experiences, ISPRA and ISCR (Institute for Conservation and Restoration) have studied a statistical sample of the Ancona monuments within the context of the LIFE ACT project (*Adapting to Climate Change in Time*).

In particular, the study has analyzed the vulnerability (state of conservation) of a few monuments selected within the town and the territorial hazard (potential impacts) in both a current and a future scenario.

The correlation between vulnerability of the heritage objects and, hazard, calculated at a municipal level, allowed determining which monuments in Ancona, from among those taken into consideration, should be viewed as being more at risk in order to develop suitable adaptation strategies for reducing negative impacts.

The ACT project (*Adapting to Climate Change in Time*)

The problem of the social, economic, cultural and environmental impacts connected with climate changes has been recently dealt with within the context of the LIFE ACT project [97] that, initiated in January 2010, is still under way[98].

The project, which saw the participation of the Municipalities of Ancona (Italy), Bullas (Spain), and Patras (Greece) with the support of ISPRA, purposes to analyze the impacts of climate change at a municipal level and to single out suitable strategies – to be suggested to the local authorities - for promoting the adaptation of the territory to current and future climate changes.

At the beginning, the project has focused on the collection of comprehensive data on the future climate scenarios for Ancona, Bullas and Patras until 2100. Based on the collected data, each one of the towns has selected the sectors deemed most vulnerable to

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[96] *Global Climate Change on Built Heritage and Cultural Landscapes, The Noah's Ark Project*, Atlas and Guidelines_2007

[97] http://www.actlife.eu/EN/index.xhtml

[98] The project should terminate by the end of 2012.

the action of the climate and to the consequent risks. These sectors were subsequently analyzed more in-depth.
The results obtained in the selected thematic areas will allow these three Municipalities to define guidelines for the adaptation strategies they will have to implement for reducing local impacts.
The Municipality of Ancona has identified a number of sectors at risk, including infrastructures, coastline, landslides and cultural heritage objects.
The subsequent paragraphs are going to outline the method and the results of the study carried out by ISPRA and ISCR with respect to the potential effects of the climate on the cultural heritage of Ancona.

The potential impacts of climate change on the cultural heritage of Ancona: method and results

The ageing of building materials is an irreversible process that affects any artifact. This is the reason why, in recent years, the growing interest in the conservation of art works has seen the parallel development of a new scientific approach to the problem that may turn into a sound decision-making support during the restoration, management or maintenance of such artifacts.
The assessment of the risk faced by historical-artistic monuments requires an in-depth knowledge of the distribution and the chemical-physical characteristics of the built heritage present in a given territory.
In fact, the potential threats to built heritage located in a specific area may only be detected if the structural elements and the composition of the monuments being considered are known.
Besides, it is essential to have at the same time a thorough knowledge of the geographic (geology, hydrology, gradient) and environmental features of the territory with which such built heritage interacts.
Climate (temperature, relative air humidity, wind, precipitation) and atmospheric pollution are some of the major factors responsible for the physical, chemical and biological processes that cause the deterioration of the materials (stone, wood, metal, etc.) constituting a monument.
The calcareous monuments analyzed in this study are generally affected by phenomena of erosion, biological deterioration and salt crystallization, and are subject to freeze-thaw cycles that favor the breaking up and the loss of cohesion of the elements that constitute the building (Figure 1).

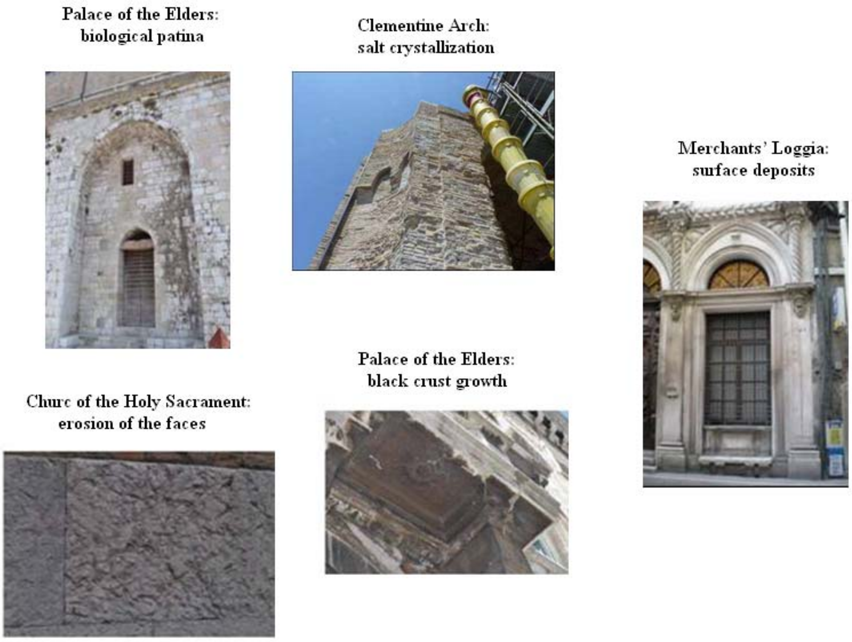

Figure 1: A few deterioration processes affecting the calcareous monuments in Ancona

In order to assess the potential risk faced by the Ancona cultural heritage, this study has had recourse to the methodological approach described in the Cultural Heritage Risk Map[99].
The individual risk of a monument is related to its *vulnerability* (conservation condition) as well as to the *territorial hazard* (the potential environmental aggression of the territory on the heritage sites)[100].
The information about the vulnerability of the monuments has been collected having recourse to a data sheet proposed by the Risk Map through special cataloguing phases that involved 27 (architectural and archeological) heritage sites that had been selected in the town.
This study has assessed the territorial riskiness by quantifying the potential degradation of the calcareous material (expressed as superficial recession, in μm/year), in relation to precipitation, relative air humidity and concentrations of atmospheric pollutants).

<u>The vulnerability of the Ancona cultural heritage</u>
For the time being, nearly 120 (architectural and archeological) heritage objects, located for the most part in the northeastern part of Ancona, have been geo-referenced in the databank of the Risk Map[101] (Figure 2).

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[99] *La cartografia tematica*, 1996, Risk Map of the cultural heritage, Ministry for the Cultural and Environmental Heritage – Central Office for the archeological, architectural, historical and artistic heritage – Central Restoration Institute, vol. 1- A.T.I. Maris
[100] *Analisi multi-hazard per la valutazione del rischio locale dei beni culturali*. Proceedings of the 12th National ASITA Conference – L'Aquila, 21-24 October 2008
[101] http://www.cartadelrischio.it/

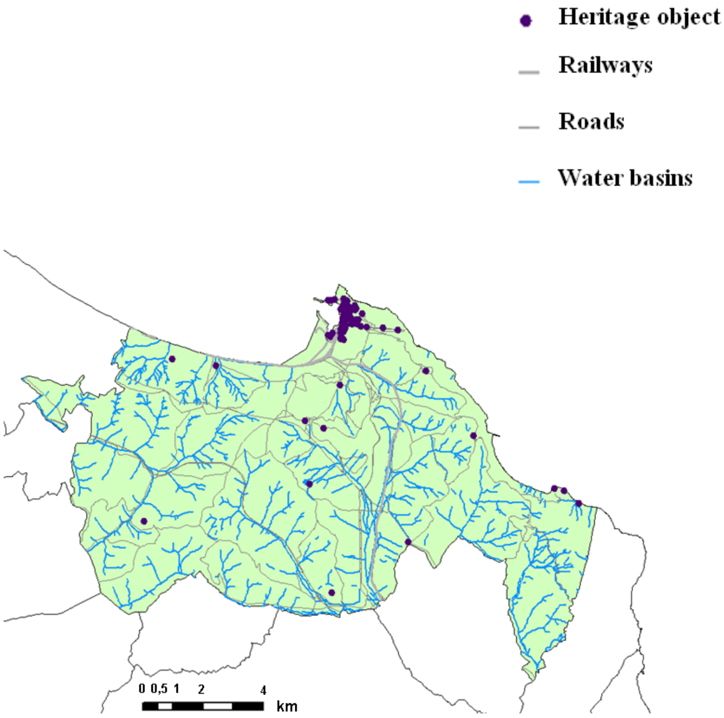

Figure 2: Distribution of the architectural and archeological heritage objects stored in the Risk Map databank[102]

Twenty-five architectural items and two archeological sites have been selected from among 120 geo-referenced heritage sites (Table 1). The conservation condition[103] of the selected objects has allowed estimating the intensity of the six damage typologies that may be found for each constructive and decorative element of the monument taken into consideration. Each typology of damage has been subsequently classified based on seriousness, extent and urgency, according to an intensity scale built around a number of levels.

[102] Source: ISCR

[103] G. Accardo, 1999, *La schedatura conservativa: esperienze dell'ICR in relazione alla Carta del Rischio*, Proceedings of the National Cataloguing Seminar

Table 1: List of the catalogued heritage sites[104]

	Name		Name
1	Sangallo Walls	15	Church of Santa Maria della Piazza
2	Building B (Former lodge - Citadel)	16	Former Church of St. Augustine
3	Watch tower (Citadel)	17	Church of Santa Maria di Portonovo
4	St. Ciriaco	18	Church of St. Dominique
5	Building A (Former lodge - Citadel)	19	Ferretti Palace
6	Fuciliera monumental building (Citadel)	20	Ravelin
7	Clementine Arch	21	Temple of St. Rocco
8	Building located in the Ancona Municipality (Old Lighthouse)	22	Farina Gate
9	Mengoni-Ferretti Palace	23	Church of Jesus
10	Bosdari Palace	24	Church of the Holy Sacrament
11	Palace of the Elders	25	Mole Vanvitelliana or Lazaret
12	Church of St. Pellegrino and St. Filippo Neri	26	Trajan Arch
13	Porta Pia	27	Ancona Amphitheater
14	Loggia of the Merchants		

The collected data allowed calculating the *surface vulnerability*, which describes the conservation condition of the surfaces in relation to the aggressiveness of environmental and climatic factors.

The results obtained for the Ancona heritage items were compared with the vulnerabilities of nationwide heritage objects located at a distance from the coast not exceeding 30 km.

The comparison showed that the share of damages detected in the Ancona Municipality is in keeping with the typology of damages detected in the entire sample of selected heritage objects.

Furthermore, as a rule, the Ancona monuments prove to be characterized by a medium-high vulnerability (Figure 3), even if it should be stressed that the monuments for which the vulnerability have been filled in represent a limited sample with respect to the actual quantity of heritage objects stored in the database of the Risk Map (27 heritage items that have been analyzed out of 120 geo-referenced objects).

[104] Source: ISCR

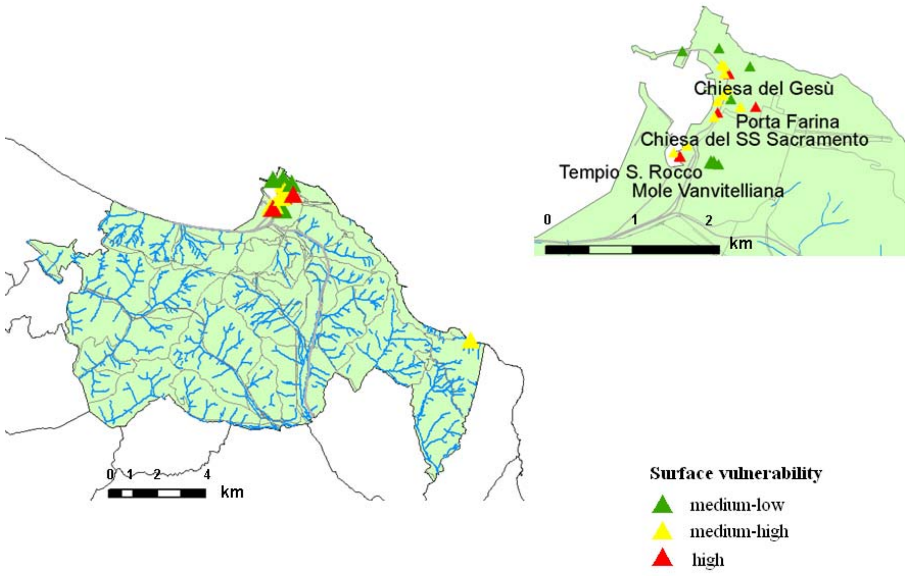

Figure 3: Classification of the surface vulnerability of the architectural monuments selected in Ancona[105]

The monuments with the highest vulnerability-related values (worst conservation condition) are the Mole Vanvitelliana or Lazaret, the Temple of St. Rocco, the Church of the Holy Sacrament, the Farina Gate and the Church of Jesus.

<u>The territorial hazard (impacts)</u>
In the Risk Map, the territorial hazard (potential level of environmental aggression) associated with the deterioration caused by climatic parameters and atmospheric pollution is defined as environmental-air hazard and is calculated in relation to the blackening index and the erosion index[106].

In this study, special attention has been paid to the erosion expressed as superficial recession (R), a phenomenon due to the synergic action of climatic factors and atmospheric pollutants that favor the processes leading to the chemical dissolution of calcium carbonate (the main component of calcareous artifacts) with the consequent loss of surface material[107].

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[105] Source: ISPRA-ISCR

[106] The risk model described in the Risk Map has been constructed by determining three *domains of hazard* (potential level of aggression of the territory where the monuments are located): the static–structural, the environmental-air and the anthropic domains. The *environmental-air risk* is damage suffered by the materials owing to the climatic and environmental (atmospheric pollution) factors that characterize the territory where the monuments are located and is calculated in relation to the environmental air hazard and the surface vulnerability of the monument being considered.

[107] P. Bonanni, R. Daffinà, R. Gaddi, A. Giovagnoli, V. Silli , M. Cirillo, 2006, *L'impatto dell'inquinamento atmosferico sui beni di interesse storico - artistico esposti all'aperto*, Rapporto APAT

Decay has been estimated by applying the Kucera algorithm[108] to the current scenario as well as to a hypothetical future scenario, in order to evaluate whether changes in the environmental and climatic parameters were likely to entail a decrease or an increase in the deterioration of the calcareous artifacts[109]. In the current scenario, the surface recession has been estimated using the data recorded in Ancona in the last 8 years (2003-2010), particularly with reference to the annual precipitation and the average annual relative humidity measured at the Falconara station, and the mean annual concentrations of atmospheric pollutants (NO_2, O_3, SO_2 and PM_{10}) recorded by the air quality monitoring stations located in Ancona (Figure 4).

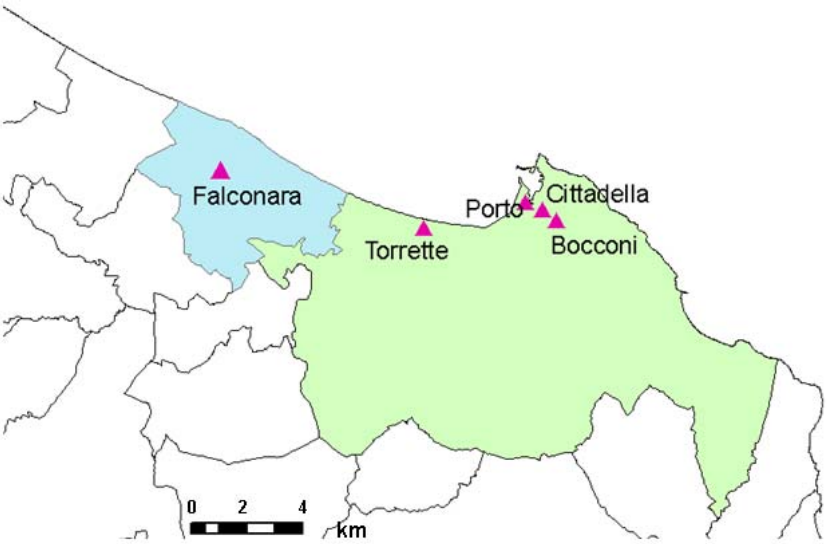

Figure 4: Location of the air quality monitoring stations in Ancona and the meteorological station at Falconara[110]

Since the data relative to the concentration of the four pollutants required for processing the surface recession are not available in all the monitoring stations present throughout the territory, the calculation was only made in the period 2003-2010[111] with data collected from the Cittadella and Bocconi (urban traffic) monitoring stations (Table 2).

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[108] $R = 4 + 0.0059 \cdot [SO_2] \cdot Rh_{60} + 0.054 \cdot Rain \cdot [H^+] + 0.078 \cdot [HNO_3] \cdot Rh_{60} + 0.0258 \cdot PM_{10}$

where R = surface recession (μm/year); $[SO_2]$ = average annual concentration of sulfur dioxide ($\mu g/m^3$); $[HNO_3]$ = average annual concentration of nitric acid ($\mu g/m^3$); PM_{10} = average annual concentration of atmospheric particulate ($\mu g/m^3$); $Rh_{60} = (R_h)$-60 (%) with R_h = average annual relative humidity; $[H^+]$ = concentration of hydrogen ions (mg/l); Rain = annual rainfall (mm/year)

[109] *Model for multi-pollutant impact and assessment of threshold levels for cultural heritage* (Multiasses)- *Report* 2005

[110] Source: ISPRA

[111] The values obtained in the period 2003-2010 do not represent the trend of the surface recession for that period of time, as they indicate the theoretical loss of material *for each year* just next to the two monitoring stations referred to above

Table 2: Surface recession (R) estimated from 2003 to 2010 at the Bocconi and Cittadella monitoring stations[112]

Year	Surface recession	
	Bocconi	Cittadella
	μm/year	
2003	7.3	-
2004	7.4	-
2005	7.5	-
2006	7.2	-
2007	8.2	6.7
2008	-	6.7
2009	-	6.0
2010	-	6.3

The results allow affirming that, in terms of surface recession, the current impact ranges between 6 and 8.2 μm/year.

Since the tolerable deterioration rate value reported in literature[113] is 8μm/year, the estimated deterioration in Ancona is generally below the acceptable level[114].

Insofar as the future scenario is concerned, the processing of the surface recession data has entailed a series of approximations due to the fact that quite a number of variables defy any rigorous quantification of the relative trend in the forthcoming years. However, with reference to international studies carried out on this very subject[115], based on the levels of a few pollutants present in the air that have been measured in 5 monitoring stations in Ancona, an attempt has been made to quantify, however roughly, the potential deterioration in 2030[116].

The precipitation data estimated for this year have been extrapolated from a study carried out by ISPRA[117], which has

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[112] Source: ISPRA

[113] The *International Co-operative Programme on Effects on Materials* (UNECE ICP *Materials Programme*) has laid down the acceptable erosion values (*acceptable deterioration rate*) for a few materials used in the cultural heritage monuments. The definition of acceptable deterioration rate has been calculated based on two components: *the tolerable corrosion before action*, which is the stage of deterioration of the material when the restoration has still to start, and *the tolerable time between maintenance*, which shows the acceptable time interval between a maintenance/restoration intervention and the next.

[114] http://www.corr-institute.se/ICP-Materials/web/page.aspx?refid=12

[115] B. Denby, J. Horàlek, S. E. Walker, K. Eben, J. Fiala, *Interpolation and assimilation methods for European scale air quality assessment and mapping, Part I Review and recommendations*, ETC/ACC Technical Paper 2005/7, 2005

[116] The decision to dwell on 2030 was taken due to the fact that an estimate of the trend of atmospheric pollution extending up to 2100 would prove to be too superficial owing to the variability of the parameters taken into consideration (variability linked to social policy measures, if any, implemented with a view to improving human wellbeing)

[117] F. Desiato, A. Toreti, G. Fioravanti, P. Fraschetti, W. Perconti *Baseline Climate Scenario, Climate trends and projections*, LIFE ACT Project 2010

provided the temperature and precipitation forecasts for Ancona up to 2100. The results of the models that have been applied[118] show, with respect to 2030, a decrease in precipitation and an increase in temperature with respect to the thirty-year reference period 1961-1990.
Since no relative humidity forecasts are available with respect to 2100, this study has assumed that this parameter is going to remain unchanged with respect to the current scenario.
Insofar as the atmospheric pollution is concerned, the concentrations of the pollutants (NO_2 and PM_{10}) in 2030 have been estimated assuming that the level of pollution follows the same trend reported from 2003 to 2010[119] [120]. The results that have been obtained with respect to 2030 point to a decrease in the concentrations of the two pollutants taken into consideration, in particular at the Bocconi station that is located in a traffic zone.

Assuming that a decrease in both rainfall and atmospheric pollution actually takes place, as anticipated by the outcome of this study, it is quite likely that in 2030 there is going to a slight decrease in the surface recession with respect to the current scenario, that is going to be more significant in the areas that are directly affected by anthropic emissions.

The risk

The potential risk faced by a monument located in a given area depends on the conservation condition of the monument and on the aggressiveness of the territory with which the monument interacts. As for the current scenario, the monuments that in this work have proved to be potentially more at risk are those characterized by a worse conservation condition (higher vulnerability). Since it is unlikely that, in 2030, the territorial hazard that has been assumed is going to change to any significant extent with respect to the present, the variation of the risk should depend on vulnerability. However, in a future scenario, vulnerability cannot be estimated (quite a number of variables defy a quantification of the likely variations in the forthcoming decades).
Two scenarios have been assumed with a view to making a qualitative assessment of the risk indicators. In these scenarios, the territorial riskiness variable is unchanged with respect to the current scenario, while the vulnerability component changes. Therefore:

1) vulnerability is constant or decreases (the state of conservation improves) thanks to periodic maintenance or

[118] The data used for estimating the surface recession in 2030 have been obtained thanks to three Regional Climate Models (RCMs): SMHIRCA, CNRM-RM5.1, KNMI-RMCO2
[119] A decreasing value of the pollutants has been calculated based on the Kendall test corrected for the seasonality, net of the regional land. In fact, it is assumed that the effect of the pollution reduction is going to affect, to a first approximation, only that share of pollution produced by human activities in the urban area that is added to the land level (which is deemed constant)
[120] G. Cattani, A. Di Menno di Bucchianico, D. Dina, M. Inglessis, C. Notaro, G. Settimo, G. Viviano, A. Marconi, *Evaluation of the temporal variation of air quality in Rome, Italy from 1999 to 2000,* Ann Ist. Super. Sanità 2010 | Vol. 46, no. 3: 242-253

restoration interventions;

2) vulnerability increases (the state of conservation gets worse).

In the first scenario, the risk remains constant or decreases. To get to this situation, the monuments that have proved more vulnerable in this study should be monitored at regular intervals to check their conservation condition, having recourse to maintenance measures in case of need in order to keep the state of their surface conservation unchanged or to improve it.

In the second scenario, the risk increases. This event is likely to occur if the monuments that have proved in critical conditions are not subjected to those conservative measures that are to make them less susceptible to environmental attacks.

Therefore, the adaptation strategies to be implemented in the field of cultural heritage consist for the most part in the planned monitoring of the conservation condition of the monuments. This approach would permit to check the conditions of the monument and, should any critical situation arise, to step in with suitable maintenance operations that are likely to reduce the number of more invasive and costly restoration measures.

Chapter 2

BIODIVERSITY AND ACTIVITIES ON ECOSYSTEMS.

Introduction

Biodiversity is the wealth of life on earth and is man's source of the goods, resources and services that are indispensable for survival.

Biodiversity may be defined as the wealth of life on earth: the millions of plants, animals and microorganisms, the genes that they contain, the complex ecosystems that they constitute in the biosphere. The *Convention on Biological Diversity* (CBD)[1], defined in its guidelines during the 1992 Earth Summit in Rio de Janeiro, defines biodiversity as the variety and variability of living organisms and of ecological systems in which they live, bringing out that it includes diversity at the genetic, specific and ecosystem levels. This variety does not refer only to the form and structure of living beings, but includes as well diversity in terms of abundance, distribution and interactions between the various components of the system. Finally, biodiversity reaches the point of including as well human cultural diversity, which however undergoes the negative effects of the same factors that, as we shall see, act on genetic, species and ecosystem biodiversity.

Biodiversity, besides its value *per se*, is important too since it is man's source of goods, resources and services (ecosystem services) that are indispensable for survival. Having the benefit of these services (which specialists classify into provisioning, regulating, cultural and supporting), directly or indirectly, are all the planet's human, animal and vegetal communities. These same services play a key role in the economy of nations.

For example, plant biodiversity, both in cultivated plants and in wild plants, constitutes the basis of agriculture, permitting the production of food and contributing to the health and the nutrition of the world's population. Genetic resources have permitted in the past the improvement of the cultivated and raised species and will go on in future performing their function. This variability will permit too responding to the evolution of the agricultural products market and will permit adapting to changing climate and environmental conditions.

The CBD contemplates three principal objectives: the conservation of biodiversity at the global level, the sustainable and lasting use of its components and a fair distribution of the goods and services that derive from it. In 2002, on the occasion of the sixth session of the Conference of the Parties to the CBD, 123 nations took on the political engagement to significantly reduce losses of biodiversity, at the local, national and regional levels, by 2010. And yet, as United Nations Secretary General, Ban Ki-Moon, admitted in the introduction to the *Global Biodiversity Outlook* of the *United Nations Environment Programme* (UNEP)[2] the rate of decline of biodiversity has shown no sign of diminishing and the objective taken on in 2002 has not been reached.

[1] www.cbd.int
[2] www.unep.org

The decline in biodiversity goes ahead at unprecedented speed and the rate of extinction of species is estimated at a hundred to a thousand times greater than that recorded in pre-human ages.
Within this context, the International Year of Biodiversity, proclaimed by the United Nations for 2010 has taken on more and more the character not only of a celebration of the variety of forms of life on Earth and of the value of biodiversity for human life, but also of a pressing appeal to intensify actions to underway and to undertake new initiatives to safeguard this indispensable component of our planet's environment.
The target: "stop the decline of biodiversity", established for the period 2002-2010, had the merit of catalyzing important results, at the local and the national and international levels, for the conservation of biodiversity. Besides numerous cases of success had in the conservation of determinate habitats and species, important advances have been made in working up mechanisms for sustaining research, monitoring and scientific evaluation of biodiversity. Among these it is impossible not to mention the *Global Strategy for Plant Conservation*, the universal program for classification and description of the characteristics of all known plants, which could be finished owing to the contribution of thousands of botanical gardens in every part of the world, and the IBA (Important Bird Areas) program, of *Birdlife International*, promoted by CBD, which has led to the identification of some 11,000 sites of importance for birds in 200 countries. Millions of persons, individual citizens, environmentalist associations and civil groups, even in the developing countries, actively support the programs for conservation of biodiversity.
Furthermore, the extension throughout the world of protected areas has quintupled from 1970 to date, reaching 12% of the lands above water. Furthermore, 87% of the nations that have signed the CBD have approved their own plans of action and strategies for the conservation of biodiversity, whose degree of implementation is, however, often as yet incomplete or full of lacunas. The central challenge is to achieve a full integration between the conservation of biodiversity and its sustainable use in sector policies.
As an important and significant step forward in the process that will lead to the Rio+20 conference of 2012 (*United Nations Conference on Sustainable Development*[3]) UNEP made known, in February 2011, a broad-based and articulated report entitled "*Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*", commonly called *the Green Economy Report* (GER[4]). The GER proposes an investment of two percent of the world's gross annual product, between now and 2050, to achieve a significant transformation, from the standpoint of sustainability, in ten key sectors (agriculture, fishing, infrastructures, energy supply, forest products, industry, including energy efficiency, tourism, transport, and the handling of wastes and of water), with the aim of proceeding towards an economy having a low carbon-use intensity

[3] www.uncsd2012.org
[4] www.unep.org/greeneconomy

and an efficient use of resources. At issue is a total figure running around 1300 billion dollars per year. GER underscores the significant importance of this natural capital and the need to eliminate perverse subsidies that go on funding activities that are unsustainable for natural systems.

Italy is included among the biodiversity hot spots that are important at the planetary level.

The variety of biogeographic, geomorphological and climatic conditions characterizing continental Europe and the Mediterranean basin makes Italy an extraordinary area of concentration both of species and of habitats, and also of areas having high naturalness levels. In Italy important centers of biodiversity have been identified, for example in the Tyrrhenian islands, in the maritime Alps and Liguria, without counting the high rate of endemisms that characterizes many areas such as, for one thing, the Appennine chain. At the planetary level Italy is included in the hot spots of biodiversity[5] and is acknowledged to be one of the top-priority regions[6].

Many critical items threaten indirectly, but also directly, the nation's natural heritage.

This great natural heritage is threatened by a series of critical problems that can be attributed, finally, to the general dynamics of economic development, whether global whether national, that lead to the destruction and fragmentation of habitats, in relation to an increasing urbanization, to the proliferation of infrastructures and to the intensification of farming practices. Besides a net loss of area of habitats we are seeing as well their progressive deterioration, owing to their non-sustainable management. The introduction of allochthonous species, the non-sustainable use of resources and of species and the effects of climate changes complete the picture of the principal threats. To these critical processes of a general nature there are also others that exert on natural systems more direct pressures, such as pollution of the environmental matrices (water, air, soil, the sound environment, and the light environment), the artificial formation of hydrographic networks, the intensification of the infrastructure network, the diffusion of genetically modified organisms whose effects on natural dynamics have not been well identified, and the dissemination of natural dangers.

Legal instruments at the national and international levels, both indirect and direct, seek to combat the loss of biodiversity.

The instruments adopted at the national and international levels to combat the loss of biodiversity are both indirect and direct. Belonging in the first category are all the operations aimed at reducing sources of pressure, for example through the control of emissions levels of polluting substances or the safeguarding of water quality. In the second category fall operations aimed at directly conserving species and ecosystems. The legal baggage in support of conservation policies is sizeable and permits, theoretically, not only the adoption of ever more effective measures at the various levels of territorial competence, but also permits starting up forms of coordination between setting constraints, territorial planning and general planning that are ever more aimed and effective. Anyway, it needs to be further strengthened and

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5 http://www.biodiversityhotspots.org/xp/Hotspots/hotspotsScience

6 http://www.worldwildlife.org/science/ecoregions/ecoregion-conservation.html; *Biodiversity Vision dell'Ecoregione Mediterraneo Centrale.* Bulgarini F., Petrella S., Teofili C., (a cura di), 2006. WWF Italia-MIUR, Roma; *La Conservazione ecoregionale e la Biodiversity Vision dell'Ecoregione Alpi.* WWF Italia, 2006. WWF Italia, Roma

harmonized, with reference in particular to a greater application and spread of checks, to the availability of greater financial resources, to its upgrading to cope with new emerging problems, for example the dissemination of allochthonous species, and global climate changes.
Starting from the information furnished by the indicators present in the ISPRA Yearbook of environmental data, this chapter wishes to summarily delineate the situation of biodiversity in Italy, bringing out briefly the state of the natural environments, the most important threats to biodiversity, and, finally, the principal safeguarding actions so far undertaken.

The status of species and of natural and semi-natural environments

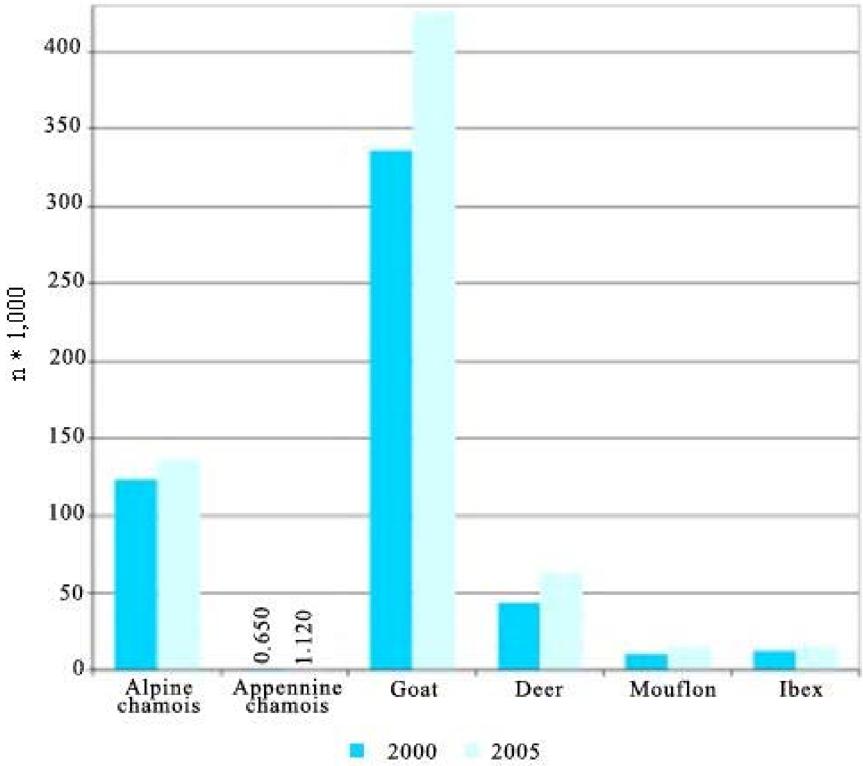
Italy is among the richest European countries in biodiversity, having one-half the plant species and one-third the animal species in Europe

Italy is among the richest European countries in biodiversity, by virtue essentially of its favorable geographic position and a great variety of geomorphologies, microclimates and vegetation, brought about too by historical and cultural factors. In particular, Italy hosts about half the plant species present in European territory and is the first nation on the continent in absolute number of species. As regards animal species it possesses a third of all those currently present in Europe.

Italy has the largest number of animal species in Europe (more than 58,000), with a high percentage of native species, among which more than 9% of the earth's?? terrestrial fauna.

According to studies carried out to date and the recent *Fauna Europaea*, Italy has the highest number of animal species in Europe, with a high incidence of native species. Italian fauna, in fact, is estimated to number more than 58,000 species, of which 55,000 are Invertebrates and 1,812 are species of Protozoa, which together account for 98% of the wealth of total species, as well as 1,258 species of Vertebrates (2%). The richest phylum is that of the arthropods, with more than 46,000 species, of which 65% belong to the class of Insects[7].
In particular, the terrestrial fauna consists of 42,000 species to date identified in Italy, of which more than 9% are of particular importance in as much as they are native species. The abundance of species of the fresh water habitats (not including the Protozoa) is estimated at 5,500 species, that is almost ten percent of the entire Italian fauna. The checklist of the Italian marine fauna includes more than 10,000 species and, considering Italy's geographic position, it is probable that these form the larger part of the Mediterranean species.

[7] *GIS NATURA: The GIS of naturalist knowledge in Italy*, Ministry for the environment and safeguarding the territory, Department for the protection of nature, Politecnico di Milano, 2005; *Stato della Biodiversità in Italia*, Blasi *et al.*, 2005



From the data on the size of the principal species of wild Ungulates in Italy a decidedly positive variation for all the populations studied is brought out, and, in particular, for those of Appenine Chamois (plus 72.3%).

Figure 2.1: The numbers of some of the principal Ungulates found in Italy during the years 2000 and 2005[8]

In Italy, the bryological flora and the lichen flora are among the richest in Europe.

Italy's bryological flora, including Mosses, Hepaticae and Anthocerote[9] is one of Europe's richest, with 1,156 species, of which 864 Mosses, 292 Hepaticae. It is necessary, furthermore, to keep in mind that knowledge on the size of these groups is being continuously updated, owing to the progress of explorations in areas of the territory that are as yet little known and to the continuous development of the techniques of genetic investigation. Italy, furthermore, with 2,328 taxa counted[10], can be numbered among the European countries having high lichen diversity.

Of the more than 6700 species of Italian vascular plants, 15.6% are native species.

Italian vascular flora includes 6,711 species, that is, 144 Pteridophytes, 39 Gymnosperms and 6,528 Angiosperms[11], with a contingent of native species that amounts to 15.6%. In numerical size there stand out the floras of the regions having the greatest environmental variability and those having more extensive territories such as the Piedmont (3,304 species), Tuscany (3,249) and the Veneto (3,111). Considering, however, the components of flora having the greatest value and with reduced distribution areas, it is noted that the regions having the largest number of native species

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[8] Source*:* ISPRA workup on data drawn from Carnevali L., Pedrotti L., Riga F., Toso S., 2009 - *Ungulates Data bank: Status, distribution, consistency, management and hunting removals from the Ungulates populations in Italy* - Rapporto 2001-2005. Biol. Cons. Fauna, 117: 1-168 *[Italian-English text]*
Note: as regards the boar, according to a very approximate estimate based on yearly kills (data in their turn often incomplete and underestimated) on the nation's territory there would have been present in 2005 no fewer than 609,000 head

[9] *Check-list of the Hornworts, Liverworts and Mosses of Italy*. Bocconea 22. Aleffi, Tacchi, Cortini Pedrotti, 2008

[10] *ITALIC - The Information System on Italian Lichens. Version 4.0.* University of Trieste, Dept. of Biology, IN4.0/1, Nimis, Martellos, 2008

[11] *An annotated checklist of the Italian vascular flora*, Conti *et al*., 2005

and of exclusive species, i.e. those present in that one region, are Sicily (322 native species and 344 exclusive ones) and Sardinia (256 native species and 277 exclusive ones).

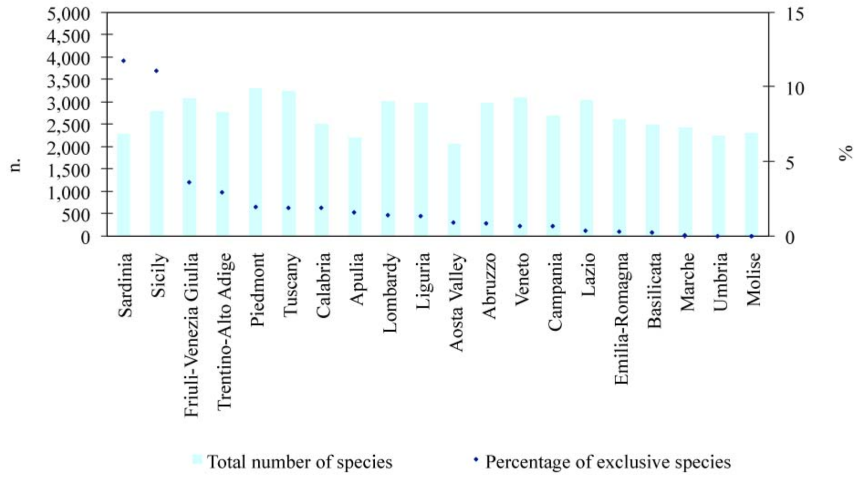


Figure 2.2: Total number of species and precentage of exclusive species by region (2005)[12]

The nation's wealth of flora is shown too by the high number of vascular species in the individual regions, with often significant percentages of exclusive species Sardinia, Sicily, Friuli-Venezia Giulia, Trentino Alto Adige, Piedmont, Tuscany, Calabria, Puglia, Lombardy, Liguria Valle d'Aosta, Abruzzo, Veneto, Campania Latium, Emilia Romagna, Basilicata, Marches, Umbria, Molise[13]*.*

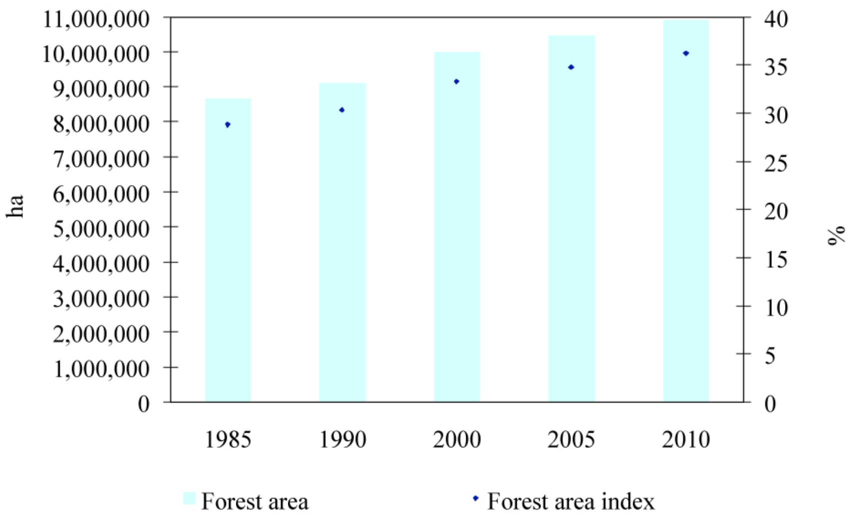
Italy is also especially rich in forests: its forest area counts over nine million hectares, while the other forested lands, that is having low-density forest areas, amount to 1,767,000 hectares[14]. With reference to the overall forested area, including woods and other wooded lands, the national forest area index is 36% and is gradually, but constantly, increasing (figure 2.3). The National Inventory of Forests and of Forest Carbon Reserves (INFC), carried out in 2005 by the state Forestry Corps (CFS products), indicates too that a significant part of the new woods are new formations of natural origin, in the development phase.

The national forest area index is 36% and is constantly increasing.

This latest data, together with the dynamics of change of coverage and use of the territory shown by the comparison between *Corine Land Cover 1990* and *Corine Land Cover 2000*, indicate an expansion of the nation's forestry heritage, estimated at 5500 hectares per year[15]. Since there has been a precise statistical memory of the forms of use of the soil, in our country such an extent of woods has never been seen. This fact, which concerns Italy as it does almost all European countries, has held true for decades and is destined to continue to do so in future. It is determined, on the one hand, by the conservation policies and measures for the existing heritage; and on the other, by the activities of forestation and reforestation, as well as, and most especially, by the natural expansion of the woods into abandoned farms, especially in the

[12] ISPRA workup of data drawn from Source: Conti, Abbate, Alessandrini, Blasi, 2005 - *An annotated checklist of the italian vascular flora.* MATTM-Dip.Prot.Nat.; Univ. di Roma La Sapienza-Dip.Biol.Veg.
[13] *VI EUAP* - Official list of Protected Areas MATTM, 2010
[14] State forestry corps, 2010
[15] *La realizzazione in Italia del progetto europeo Corine Land Cover*, APAT, 2005

country's marginal hilly and mountainous areas.



Italy is particularly rich in forests; her forest area index is constantly increasing owing to the natural expansion of woods and to forestation and reforestation activities.

Figure 2.3: Variation in the forest area and in the forest area index[16]

The amount of urban vegetation in the ordinary provincial seats displays a trend that is timidly increasing, from 2000 to 2010, both in density and in per capita availability.

Besides the natural and semi-natural environments properly so-called, urban and peri-urban vegetations too are an important component of biodiversity. The natural heritage in our cities is extremely varied and complex, including various typologies of planted areas and animal and plant biodiversity associated with them. Some of these areas are seen in the more central urbanized areas of the city fabric (public gardens, urban parks, tree-lined boulevards, schoolyards, botanical gardens, etc.), others were progressively incorporated into the urban area during the city's expansion, such as the farmlands, which even if not directly enjoyed by the citizens are of great value, both ecological and social and economic.

The urban and peri-urban green spaces perform multiple functions: from mitigation of climate changes to beautifying the landscape, from ecological connectiveness through environmental education, to the safeguarding of biodiversity (consider, for example, the monumental trees that are the subject of specific safeguarding measures). With reference to the provincial seats, the amount of urban vegetation that is directly or indirectly managed by public bodies displays a trend that has been hesitantly increasing from 2000 to 2010, considering both density (percentage of city area) and per capita availability[17]. The data varies considerably from city to city, also because of the strong incidence for some realities of protected natural areas, characterized by greater areas. Significant, in fact, is the presence in many cities of safeguarded planted areas (protected areas, Nature Sites 2000), which play an important role in maintaining biodiversity and contribute to maintaining the ecological continuity of the extensive area

The data gathered on the instruments for supervising urban vegetation brings out that the Green Plan is still scantly present

[16] Source: ISPRA workup of State Forestry Corps data.

[17] ISTAT, 2010

among the cities considered, while more broadcast are the Regulation of Greenway (to be found in 33 of the 48 cities considered) and the Green Census, to be found in 44 cities[18]. Analysis of the agricultural areas brings out a general trend toward a constant and progressive reduction of both the indicators analyzed (number of farms and total farmland area). With reference to the monumental trees to be noted is that after the first and only national census made by the Forestry Corps at the end of the '80s, the data was updated at the regional level. Furthermore, with the exception of Campania, all Italian regions have adopted laws for their safeguarding and exploitation, and many have instituted special official registers. As regards the fauna atlases in urban areas, among the 48 cities analyzed few as yet are those for which at least one atlas is available, even if their number is increasing.

The percentage of threatened Vertebrate species always displays values greater than 50%.

The wealth of biodiversity set forth to this point is however seriously threatened and runs the risk of being irremediably lost. The picture of the levels of threat to animal species on the nation's territory has been delineated by various authors in specific Red Lists, with special reference to the autochthonous species of the Vertebrates. For the evaluation of the categories and of the degree of threat the authors have referred to the categories of the *International Union for Conservation of Nature* (IUCN), From the analysis it has been shown that the percentage of vertebrate species threatened varies depending on the evaluations of different authors, but always displays values greater than 50%[19]

In particular, for the Cyclostomes and the Fish in inland waters more than forty percent of the threatened species are in particularly critical condition (IUCN categories: CR – critically endangered and EN – endangered), while for the Birds and the Mammals, 23% and 15% respectively of the threatened species are under strong risk of extinction. *LIPU-Birdlife Italia*, in collaboration with ISPRA, the Lombardy Foundation for the Environment and CISO, completed in 2010, for the Ministry for the Environment and for Safeguarding the Territory and the Sea, the evaluation of the state of conservation of birdlife in Italy, according to the requirements of the Birds Directive[20]. Of 246 species evaluated, 76 (30.9%) are in a poor state of conservation, 81 (32.9%) are in a state of inadequate conservation and 79 (32.1%) are in a favorable state. For ten species it was not possible to make an evaluation.

One-third of the fish species, one-sixth of

A further analysis conducted on native and sub-native species has

[18] *VII Rapporto sulla qualità dell'ambiente urbano – edizione 2010*, ISPRA

[19] *Libro rosso degli Animali d'Italia*, Bulgarini *et al.*, 1998; *Application to the terrestrial vertebrates of Italy of a system proposed by IUCN for a new classification of national Red List categories*, Pinchera *et al.*, 1997; *Condannati all'estinzione? Biodiversità, biologia, minacce e strategie di conservazione dei Pesci d'acqua dolce indigeni in Italia*, Zerunian, 2002

[20] *Valutazione dello Stato di Conservazione dell'avifauna italiana. Specie in Allegato I Direttiva Uccelli.* Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Lega Italiana Protezione Uccelli (LIPU). Pp: 1156; Gustin M., Brambilla M. & Celada C. (a cura di) 2009. *Valutazione dello Stato di Conservazione dell'avifauna italiana. Volume I. Non-Passeriformes.*Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Lega Italiana Protezione Uccelli (LIPU). Pp: 842; Gustin M., Brambilla M. & Celada C. (a cura di) 2010a. *Valutazione dello Stato di Conservazione dell'avifauna italiana. Volume II. Passeriformes.* Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Lega Italiana Protezione Uccelli (LIPU). Pp: 1186; Gustin M., Brambilla M. & Celada C. (a cura di) 2010b

confirmed the picture just sketched out. One-third of the fish species and a sixth of the species of Reptiles threatened are native. But the most critical situation is that regarding the Amphibians, where the absolute percentage of native species threatened is the highest, with more than 66%. To date there is no analogous evaluation of the threat levels for the Invertebrates. However, the very high number of species of this taxa, the highest percentage of native species relative to the Vertebrates, that is more than ten percent of the total, the high niche specialization and the limited dimension of the areas that characterizes many species make it reasonable to suppose that for equal conditions of threat with the Vertebrates, the level of threat for the Invertebrates, and therefore the danger of their extinction, is decidedly higher.

the Reptile species and 66% of the species of Amphibians threatened are native.

Also the data on the state of threat to which are subject the vegetal species in Italy are the result of the publication of Red Lists by specialists. In 1992 deemed at risk of extinction were 458 entities[21]. This became 1,011 in 1997 with the publication of the Regional Red Lists of the Plants of Italy[22], in which are applied the IUCN categories of threat (version 2.3). This list was then reviewed and filled out in the Atlas of species at risk of extinction[23], arriving at the identification of 1,020 species, the precise distribution of which is also reported. 15.2% of the Italian vascular flora is currently threatened with extinction (EN – endangered, for IUCN), while the worst situation is found in the lower plants with some 40% of the total of species known to be in danger (figure 2.4).

Under threat are 15% of the higher plants and 40% of the lower plants.

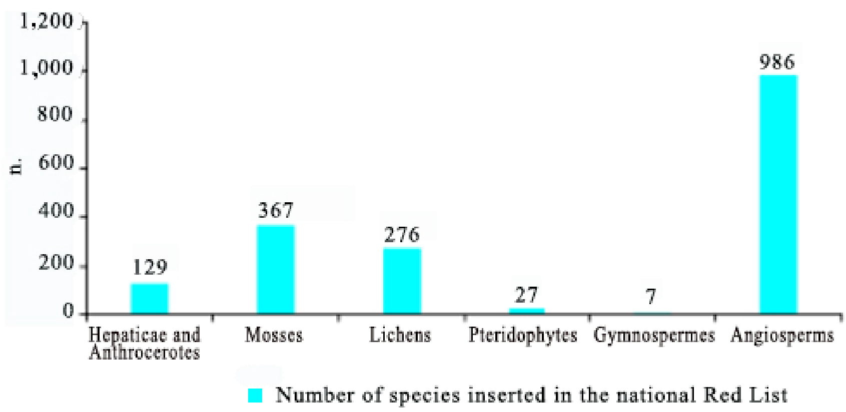


Figure 2.4: Plant species under threat in Italy, distributed by systematic group[24]

15% of the Italian vascular flora is threatened with exitinction. A worse situation holds for the lower plants, with 40% of the total of the known species in danger. In detail, the plant entities at risk include 772 species of hepaticae, mosses and lichens and 1020 vascular plants.

Knowledge on vegetal entities at risk is today still far from being exhaustive, since the state of conservation of the taxa of Italian flora must be evaluated according to the most recent criteria, published in 2001 by the IUCN, to arrive at the compilation of a New Red List of

The "Italian Initiative for the implementation of the categories and

[21] *Libro Rosso delle Piante d'Italia*, Conti *et al.*, 1992

[22] Conti *et al.*, 1997

[23] *Atlante delle specie a rischio di estinzione (CD-ROM),* Scoppola & Spampinato, 2005

[24] ISPRA workup of data drawn from *Check-list and red-list of liverworts (Marchantiophyta) and hornworts (Anthocerotophyta) of Italy*, Aleffi & Schumacker, 1995; *Libro Rosso delle Piante d'Italia*, Conti *et al.*, 1992; *Liste Rosse Regionali delle Piante d'Italia*, Conti *et al.*, 1997; *Atlante delle specie a rischio di estinzione (CD-ROM),* Scoppola & Spampinato, 2005

Italy. To this purpose there came into being in 2006, within the Italian Botanical Society, an Italian "Initiative for the implementation of the IUCN categories and criteria for the compilation of new Red Lists".

of the IUCN criteria (2001) for the compilation of new Red Lists".

In 2008 the first results of the application of the IUCN critera to forty target species of Italian flora were published [25]. The work of assessment by the experts is going ahead and new data cards on other Italian plant species at risk are always being published.[26]

In the application of the Habitat Directive, (92/43/EEC) (one of the most important standards-setting instruments for the conservation of the habitats and of biodiversity), as we shall see in what follows Italy plays a role of considerable importance.

More than fifty percent of European habitats to be protected according to the Habitat Directory *are in Italy.*

Her peculiar geographic conditions bring it about that Italy falls within three different biogeographic regions (Alpine, Continental, Mediterranean), with more than 50% of the habitats to be protected according to the directive.

Among the habitats set forth in attachment I to the Habitat Directive, 131 are present in our country[27], and among these 24 (of which thirteen are top-priority) are to be found exclusively in Italy with reference to the biogeographic region of reference[28]. In the "Italian manual of interpretation of the habitats of directive 92/43/EEC"[29], of the 131 habitats of the directive present in Italy: sixteen (of which four are top-priority) fall within the marine-coastal habitat typology and eleven (of which nine are top-priority) are forest habitats, sixteen (of which three top-priority) are bush habitats, fifteen (of which five top-priority) are natural and semi-natural meadow habitats.

24 habitats to be protected according to the Habitat Directory *, of which 13 are top-priority, are present exclusively in Italy relative to the reference biogeograhic region.*

There are then fifteen fresh-water habitats, eight peatbog-and-marsh habitats and eleven rock habitats.

The state of conservation in the nation's territory of the habitats and of the species of Community interest inserted in the attachments to the directive was presented in the second National Report that Italy worked up and sent, during 2007, to the European Commission, according to the provisions of art. 17 of the directive itself[30].

This Report, regarding the period 2001-2006, is a point of reference for comparison with the results that will emerge in the subsequent national reports that, as prescribed by art. 17, will be worked up every six years. Being worked up now is the third National Report, for the period 2007-2012.

Besides the natural environments, the agricultural areas too play an important role for biodiversity and the other environmental components, considering that a large number of species has adapted to living in farm environments of secondary formation. The farm environment furnishes habitats that constitute

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[25] *Informatore Botanico Italiano*, vol. 40, suppl. 1, 2008

[26] *Informatore Botanico Italiano*, vol. 42, suppl. 2, 2010

[27] *Manuale Italiano di Interpretazione degli Habitat della Direttiva 92/43/CEE*. MATTM, 2009 (http://vnr.unipg.it/habitat)

[28] *Reference list of habitat type*, EU Commission and EEA, 2009

[29] *Manuale italiano di interpretazione degli habitat (Direttiva 92/43/CEE). Contributo tematico alla Strategia Nazionale per la Biodiversità.* MATTM, 2010

[30] *Attuazione della Direttiva Habitat e stato di conservazione di habitat e specie in Italia.* MATTM, 2008

“surrogates” for natural environments. A typical example is the rice paddies that host numerous original species of wet environments.

The farm areas, besides sustaining the production of foods and fibers, are strongly tied to the environment, giving origin to very complex relationships, at times of counterposed natures.

43% of the nation’s territory is assigned to agricultural activities and 21% of the UAA (Agricultural Utilized Area) displays an important value too, in terms of biodiversity.

In confirmation of the importance of agriculture vis-à-vis the natural heritage it is worthwhile noting that 43% of the nation’s territory is assigned to agricultural activities[31][32], and a portion of this, some 21% of the Utilized Agricultural Area (UAA, including planting, family orchards, plantations and permanent crops, meadows and pasturelands) display an important value also in terms of biodiversity, at the genetic level, and at that of species and of landscape, constituting an element of connection between the natural spaces.

In this regard to be noted are some investigations, fruit of the cooperation between LIPU-BirdLife, WWF Italia and the National Institute of Agricultural Economics (INEA), that use birds and lepidoptera to verify the presence and distribution of agricultural areas having a high nature value (High Nature Value – HNV areas).

Over the past decades, in parallel with demographic stagnation and the stagnation of demand for farm products, with the exodus from rural areas and the increase in productivity per unit area, Italy has recorded a significant reduction in the number of farms and in SAUs.

This latter, according to the sixth general census of agriculture, is 12.9 million hectares, a data item that indicates the gradual drop during the decade 2000-2010 (-2.3%), even if more limited than that of the period 1990-2000 (-12%).

It is important to note however that compared with this drop, the mean farm size has grown by 44.4% during the last decade, going from 5.5 hectares of SAU per farm to 7.9 hectares.

This is the result of a strong contraction in the number of farms and livestock ranches active (-32.2%) The effect of Community policies and of the behaviour of the markets has brought about the exit of small farms from the sector, favoring the concentration of farm and livestock-raising activities in units of larger size and thus bringing our country’s farm structure closer to the European average.

The progressive reduction (although largely reversible) of farmlands signals a very complex fact, with very strong social, economic and environmental implications.

The abandonment of farm lands can be followed by processes of recolonization by trees, bushes and meadow

During the past fifty years, hundreds of thousands of hectares have been traversed by evolutionary phenomena: farmlands converted into other forms of use (building-construction, infrastructures, etc.); abandoned farmland areas have become first unproductive and then invaded by spontaneous vegetation, then devasted by

[31] ISTAT, 2011

[32] The territorial agriculture area, including the SAU, of the non-utilized agricultural area, of the wooded area and of other areas (buildings, canals, etc.) covers 17.3 million hectares (-8.0% relaltive to 2000), or 57.3% of Italian territory

fires, involved in estate conversions or recovered for agriculture. This form of “non”-management of the soil, with characteristics of transitoriness and reversibility, has followed and follows various routes, which from the environmental standpoint can have opposite signs.

(revegetation) or by processes of soil deterioration tied to the loss of organic substance or to erosion processes (devegetalization and desertification)

Abandonment, in fact, can be followed by recolonization by trees, bushes or grass (revegetation), or by deterioration of the soil, tied to the loss of organic substances or to erosion processes (devegetalization and desertification).

The specialization and intensification of agriculture, as well as the globalization of the agriculture economy, have produced a serious loss of biodiversity, with the diminution, for example, of bird populations peculiar to an agricultural environment.

In Italy too, as in many other countries in the western world, the process of specialization and intensification of agriculture brought ahead from the fifties through the first years of the nineties, as well as the globalization of the agricultural economy, have produced a serious loss of biodiversity.

At present almost half of the 12.9 million hectares of SAU is dominated by only five crops: wheat, corn, rice, olives and grapes. These themselves have been subjected to a worrisome degree of genetic erosion, with the abandonment of local varieties to the advantage of more productive commercial genotypes.

In witness to the loss of biodiversity in agriculture are the results of the working up of an indicator on the possible behaviours of the common nesting species in italy, carried out within the MITO2000 Project (ITalian Ornithological Monitoring), an initiative coordinated at the Italian level by the Italian Center for Ornithological Studies, by LIPU, DREAM and Faunavia, fit within the Pan European Common Bird Monitoring program, started up by the European Bird Census Council (EBCC) to continental scale and financed, in 2000, by MATTM and, from 2008, by MIPAAF.

The methodology of MITO2000 has permitted obtaining the Farmland Bird Index, an indicator of biodiversity envisaged in (EC) Regulation 1974/2006, for rural development policy.

Although the aforesaid indicator as a whole does not indicate a trend during the period 2000-2009, on examining the individual species a decreasing trend can be observed in 44% of cases[33].

Set-aside policies have facilitated the re-creation of habitats that had almost disappeared, such as wet zones, meadow areas alternating with bushes and flooded meadows.

It is further to be noted however that, owing too to the set-aside policies promoted by the reform of the CAP in 1992, which envisaged a contribution to farmers to put to rest ten percent of their cultivated areas, the re-creation of habitats that had almost disappeared as wet areas (alternating meadow areas with bushes and flooded meadows) was facilitated, so that the meadows and the pasturelands (at present 26.9% of the SAU) and the fields in repose and other crops (currrently 4.1% of the SAU) have demonstrated growth over the past decade.

[33] Rete Rurale Nazionale MIPAAF, 2010

The principal causes behind the threat to biodiversity

Biodiversity is principally threatened by man's activities and by the growing demand for natural resources and for ecosystem services.

The major threats to the natural heritage are tied mainly to the impact of human activities and to a demand for natural resources and ecosystem services that is ever more accentuated and ever less compatible with their conservation in a state such as to ensure their survival and transmissability to future generations. In western and central Europe and in the entire Mediterranean basin the ancient presence of man has led to the alteration of ecosystems and of the natural habitats, which today appear for the most part fragmented and subject to various kinds of disturbance. At present five principal causes of the loss of biodiversity[34] and the destruction and degrading of the habitat are recognized: fragmentation, introduction of exotic species and over-exploitation of resources and of species.
This last-named aspect is tied first of all to the lack of proper legislation, or to the failure to apply existing laws, which regulate according to ecological criteria the activities of drawing upon wild species and dealing in them. These threats lead to a reduction in biodiversity, through the degradation and banalization of the ecosystems and through the local extinction of many species, first of all of those that are ecologically most sensitive, and of those that are native or localized. At times, created too is a turnover among species, since it may happen that the near-irreversible disappearance of many species typical of the natural habitat is accompanied at the same time by the entrance of exotic species that are competing, generalist, ruderal and synanthropic.

The conversion and modification of natural habitats threaten 50.5% of the vertebrate animal species.

Regarding the vertebrate animal species, figure 2.5 sets forth the overall picture of the various factors of threat and their incidence on the state of conservation, made on the basis of data from the Red Lists published to date for the typologies of threat of the IUCN. In general analysis brings out that the most frequent threat typology (50.5% of the threatened species) among all the indirect anthropic influences, is the transformation and modification of the natural habitats (A2) while poaching and illegal fishing (B7) are among the direct anthropic influences[35].
In particular, although hard to quantify, poaching is in Italy an important threat to birds and mammals, including many protected species among which some are in danger of extinction. In many regions still widespread are illegal practices for capturing wild fauna with traps, nooses and snares, as well as killing with poisons and firearms. These practices are particularly concentrated in such critical areas as the valleys of Brescia, those of Bergamo, the Tyrrhenian islands and the straits of Messina[36], southern Sardinia and many of the small islands (LIPU).

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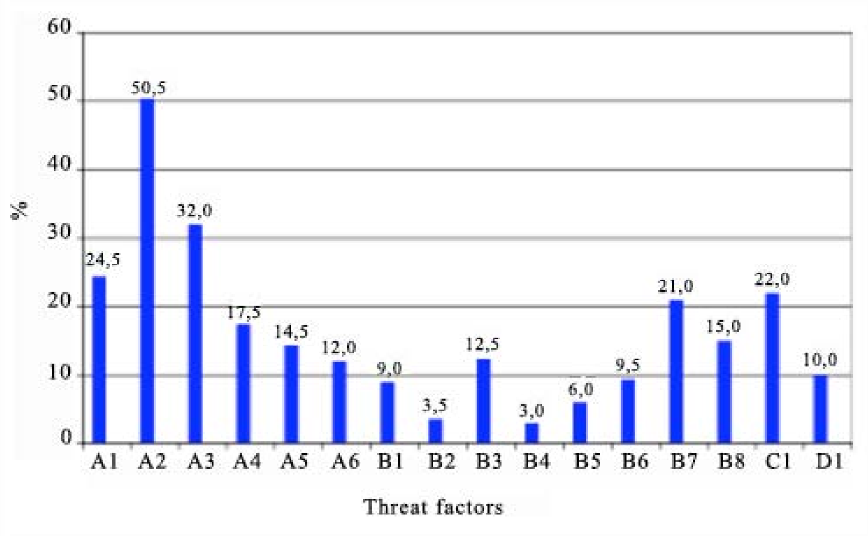
[34] *Conservazione della natura*, Primack & Carotenuto, 2007

[35] *Libro rosso degli Animali d'Italia*, Bulgarini *et al.*, 1998; *Application to the terrestrial vertebrates of Italy of a system proposed by IUCN for a new classification of national Red List categories*, Pinchera *et al.*, 1997; *Condannati all'estinzione? Biodiversità, biologia, minacce e strategie di conservazione dei Pesci d'acqua dolce indigeni in Italia*, Zerunian, 2002

[36] *Bracconaggio e trappolaggio.* Todaro G., 2006, Perdisa Ed., Bologna



Legend:

Indirectr anthropic influences:
A1: Reclamation of marshes and swamps
A2: Modifications and conversions of the habitat (construction, buildingss, streets, ports, cementing of river dikes, climate variations due to man's influence,dams of watercourses, tapping of water, modifications of flow rates)
A3: Use of pesticides and pollution of waters
A4: Firing and cutting of woods
A5: Changes in agricultural and pastural activities, and fishing,.
A6: Leisure-time activities (tourism, bathing, excursions, nautical sports, sport fishing, photographic hunting, free climbing)

Man's direct influences
B1: Hunting
B2: Combatting against harmful things
B3: Taking of eggs, chicks, larval stages for commercial purposes or for collections
B4: Vandalism
B5: Genetic pollution
B6: Excessive fishing
B7: Poaching and illegal fishing
B8: Competition or hunting by other species or allochthonous populations
C1: Natural causes
D1: Unknown causes.

The figure refers exclusively to the threatened species for which validated chronological information is available
Note that the threat factor categories set forth in the reference source were later modified by ICCN, and thus do not correspond to those at present adopted (ver.3.0)

Figure 2.5: Incidence of threat factors for the Vertebrates on the total of threatened species.[37]

In Italy biodiversity is principally threatened by man's activities and by the growing demand for natural resources.. The most frequent threat typology among the indirect anthropic influences is the conversion and modification of natural habitats, while poaching and illegal fishing are among the direct anthropic influences.

Going on now to an analysis in greater detail, among the causes of impact can be noted those tied to hunting, which can be practiced over more than 62% of the nation's territory (ISTAT 2007). The density of hunters is not uniform throughout the nation: in some regions, such as Liguria, Umbria, Tuscany and Latium, this figure is decidedly higher than the average. Exhibiting values of greater pressure are both regions of larger size (Tuscany, Latium, Lombardy, Campania) and those of smaller (Umbria and Liguria). Supposing that the number of hunters constitutes the primary factor behind hunting pressure on the territory, a drop is found, from 2000 to 2007, due to a dip of 6.2 percentage points in the number of hunters nationally. Regionally, a good eleven regions display percentages of reduction in the number of hunters greater than the value for Italy as a whole. Only five regions (Trentino-Alto Adige, Latium, Calabria, Sardinia and Molise) instead show an increase in the number of hunters.

Among the causes of impact to be noted are those tied to hunting, which can be practiced over more than 62% of the nation's territory. Hunting pressure is however diversified among the regions.

[37] Source: ISPRA processed data from: *Libro rosso degli Animali d'Italia*, Bulgarini *et al*., 1998; *Application to the terrestrial vertebrates of Italy of a system proposed by IUCN for a new classification of national Red List categories*, Pinchera *et al*., 1997; *Condannati all'estinzione? Biodiversità, biologia, minacce e strategie di conservazione dei Pesci d'acqua dolce indigeni in Italia*, Zerunian, 2002

In any event, in Italy numerous species having an unfavorable state of conservation are still susceptible of being hunted, according to *Birdlife International*[38], details to national scale provided by LIPU, ISPRA, FLA and CISO[39].
In fact, nineteen species that can still be hunted in Italy are considered to be SPEC (Species of European Concern) 2 (species in a state of unfavorable conservation and concentrated in Europe) or SPEC 3 (unfavorable state of conservation and not concentrated in Europe).
At issue are six species of ducks, six species of gallinacians, five species of charadriidai and, finally, doves and larks. For many of these species the suspension or the exclusion from the list of those species that can be hunted is recommended, even if hunting is not the cause of their unsatisfactory state of conservation nor does it contribute[40] to such. Also the document on the state of conservation of nesting species in Italy, mentioned above, proposes to suspend or exclude hunting for thirteen of the nineteen species having an unfavorable state of conservation in Italy.
The impact of hunting is not tied only to the killing of huntable fauna, for which at this time there is only partial data on the subject regarding some regional administrations that have produced hunting statistics. Of particular importance too are the indirect impacts such as: disturbance, involuntary killing of species like those that can be hunted and the diffusion into the environment of the lead in the cartridges. Data on the disturbance at this time is available only for some environment typologies (for example wet areas) and demonstrate how an army of hunters improperly regulated can effectively make some environments unavailable to the fauna. The involuntary killing of species like those that are huntable can probably have an effect for some groups of species (larks, anatids) but at this time adequate information is not available on this.
To be brought out as well is that some regions permit hunting species that are not huntable by using the mechanism of waivers as per art. 9 of the Birds Directive, through measures that have been censured more than once by the European Commission. Regarding the diffusion of lead into the environment, this problem to date has been greatly undervalued. Recent estimates made by ISPRA indicate that each year large amounts of lead are dispersed into the environment. A portion of the shot fired accumulates in the soil, bringing about local pollution problems, other shot strikes the prey, often entering into the food chain with consequent problems of

[38] *BirdLife International, 2004. Birds in Europe: population estimates, trends and conservation status*. Cambridge, UK: BirdLife International. (*BirdLife Conservation Series* N. 12).

[39] *Valutazione dello stato di conservazione dell'avifauna italiana. Specie in Allegato I Direttiva Uccelli.* Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Lega Italiana Protezione Uccelli (LIPU). Pp: 1156; Gustin M., Brambilla M. & Celada C. (a cura di) 2009. *Valutazione dello Stato di Conservazione dell'avifauna italiana. Volume I. Non-Passeriformes.*Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Lega Italiana Protezione Uccelli (LIPU). Pp: 842; Gustin M., Brambilla M. & Celada C. (a cura di) 2010a. *Valutazione dello Stato di Conservazione dell'avifauna italiana. Volume II. Passeriformes.* Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Lega Italiana Protezione Uccelli (LIPU). Pp: 1186; Gustin M., Brambilla M. & Celada C. (a cura di) 2010b

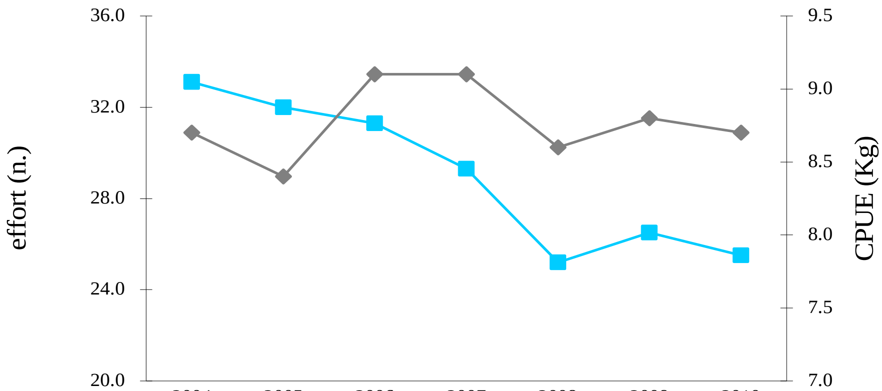
[40] *Guidance document on hunting under Council Directive 79/409 EEC on the conservation of wild birds "The Birds Directive",* European Commission 2008

poisoning for the wild fauna and for man himself. Analogous risks are tied to the use of bullets used in weapons having a rifled barrel for hunting ungulates. For this reason it becomes necessary to intervene by calling for the replacement of lead with a non-toxic material and carrying on a campaign to inform hunters and make them sensible of the facts.

Fishing can be an important factor of impact on the marine environment. Italy performs 5% of the total captures in Europe, but, like the other countries of the European Union, takes part in the effort to contain the impact of fishing that has been pursued for some time.

As regards fishing, it is an important factor of impact on the marine environment, involving as well the alteration of extensive portions of the habitat, but affecting however more the demographic structure and the biomass of the fished populations than the specific diversity. Italy makes five percent of the total captures in Europe and, together with the other countries of the European Union, has going on a policy of containment of the fishing effort in accordance with Common Fisheries Policy (CFP) which went into force on January 1st 2003. In 2010 the activity that started up in 2000 continued, consisting in a down-sizing of the fishing fleet in terms of both number of vessels (-0.6% below 2009) and total power (-1.9% relative to 2009). The total tonnage of the nation's fleet too continues to display a constant yearly dip (-3.3% relative to 2009). The fishing effort, constantly dropping since 2005, recorded an increase between 2008 and 2009, going from 25.2 to 26.5, to then diminish again between 2009 and 2010, the year in which a value of 25.5 was recorded. The Catch Per Unit of Effort – CPUE), equal to 8.7 kg, remains in line with the values of the past two years[41].

The fishing effort and the CPUE are stabilizing in the past few years, after a phase in which they lessened.



	2004	2005	2006	2007	2008	2009	2010
Effort	33.1	32.0	31.3	29.3	25.2	26.5	25.5
CPUE	8.7	8.4	9.1	9.1	8.6	8.8	8.7

Effort CPUE

Figure 2.6: Behaviour of the principal national "fishing" indicators[42]

The Italian fishing fleet generally consists of medium-to-small fishing craft. Artisan fishing still represents , in many

The Italian fishing fleet generally comprises boats of small to medium size, bringing out that artisan fishing is still in many regions the most widespread fishing typology. The situation is however diversified along the national territory. In 2010 more than 36% of the nation's fleet was registered in Sicily (23.4%) and in Puglia (12.8%). The largest number of fishing days for 2010 was instead found in Puglia (168.7), the Marches (150.9) and Campania

[41] MIPAAF-IREPA, 2010

[42] Source: ISPRA processed data from MIPAAF-IREPA

(131.6).

The most-used fishing systems are the drag net, the rod and small coastal fishing, confirming the above-mentioned trend typical of the Mediterranean toward a fishing that is for the most part artisan. In 2010 35.1% of the total of national captures took place by the dragnet and 46% was to be attributed to Sicilian and Puglian seacraft. Regarding the characteristics of the fishing, three species of fish subject to capture are entered in the IUCN red lists (albacore, swordfish and red tunny). Among these, the swordfish in particular is the subject of intense fishing especially by passive multivalents, and also bonitas, these being in fifth place in the total catches after the anchovy, the sardine, "other fish" and the hake[43].

regions, the most broadcast typology.

Also the biodiversity of the forest ecosystems is subject to different forms of threat, despite the fact that, as was noted above, the national forest area index recorded for various decades a positive trend, the reflection, however, of choices matured in other economic sectors and not the result of deliberate forest policies or of environmental safeguarding. This is shown by the fact that the increasing wooded areas are more and more subject to being abandoned and therefore to destruction, first of all by fire.

The biodiversity of the forest ecosystems is subject to various threats, despite the positive trend.

With regard to these latter a considerably critical period may observed during the middle of the 80's, which were followed by years in which the level of the phenomenon was maintained always high, with a progressive mitigation up through 2006, a subsequent strong recrudescence in 2007 and more-contained events from 2008 to 2010, during which 4884 events took place that involved 46,537 hectares, of which 19,357 regarded wooded areas properly so-called. 68% of the fires are intended and 20% for negligence, while the remaining 12% is prevalently of dubious origin[44]. To be noted too is that in 2010 fires, as the principal source of disturbance to the Italian forest heritage, caused the emission into the air of 1.8 million tons-equivalent of carbon dioxide, or 0,4% of the total national emissions of greenhouse gases (493.6 equivalent $MtCO_2eq$).

After the strong recrudescence of 2007, between 2008 and 2010 there was an attenuation of woods fires,.

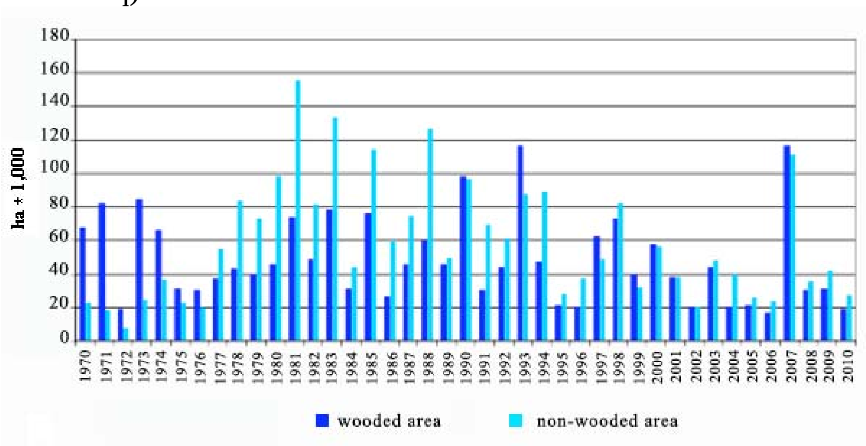


Figure 2.7: Wooded area and non-wooded areas struck by fire[45]

Forest fires displayed a progressive mitigation through 2006, a successive strong recrudescene in 2007 and more contained events from 2008 to 2010.

The increase in forest area in Italy was accompanied by an increase

The increase in

[43] MIPAAF-IREPA, 2010

[44] CPH products, 2010

[45] Source: CPH products, 2010

in the volume of trunks and large boughs (this later equal to 1269 million cubic meters, an average of 144.9 cubic meters per hectare), for a current increase in volume of wood of the total of Italian forests that runs around 37 million cubic meters (4.3 cubic meters per hectare) [46]. The increase in volume of trunks and large boughs and, more in geneal, of biomass is limited by lumbering, by fires, by plant diseases and by natural death.

forest area is limited by cutting, by fires, by plant diseases and by natural death.

Activities using forest products on the basis of data published by Eurostat[47], are quite limited and, since the first years of the ‘80s, are characterized by a negative trend as regards the component of lumbering by industry, compensated by a positive trend as regards wood for energy purposes. In 2010 almost 7.3 million cubic meters of lumber were cut from Italian woods, or 19.4% of the current increase in wood volume (37.6 million cubic meters of lumber). The lumbering diminished relative to the almost 87 million cubic meters of 2005 (24.2% of the current increase in wood volume) and to the more than 9.3 million cubic meters of 2000 (equal to 27% of the current increase in wood volume). The use of wood for burning in 2010 accounts for two-thirds of total utilizations. This percentage has been increasing over the past years, the sign of a process of de-specialization of the production of lumber towards productions of lower absolute value and lower final added-value.

Timbering in Italian woods between 2000 and 2010 has been dropping and is sensibly lower than the current increase.

As regards the rate of cutting (ratio of cubic meters cut to total forest area) it has progressively dropped between 2000 (0.9 cubic meters per hectare) and 2005 (0.8 cubic meters per hectare), to reach the yearly value of 0.7 cubic meters per hectare in 2010.

The rate of timbering has progressively dropped between 2000 and 2010: from 0.9 to 0.7 m3/hectare

The introduction of allochthonous species that are potentially invasive constitutes another threat to biodiversity. Their presence in nature can be traced back essentially to two typologies of introduction: intentional, for raising, cultivation, hobby purposes, etc.) and accidental or secondary (e.g. through the transport of freight, ship ballast waters, fouling, etc., or taxa introduced originally into areas outside the borders of Italy, which then arrived on their own in our country). To be underscored is that in many cases the origin and the carriers for introduction of the species are unknown. On the basis of the data available on the presence of allochthonous animal and plant species introduced into Italy starting from 1500 AD, a year taken as reference for introductions into Europe, it may be brought out that the total number is currently 2029 documented allochthonous species[48][49]. It is necessary however to underscore that this number is an underestimate of the true dimensions of the phenomenon, whether owing to the limitedness of specific studies or of aimed monitorings, or owing to the delay with which the species, once identified, are inserted in the

The introduction of allochthonous species that are potentially invasive constitutes another factor of threat to biodiversity. In Italy the number of documented allochthonous animal and vegetal species is currently 2029.

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[46] CPH products, 2010

[47] Since 2008 ISTAT has interrupted publication of data on lumbering (amounts and value) similarly to what it has done regardng the forest area and for the data on non-lumber forest products

[48] DAISIE, *European Invasive Alien Species Gateway* (http://www.europe-aliens.org) – agg. 2007

[49] *Non-native flora of Italy*. Celesti-Grapow *et al. (eds)*, 2009

lists or in the databases.
Analysis of the percentage distribution of allochthonous species in the different taxonomic/environmental groups (figure 2.8), which followed the taxonomic distribution used in the *European Invasive Alien Species Gatewa y* (*Delivering Alien Invasive Species Inventories for Europe* – DAISIE), brings out that, of the 2,029 allochthonous species documented in Italy, plants account for 50% of the total, followed by the terrestrial invertebrates, which constitute 33%. The other groups account for notably lower percentages: the marine species amount to almost 6%, those of internal waters, 4.8%, the terrestrial vertebrates for 3.6% and the mushrooms 2.7%.

Plants account for 50% of the total of the allochthonous species documented in Italy followed by the terrestrial invertebrates, which account for 33%.

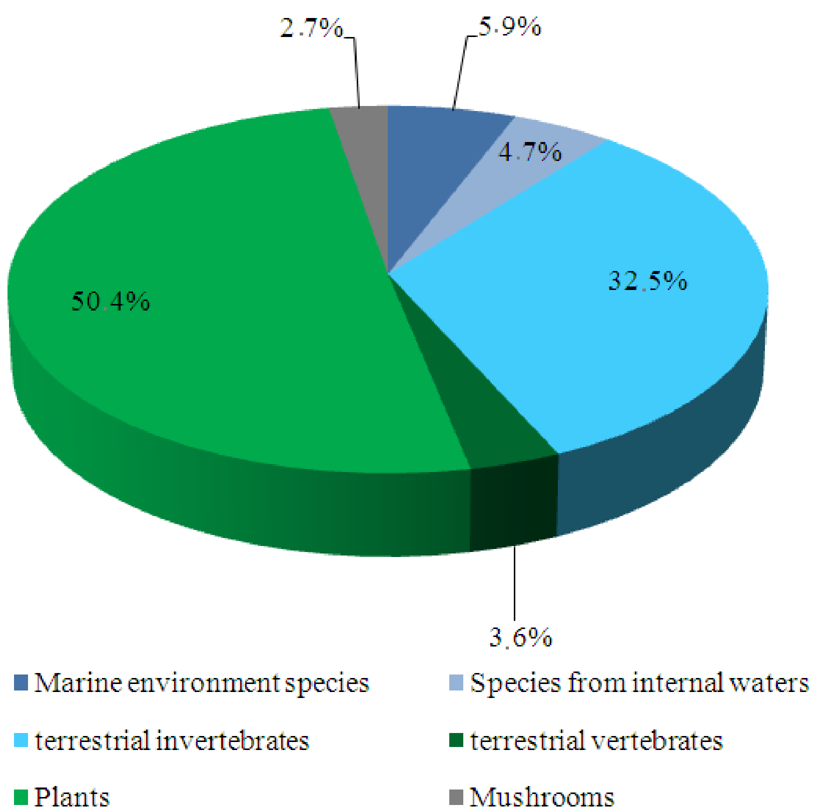


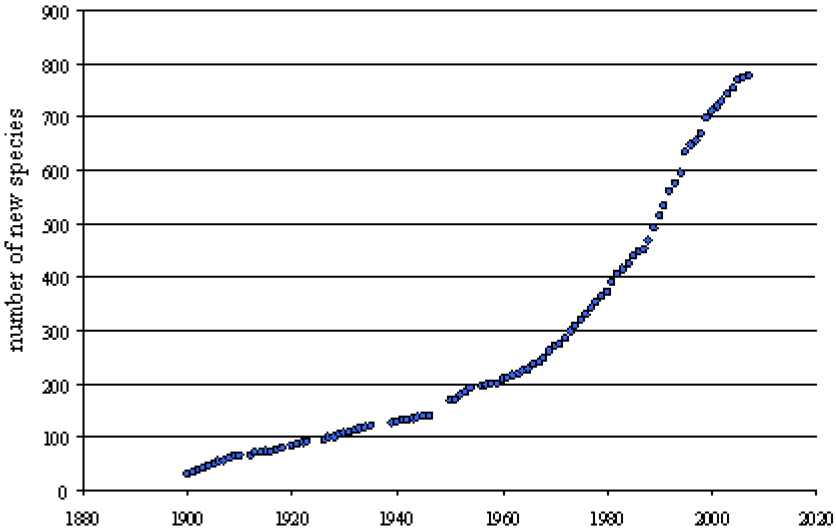
Figure 2.8: Percentage distribution into environmental/ taxonomic groups of the 2029 allochthonous species introduced into Italy since 1500 AD (updated to 2007, for vascular plants only to 2009)[50]

From the analysis of the trend, obtained by calculating the cumulative number of allochthonous species introduced into Italy starting from 1900 AD (figure 2.9) evident is the exponential increase in the number of introductions, in particular starting from the '50s of the past century. This rapid increase, which can be correlated with the increase in trade and with the development of transport systems, does not seem to exhibit any effect of saturation, supporting the thesis that rarely do ecological systems show

The rapid increase in allochthonous species introduced into Italy can be correlated with the increase in trade and with the development of transport.

[50] Source: ISPRA processed data from DAISIE, *European Invasive Alien Species Gateway* (http://www.europe-aliens.org) – agg. 2007*; Non-native flora of Italy,* Celesti-Grapow *et al. (eds.)*, 2009

themselves saturated by new species introduced.



The trend of introductions into Italy starting from 1900 brings out the exponential increase in the number of allochthonous species, in particular starting from the'50s of the last century.

Figure 2.9: Cumulative number of allochthonous species introduced into Italy starting from 1900, computed on 778 species whose date of introduction is certain (updating: 2007)[51]

Furthermore, the mean yearly rate of new "introductions", computed starting from 1900 on the basis of the same contingent of species, brings out an exponential increase in the mean number of allochthonous species introduced per year, going from little more than one species per year at the start of 1900 to fifteen species per year at the end of that same century.

The mean yearly rate of new introductions, calculated starting from 1900, displays an exponential increase in the mean number of allochthonous spcies introduced per year.

Although in the past years the quota of accidental "introductions" or those of unknown origin has increased, nonetheless the intentional introductions are something that is still more widespread, in particular for some groups of animal species such as the fresh-water species of interest for sport fishing.

It is then necessary to mention the indirect effects of man's action and in particular those induced by climate changes. Year after year the scientific evidence increases on the impact of climate changes on biodiversity, whether aquatic or terrestrial, at the level of ecosystem, of species and genetics[52][53]. Various investigations made in Italy on a time scale that is by now broad indicate that the climate anomalies recorded to date, especially in the daily temperature and in rainfall, have altered the physiological processes (photosynthesis, respiration, plant growth, efficiency of water use, composition of tissues, metabolism and decomposition), as well as the distribution, the phenology of the plants, the migration patterns, the periods of reproduction of many animal species and the interactions between these and biotic and abiotic factors.

The indirect effects of man's action and in particularr those due to climate changes are indicated by various investigations carried out in Italy.

The impacts observed to date include the shift towards the north and towards higher elevations of the geographic range of many species.

In Italy the impacts of climate changes exert an influence

[51] Source: ISPRA processed data from DAISIE *European Invasive Alien Species Gateway* (http://www.europe-aliens.org) – agg. 2007

[52] Butchart *et al.* (2010). *Global Biodiversity: Indicators of Recent Declines.* Science 328: 1164-1168

[53] Bálint *et al.* (2011). *Cryptic biodiversity loss linked to global climate change.* Nature Climate Change, 1: 313–318

The extension of the vegetative season has brought about an increase in the productivity of the Alpine biogeographic region, while drier and hotter climate conditions have been responsible for a more reduced forest productivity and for an increase in the frequency and in the severity of fires in the Mediterranean belt.

on the geographic range of many species and on the vegetative season.

For the future, the impacts on and the replies of the agricultural and forest ecosystems to climate changes will become ever more acute, even if of different amount, depending on the geographic regions and on the types of vegetation. Regarding agriculture, a large part of the studies indicate that climate changes will have generally negative effects on its production capacity. For example, the highest temperatures recorded in Italy have already had the effect of anticipating the grape harvest, of increasing grape sugar content, of diminishing its acidity and of changing its bouquet.

Climate changes will have generally negative effects on production capacities of the agriculture sector.

The Alpine region and the mountain ecosystems are considered to be particularly vulnerable to the impacts of climate change. For the Mediterranean region, faced by climate scenarios involving reduced precipitations (especially during summer) and the increase in temperature above expected values on a global scale, envisioned is an expansion of the adjacent arid and semi-arid systems. The experts foresee a change in the spatial distribution of the flora and the contraction of the distribution of the forests, especially in Southern Italy. The native Mediterranean species will face the greatest threats, owing to the envisioned reduction in precipitations, the greater intensity of fires, and the alteration of the fenology and of the vegetative season. The positive effects of carbonic fertilization could be neutralized by the limited availability of water and by the higher temperatures. Climate changes, finally, will inevitably exert an impact on the ecosystem services that agriculture and the forests offer, with important consequences both economic and social for the sector.

The Alpine region is considered to be particularly vulnerable to the impact of climate changes, while expected for the Mediterranean is an expansion of the adjacent arid and semi-arid systems.

Many areas could become suited to the grapevine or to new grape varieties (replacing others no longer suited to the changed climate). On the other hand, some vine-growing regions could become no longer capable of bringing to ripeness typical varieties. The hot arid areas (Pantelleria, Salento) could be thrust outside the area of cultivation of the vine (but also of the olive and of citrus). The cultivation of hard wheat, a cultivation that is the symbol of Italian agriculture, could undergo significant impacts from future climate changes[54]. As regards wines, the major difficulties are expected for the whites and, in particular, for the aromatic wines.

There is considerable scientific evidence to demonstrate that the capacity of the natural, semi-natural and agricultural areas of resistence to climate changes, and of resilience under their effects, depends strongly on biodiversity, on the seasonal level to the bioregional, on the genetic level to the ecosystem level

The resistance to climate changes of the natural areas strongly depends on biodiversity

With respect to climate changes, it is to be noted that the natural and agricultural areas play a significant role in the global carbon cycle, and, therefore, in the problems raised by the greenhouse effect. The

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The natural and agricultural areas play a significant

[54] Ferrise R *et al.* (2011). *Probabilistic assessments of climate change impacts on durum wheat in the Mediterranean region.* Natural hazards and earth system sciences 11: 1293-1302

agriculture sector is on the whole a net emitter of greenhouse gases, principally owing to the enteric fermentation of the stock being raised, of their urine and feces, of the agricultural soils, to the cultivation of rice paddies and to the burning of agricultural residues. It is finally to be noted how the non-climatic factors of threat to biodiversity can interact with climate changes in non-linear fashion, and with consequences that at least in part are not predictable.

role in the overall carbon cycle and therefore in the problems created by the greenhouse effect.

According to the national inventory of greenhouse-effect gas emissions and absorptions, made up by ISPRA[55] in 2010, agriculture was responsible for atmospheric emissions of 33.7 million tons of CO2 equivalent ($MtCO_2eq$), confirming a diminishing trend relative to 1990 (40,7 $MtCO_2eq$).

Agriculture contributes 6.7% of the quantity of greenhouse-effect gases emitted, placing after energy-use (31%), energy production (26.6%) and transport (23.7%). From 1990 to 2010 there was a reduction in emissions of 17.2%, principally owing to the reduction in the number of heads of livestock raised and to the contraction of the SAU. On the other hand, some forms of use and management of agriculture and forest soils make it possible to increase the quantity temporarily fixed of CO_2, through the conservation or expansion of the stocks of carbon in forest ecosystems and in agricultural soils. This capacity is tied to the development of the sector and, therefore, to agriculture policies and rural development policies, to energy and climate policies that influence the methods of managing lands, just as to the capacities for "spontaneous" reaction of agriculture to the climate change process itelf.

According to the national greenhouse gas Inventory sent in 2012 to the Secretariat of the UN Convention on Climate Changes there was a net positive balance on the books between absorptions and emissions arising from the Use of the soil, Change of Use of The Soil and Forest culture (LULU conference[56]) sectors equal to 56.5 $MtCO_2eq$ (+63,9% relative to 1990). Of these, 39.9 $MtCO_2eq$ arise from forested areas, 12.4 $MtCO_2eq$ from agricultural areas, and 7.6 $MtCO_2eq$ from meadows and pasturelands[57]. Relative to this, deriving from the creation of man's settlements (infrastructures, buildings, industrial and urban areas, etc.) are instead emissions amounting to 3.4 $MtCO_2$ eq.

Among the causes of impact on the natural heritage, a controversial role is played by the activities tied to agriculture. On the one hand, in fact, farmlands undergo the negative impact of other activities and of other production areas, since often subjected to urbanization phenomena, to unlicensed dumping, to pollution coming from industry. On the other, it is just the agricultural activities that are often pointed to as among the main causes of pollution of the waters, of losses of stability of the soils, and of their pollution, of the increase in the greenhouse effect, of loss of biodiversity, of simplification of

Farmland areas on the one hand undergo the negative impact of other economic activities, and on the other can be the cause of pollution and loss of biodiversity.

[55] http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/6598.php

[56] LULUconference: *Land Use, Land Use Change and Forestry*

[57] http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/6598.php

the landscape.

In Italy, the major impact on the environment and on biodiversity directly associated with agriculture arises from the use of fertilizers and of plant health products. The distribution over the agricultural soils of synthetic fertilizers, the spreading of the effluents coming from livestock ranches and from small agro-food farms, the distribution of the purification slimes are key factors both in pollution of bodies of water and of the coastal marine habitat and of eutrophization, with consequences for human health as well as for the flora, the fauna and the complex of ecosystems. On the other hand numerous studies indicate that the reduction of biodiversity in agriculture (understood as the reduction in the varieties of species cultivated, of the grassy unfertilized "buffer" bands and of the hedges along watercourses and creekbeds) and the abandonment of crop rotations and of the marginal uncultivated zones bring about specific consequences for the migration of nutrients and of other pollutants towards the surrounding hydrographic basins.

In Italy the major impact on the environment and on biodiversity directly associated with agriculture arise from the use of fertilizers and of plant health products.

An ISPRA workup on data, furnished by ARPA/APPA, by the autonomous provinces and by the regions, on the contamination of surface and underground waters by residues of plant-protection products states that, during 2008, pesticide residues were measured in the surface waters in 47.9% of the total monitoring points, in concentrations that in 30.9% of the cases exceeded the legal limits for potable waters. In the underground waters 28.8% of the total of monitoring points were found contaminated, which in 15.6% of the cases had concentrations exceeding the limits. Residues of every typology of plant-health products were found in the surface and underground waters, even if the herbicides and the metabolites connected with them are the substances most largely found (including the infamous atrazine, a substance not on the market for two decades, but still present as residue of an old contamination).

Surface and underground waters frequently display plant-health-product concentrations exceeding legal limits.

Regarding the distribution of fertilizers in Italy, to be remarked is an increase during the period 1998-2007 and an inversion of trend during the past three years. On analyzing this behaviour, what emerges is the progressive reduction of fertilizers and a considerable increase in organic substances. In 2010, in particular, the national figure is 4.4 million tons of fertilizers, of which more than 2.1 million (49.2%) consist of mineral fertilizers. The most-sold type goes on being that composed of mineral fertilizers, where the nitrogen-containing products predominate and represent more than 81%.

In Italy over the past three years a reduction in the quantities of fertilizer put on the market has been seen.

As for the plant-health products, durng 2000-2010 their presence on the market displayed a contraction of 6.8%. In 2010 a little less than 144 thousand tons were sold, with a reduction of 2.4% below the preceding year. 73.9% of them were "non-classifiable" products, and the remaining 26.1% included the very toxic, the toxic, and the harmful, which, being most dangerous from the toxicological, eco-toxicological and physical-chemical standpoints are subject to special restrictions on their sale and storage. Relative to 2009 the non-classificable products were reduced by 3.8% (-8300 tons), while the toxic and very toxic increased by 57% (+3000 tons) and the harmful

During 2000-2010 the placement on the market of plant-health products displayed a contraction of 6.8%.

by 6.2% (+1700 tons)[58].

The principal safeguarding actions

Italy has signed numerous conventions and international agreements aimed at safeguarding biodiversity, among which the convention on Biological Diversity.

As already brought out, the conservation of biodiversity often comes into conflict with man's exploitation models. The efforts to reconcile the clash in the best possible way with the needs of society often take the form of agreements and laws, essential elements indispensable to integrating the needs of conservation with economic, social, cultural and local-population needs.

Italy has signed numerous conventions and international agreements aimed at safeguarding biodiversity. Among these, to be noted for its strategic importance on a global scale is the already mentioned CBD. This poses three main objectives: 1) conservation *in situ* and *ex situ* of biological diversity; 2) the sustainable use of its components; 3) the fair division of the benefits arising from the use of genetic resources. In Italy the CBD was ratified by law no. 124 of February 14th 1994. Later, on March 16th 1994, the Interministerial Economic Planning Committee decided on the document *Strategic lines of action and preliminary program for enforcing the Convention on biodiversity in Italy*.

In particular, the CBD acknowledges the importance of the ecosystem approach as a strategy for the integrated management of the territory, of the waters and of the living resources, a strategy able to promote conservation and sustainable use in an equitable fashion. Its application favors the striking of a balance among the three objectives of the CBD. The ecosystem approach is based on the application of appropriate scientific methodologies focussed on levels of biological organization that include the essential processes, the functions and the interactions between organisms and their environment. It acknowledges that human beings, with their cultural differences, are integral parts of the ecosystems.

The Tenth Conference of the Parties in Nagoya.

From October 18th through 29th 2010 the Tenth Conference of the Parties of the CBD (COP10) was held in Nagoya (Japan), which produced an important agreement on safeguarding biodiversity and ecosystems, within the purview of a more equitable sharing of the benefits among the advanced and the developing countries.

The CBD's Plan for Strategic Action 2011-2020, adopted during the conference, includes twenty principal objectives organized in five strategic points: to identify the causes at the basis of the loss of biodiversity, to reduce the pressures on biodiversity, to safeguard the biological heritage at all levels, to increase its benefits and to strengthen its capabilities.

Among its various objectives, it is important to underscore that the contracting parties:

- have agreed to halve, and where possible, annull, the rate of loss of natural habitats, including the forests;
- have established a protection objective of 17% of the earth's land areas and internal waters, as well as 10% of the sea and coastal areas;
- have undertaken to see that the governments, through conservation and restoration operations, recover at least 15% of the

[58] Source: ISTAT, 2011

deteriorated areas;

- will devote especial attention to reducing the pressures on the coral barrier reefs.

In particular, it was also decided that, by 2020, the biodiversity values will be integrated into the planning processes, the national accounting systems, and the reporting systems(*Target 2*), and that the extinction of threatened species will be warded off, by improving their state of conservation (*Target 12*).

The parties have agreed on a substantial increase in the level of financial resources set aside for carrying out the Convention.

The Strategic Plan of Action (the *Aichi Target*) will be the general reference picture for biodiversity not only for the conventions closely concerned with biodiversity itself, but for the entire system of the United Nations. The parties have agreed to translate this international reference picture into national strategies for biodiversity and into plans of action within two years.

The financial support for the Strategic Plan of Action will be found within the picture of a strategy for mobilizing resources. The Parties will work to define, for the eleventh conference of the Parties of 2012, the objectives and the mechanisms through which financial resources can be identified, mobilized and channeled.

The Parties have also adopted the Nagoya Protocol on *Access to the genetic resources and the just and fair subdivision of the benefits accruing from their use*. The agreement, which can be called historic, creates a reference framework that balances access to genetic resources. It provides for an informed concensus and for mutually agreed-upon accords within the purview of a just and fair division of the benefits, taking into account too the important role played by traditional knowledge.

The Nagoya Protocol is envisaged to go into force by the end of 2012, with the financing of a million USA dollars supplied by the *Global Environment Facility* (GEF) to support the first phases of activity.

Finally, a moratorium on geoengineering experiments (that is, intentional operations to large-scale on the climate system for the purpose of reducing environmental alterations, among which climate changes) was adopted, owing to the impacts on biodiversity that such experiments could cause.

*The international initiative TEEB (*The Economics of Ecosystems and Biodiversity) *aims at rendering the economy, both in theory and in practice, ever more based on the biophysical fundamentals of the natural systems that support it.*

On the occasion of COP10 the concluding report was made known on the great international initiative *The Economics of Ecosystems and Biodiversity*" (TEEB)[59]. TEEB, directed by Indian economist Pavan Sukhdev, and launched by Germany and by the European Commission in 2007, has been supported by UNEP and by the United Kingdom, Norway, Holland and Sweden. TEEB aims at composing all the experience, knowledge and know-how existing in all regions of the planet to make our economy ever more based, both in theory and in practice, on the biophysical fundamentals of the natural systems that support it.

TEEB brings out the failure of the markets to properly consider the value of ecosystems and of the the entire planet's biodiversity,

[59] www.teebweb.org

demonstrating how the activities aimed at conservation, restoration and rational management of resources and of natural systems constitute an authentic economic investment. The lack of a market price for the services offered by ecosystems and for biodiversity demonstrates that the beneficial fundamentals deriving from these goods (in many cases public and community goods) are almost always neglected or undervalued in policy decisions.

The effects of these undervaluings reverberate not only in the continual and progressive worsening of the state of health of the entire world's ecosystems, but also on the state of health of humanity and of human well-being on the whole. The value of ecosystems and of biodiversity is today paradoxically invisible to the economy that guides policy choices throughout the world. The scientific knowledge acquired demonstrates to us, instead, that the natural capital, the ecosystems, biodiversity and natural resources are at the base of the well-being of economies, societies and individuals.

Other important international agreements are the Bonn and Berne conventions.

Among the principal international agreements of particular importance are also the Bonn convention on the conservation of migratory species belonging to wild fauna (*Convention on Migratory Species of Wild Animals* – CMS) adopted in Bonn on June 23rd 1979 and that of Berne, regarding the conservation of wildlife and of the natural environment in Europe, with attachments adopted in Berne on September 19th 1979.

In particular, the Bonn convention is a framework agreement after which agreements were signed on safeguarding particular species, such as the chiroptera (EUROBATS) the cetaceans (ACCOBAMS), the wild migratory bird species between Europe and Africa (AEWA) and the raptors (*Raptors* memorandum of understanding).

The Siracuse Paper on biodiversity.

Finally, to be noted too is the recent *Syracuse Paper on biodiversity*, signed by the environment ministers of G8 in concert with those of other countries and with the international organizations taking part in the Syracuse meeting of April 22nd-24th 2009. The Paper envisages undertaking a series of actions regarding the relationship between biodiversity and the climate, the economy, ecosystem services, science, research, and policy. On the basis of such actions a common path was proposed towards the post-2010 context on biodiversity.

The European Union is strongly committed to the protection of nature and of biodiversity. The thematic strategies of the EU Program for environmental action relative to the policy on the protection of nature are strongly integrated both into the Strategy for Sustainable development, and into the objectives of the Lisbon Treaty, as too into the sectorial policies, among which those of agriculture and fishing, of industry, of energy, of transport.

The two fundamental pilasters of the EU for policies involving the conservation of nature and of biodiversity are the Birds Directive *and the* Habitat

The pilasters of the EU for policies regarding the conservation of nature and of biodiversity are two fundamental directives: the Birds Directive (79/409/EEC), concerning the protection of wild birds, and the Habitat Directive (92/43/EEC) on the conservation of natural and semi-natural habitats and of the wild flora and fauna. The Birds Directive was then abrogated and replaced *in toto* by the codified version of Directive 2009/147/EC, which maintains its fundamental objectives. Among the specific objectives of the Habitat directive there is the creation of a coherent European ecological network, called *Nature Network 2000*, consisting of Special Areas of Conservation zones (SACs) and of Special Protection Areas (SPAs), these later being identified by the Birds Directive.

Directive.

Nationally, the Birds Directive was incorporated into Italian law by law no. 157 of February 11th 1992, while the Ministerial decree of June 19th 2009 was published in the last updated list of the Italian ZPSs. The Habitat Directive was fully incorporated into Italian law by Decree of the President of the Republic no. 357 of September 8th1997, subsequently modified by Decree of the President of the Republic no. 120 of 2003. The last updating of the lists of the Italian Sites of Community Importance (SCIs) was recently adopted with the following decisions of the European commission:

- no. 2011/62/EU, incorporated by Ministerial decree of March 14th 2011 - Fourth updated list of the SCIs for the Alpine biogeographic region;
- no. 2011/64/EU, incorporated by Ministerial decree of March 14th 2011 - Fourth updated list of the SICs for the Continental biogeographic region
- n. 2011/85/EU, incorporated by Ministerial decree of March 14th 2011- Fourth updated list of the SICs for the Mediterranean biogeographic region.

At present the Nature Network 2000 in Italy consists of 601 ZPSs , with an area of 4,379,683 hectares and of 2287 SIC, with an area of 4,770,850 hectares.
Net of superpositions, the Nature Network 2000 sites number 2564, with an area of 6.316.664 hectares (21% of the nation's territory)

At present the *Nature Network 2000* in Italy consists of 601 SPAs, with an area of 4,379,683 hectares, and of 2287 SCIs, with an area of 4,770,850 hectares. Net of the overlapping between SPAs and SCIs, the Nature Network 2000 sites in Italy number 2563, and occupy an area of 6,316,664 hectares, or 21% of the national territory[60].

Another basic reference for the conservation of biodiversity in Italy is the framework law on protected areas, no. 394 of December 6th 1991, which "…dictates fundamental principles for the institution and management of protected natural areas, in order to guarantee and promote, in coordinated fashion, the conservation and the benificent exploitation of the country's natural heritage". Side by side with it is a series of measures aimed at safeguarding the fauna and flora, at regulating hunting, at the protection of marine species and the regulation of sea fishing, and at safeguarding the forest heritage. The set of laws approved made it possible to carry out various initiatives that seek to safeguard and improve the conditions of our natural heritage. In Italy there are 871 protected areas, which occupy an area of 3,163,591 hectares (10.5% of the nation's terrestrial territory)[61].

In Italy 871 protected areas exist, which take up an area of more than three million hectares (10.5% of the national terrestrial territory).

Among the safeguarded marine areas of particular importance are the *Marine Protected Areas* (MPAs), which are marine environments consisting of waters, seabottoms and the stretches of

Among the safeguarded sea areas of particular importance are the

[60] MATTM, ottobre 2011
[61] *VI EUAP - Elenco Ufficiale delle Aree Protette*, MATTM, 2010

coast behind, which are of relevant interest owing to their natural, geomorphological, physical and biochemical characteristics, with special regard for the marine and coastal flora and fauna and for the scientific, ecological, cultural educational and economic importance they have. In Italy, the AMPs can be instituted if they have been earlier identified as *areas foreseen by law*. Laws 979/82, 394/91, 344/97, 426/98 and 93/01 furnish a list of fifty areas. To date, 27 MPAs have been instituted. They achieve, at the same time, the objective of safeguarding biodiversity and of maintaining and diversitying the local economy by means of three principal levels of differentiated protection (Zones A, B and C).

Protected Marine Areas(AMP),as well as the Pelagos *Sanctuary for marine mammals.*

Finally, to be kept in mind as well too is the *Pelagos* Sanctuary for marine mammals, which, being an international protected pelagic area, which came out of an agreement beween France, the Principate of Monaco and Italy, has followed a different instituting procedure and at present calls for the promotion of measures for the maintenance of the good state of conservation of the marine mammal populations and the prohibition on putting on off-shore races.

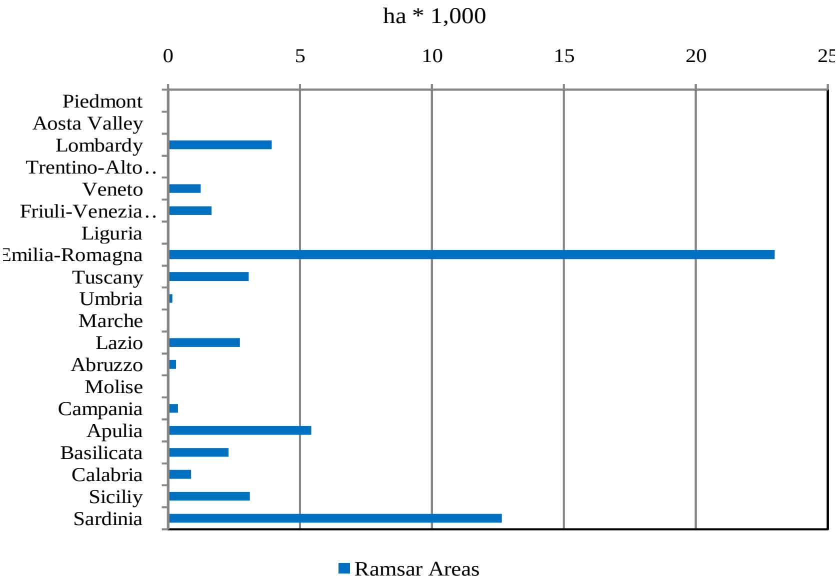
The law mentioned, 394/1991, introduces the instrument of the "Plan for the Park" which, breaking the territory down in relation to the various degrees of safeguarding, guarantees the pursuit of the conservation of biodiversity, reconciling it with man's activities. This instrument, of fundamental importance for the management of top-priority areas for conservation, has encountered many difficulties in its complex path to becoming law. In fact, the picture as of December 31st 2010 referring to the 24 Italian National Parks and based on official legal instruments brings out that one National park (4%) has not as yet instituted the Park Agency; another Park (4%) has not started up the procedures for the preparation of the Plan for the Park; twelve (50%, +20% more than in 2009) are in phase of preparation and adoption, specifically in the phase of gathering observations, eight (33%, + 33% more than in 2009) are in the final phase of approval and publication.

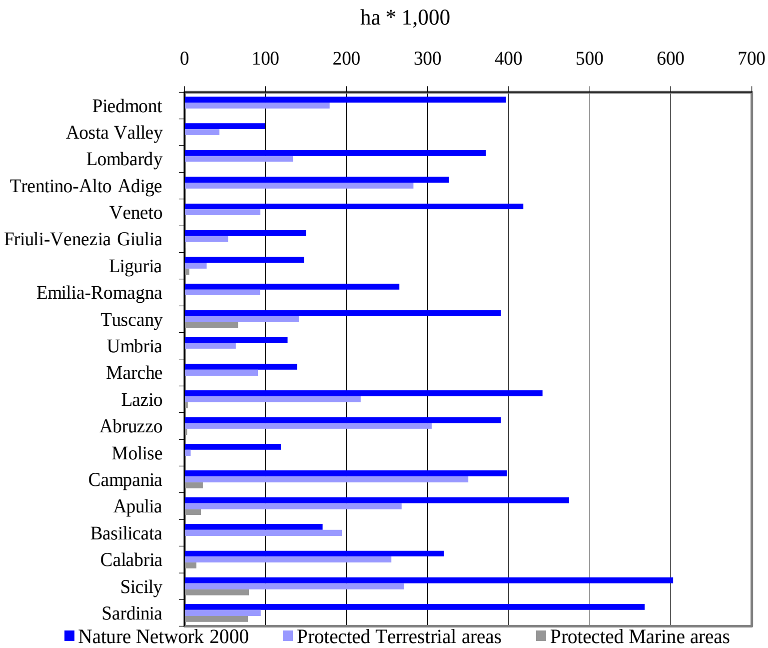
Law 394/1991 introduces the instrument of the Plan for the Park, *which, breaking down the territory in relation to the various degrees of safeguarding guarantees the pursuit of the conservation of biodiversity, reconciling it with man's activities.*

It should be noted, furthermore, that the Strategic Environmental Evaluation procedure to which the Plan for the Asinara National Park was subjected and is underway for the Alta Murgia Park, or that regarding the Incidence Evaluation for the Casentine Forest Plan, the Monti Sibillini Plan and the Tuscan Archipelago plan guarantee full participation and the pursuit of the objectives of safeguarding, but involve a further lengthening of approval times.

To complete the picture of the natural areas subjected for various reasons to forms of safeguarding, it must finally be noted that, owing to Italy's joining the 1971 Ramsar Convention (Iran) on wetlands of international importance, 57 sites of great ecological importance are safeguarded, extending over a total area of 60,768 hectares. Figure 2.10 shows the regional distribution of the areas safeguarded as per the instruments set forth above.

Owing to Italy's joining the Ramsar Convention there are safeguarded 57 wetlands of great ecological importance.





21% of the national territory is involved in the Nature Network 2000, 10.5% in protected terrestrial areas. Present too are 27 Marine Protected Areas and 57 Ramsar sites.

Figure 2.10: Regional distribution of protected[62] areas (except for the Sanctuary for Marine mammals)[63]

In compliance with the international conventions for safeguarding biodiversity, with the Community Directives *Birds* and *Habitat*, with the national laws on protected areas and on the conservation of the fauna, sixteen "Action plans" were created for species of fauna in danger and four "Guidelines" for containing species that cause damage to the autochthonous fauna and to natural habitats. Action plans and Guidelines were made up, almost in their entirety, by the former National Institute for Wild Fauna (currently ISPRA), on commission of MATTM. Taking part in their drafting were,

In Italy there were created various"Action Plans" for endangered species of fauna and "Guidelines" for containing species that endanger autochthonous fauna and natural habitats.

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[62] Source: per le Aree Ramsar: MATTM, 2011; per le Aree protette terrestri e marine: VI Elenco Ufficiale delle Aree naturali Protette, MATTM, 2010; per la Rete Natura 2000: MATTM, ottobre 2011 (the extent of the Nature 2000 sites per Region was computed excluding the overlappings between the SIC and ZPS)

[63] The Sanctuary for marine mammals extends over a total 2,557,.258 hectares

depending on cases, the major experts for each species (indicated by MATTM, by the main research bodies, by the Italian Zoological Union or by the most representative non-governmental associations) and by national agencies (National Parks, State Forestry Corps) or local ones (protected areas, regions, provinces) that are competent within the territory for implementing the actions contained in the plans.

The national Strategy for biodiversity

With the agreement (Register no. 181/CSR) expressed by the Permanent Conference for relations with the state, the regions and the autonomous provinces, in the session of October 7th 2010 the procedure for approval of the National Strategy for biodiversity was concluded, after a profitable orchestration between MATTM, the regions and the autonomous provinces of Trento and Bolzano, after a path of participation and sharing between the various institutional, social and economic actors concerned. The participation in the drafting of the Strategy was seen to with the organization of a series of territorial seminars (Florence, April 29th 20\10, Padua, May 6th 2010, Naples, May 13th 2010) and one devoted to the Protected Areas (Sabaudia, P.N. of Circeo, May 11th 2010) and culminated with the organization of the first National Conference on Biodiversity in Rome on May 22nd 2010.

The National Strategy for Biodiversity, whose preparation is envisaged by the CBD, is an instrument of great importance for guaranteeing, in the years to come, a true integration between the objectives of development of the country and the safeguarding of its inestimable heritage of biodiversity.

In confirming the national commitment to achieving the objective of arresting the loss of biodiversity, the Strategy is put forward, in fact, as a tool for integrating the exigencies of biodiversity into national policies in the sector, acknowledging the need to maintain and strengthen its conservation and the sustainable use for its intrinsic value and in so far as it is an essential element for human well being. The plan for the conservation of biodiversity of the Strategy envisages, in fact, that "biodiversity and the ecosystem services, our natural capital, are conserved, evaluated, and, insofar as possible, restored, owing to their intrinsic value and because they can go on sustaining in lasting fashion economic prosperity and human well-being despite the deep-cutting changes going on at the global and local levels".

To realize the plan the national Strategy was articulated around three cardinal themes (Biodiversity and ecosystem services, Biodiversity and climate changes, Biodiversity and economic policies). In close relationship with the three cardinal themes, the identification of three strategic objectives, among themselves complementary, arises from a careful technical and scientific evaluation that sees in the safeguarding and in the recovery of the ecosystem services and in their essential relationship with human life, the top-priority aspect of carrying out the conservation of biodiversity. The three strategic objectives call for, by 2020, guaranteeing the conservation of biodiversity, by ensuring the safeguarding and the restoration of ecosystem services, of suhbstantially reducing within the nation's territory the impact of

climate changes on biodiversity, and of integrating the conservation of biodiversity into economic policies and policies peculiar to the sector.
The achievement of the strategic objectives is taken on in fifteen areas of work, while, for the purpose of evaluating the efficiency and the efficacy of the Strategy, it is expected to define a system of periodic monitoring based on a set of indicators of evaluation, which make it possible to estimate the efficacy of the policies undertaken and the achievement of the specific objectives through the priorities of operation for the achievement of the plan and of the strategic objectives. In this sphere, useful points of reference at the national level for the identification of the indicators consist of the Yearbook of environmental data worked up by ISPRA and of all the instruments for monitoring the territory perfected by the regions and the autonomous provinces, by the agencies managing the Protected Areas and by the universities and research agencies. The workup of a proposal for a set of indicators of evaluation is underway now by ISPRA, commissioned by MATTM.
By decree of June 6th 2011 published in Official Gazette no. 143 of June 22nd 2011, the Minister Of The Environment And Of Safeguarding The Territory And The Sea instituted the functioning departments of the Strategy (joint Committee for Biodiversity, National Observatory for Biodiversity, Consultation table).

The Common Fisheries Policy (CFP) is the instrument through which the EU, and therefore the member states, manage fishing and aquiculture in all its components biological, environmental, economic and social.

Fishing, like agriculture, with which we shall deal further on, is one of those competences historically shared between the European Union and its member states that, with the entry into force of the Treaty of Lisbon in 2009, passed to the exclusive competence of the European Union. The instrument through which the EU manages fishing and aquiculture in all its components (biological, environmental, economic and social) is the Common Fisheries Policy (CFP).
Although the CFP is only twenty years old, in 2002 its reform became necessary since, after the development of the fishing sector, it no longer sufficed to achieve the purpose for which it had been conceived, that is to ensure the economic profitability of the Euopean fleets and a product of good quality to consumers, while guaranteeing at the same time the conservation of fish resources and the safeguarding of the sea environment. The lacks of the CFP were fundamentally tied to the difficulty of Community policy in solving such serious problems as: 1) excessive exploitation of the stock and the fleet’s overcapacity; the excess of fishing effort was not reduced even by the instruments applied by the CFP, such as the program for multi-yearly orientation; 2) the low profitability of fishing, owing to overinvestment, to increases in running costs (labour and fuel), and to the reduction in resources.
Low profitability was followed up by a constant drop in employment. This situation displayed all its seriousness especially within the context of the enlargement of the European Union and of the globalization of the economy, (with the appearance of new competitors, among which many of the developing countries, new protagonists active in fishing at the world level) and the increasing attention paid to topics tied to the environment. The scant efficacy

of the CFP's measures of control and the failure to involve those interested compromised full compliance with the conservation measures adopted. This made necessary a reform to arrive at fishing activities that were ecologically and economically sustainable.

The current CFP is based on a reform carried out in 2002 that introduced numerous innovations.

The current CFP is based on a reform carried out in 2002, whose principles are enunciated in the Rules (EC) nos. 2369/2002, 2370/2002 and 2371/2002. Among the numerous innovations introduced by this law there are a simplification of the policy of management of fishing capacity, a long-term approach in the management of fishing with the introduction of multi-year plans for the reconstitution and management of stock, the granting of incentives to the definitive arrest and the introduction of restrictions on the measures for renewing and for modernizing the fishing boats. Framework regulation no.2371/2002 of the Council of December 20th 2002, regarding the conservation and the sustainable exploitation of fishing resources within the CFP, constitutes the legal basis for all the subsequent legislation in the matter adopted at the level of the European Union. Regulation no.2371/2002, in abrogating that of 3760/1992, has substantially modified the Community laws on conservation and on sustainable exploitation of fishing, thus redesigning the field of application, the content and the objectives of CFP.

With the CFP there was introduced an approach of the precautionary type, to protect and conserve resources and to reduce to the minimum the impact of fishing on ecosystems and it was sought to give a reply to some specific problems as regards conservation of living marine resources, the preservation of the environment, the management of the fleet, the organization of markets, control systems, etc. From a structural standpoint, the European Fund for Fishing (EFF) - Regulation no.1198/2006 of the Coucil of July 27th 2006 represents its financial component and is based on seven-year programs (2007-2013).

For the aspects regarding the management measures in order to have sustainable exploitation of the Mediterranean's fishing resources, Regulation no.1967/2006 was issued, bearing the modification of EEC Regulation no.2847/1993 and which abrogates EC regulation no.1626/1994.

Among the more significant measures introduced by the reform of the CFP there are TAC; technical measures; reduction of accessory or accidental captures; limitations on the fishing effort; IUUF reduction.

Among the more significant measures introduced by the reform of the PCP there are: the TAC (Total Allowable CatchAdmissible Capture Totals), which in the Mediterranean are set each year only for the red tuna, through ICCAT (*International Commission for the Conservation of Atlantic Tuna)*; technical measures such as the minimum dimension of the net meshes, the use of selective fishing equipment, the interdiction on fishing in certain areas or periods, the minimum sizes of fish that can be unloaded, the reduction of accessory or accidental captures; limitation of the fishing force in terms of capacity (tonnage, engine power and days spent at sea); reduction of illegal, unreported or unregulated fishing (IUUF – *Illegal, Unreported, Unregulated Fishing)*

Some among the technical measures listed, such as the adoption of nets having larger meshes or of new minimum values for distance from the coast and depth, as well as provisions regarding the species and the protected habitats, are specifically the subject of the Mediterranean Regulation (EC) 1967/2006, which went into force on June 1st 2010. This regulation envisages for the carrying on of a certain number of fishing activities the preparation of national management plans, on the basis of scientific evaluations that guarantee ecological and biological sustainability.

Despite the progress obtained by the CFP in guaranteeing the sustainability of fishing from the environmental and socio-economic profiles, this sector of fishing appears as yet to be economicall and socially fragile. The objectives of reduction of fishing capacity have not been achieved, the fish stocks are prevalently subjected to excessive exploitation and at the same time the captures and their profitability are reduced, in consideration too of the difficulty of the CFP in exerting an effect on the development of fishing in non-Community mediterranean countries.

Despite the progress obtained by the CFP in assuring the sustainability of fishing from the environmental and socio-economic standpoint ,the sector appears as yet economically and socially fragile.

Fishing's environmental and economic dimensions, even if they can enter into conflict in the short term, are to be considered inseparable in any approach taking the long view that is adopted as regards the management of fish resources (*Reykjavik Declaration)* – FAO, 2001. For this reason a revision of the CFP has been started up, which has had as well a phase of consultation with the publication by the Commission in April 2009 of a Green Book for the reform of the CFP (COM(2009)163), in which are delineated the challenges that European fishing must face during the coming years.

The search for the indispensable balance between the environmental and economic dimension of fishing has startd off a revision of the PCP within a picture of an"ecosystem approach"

During 2011, by means of a series of EC communications, there was initiated the process of a proposed law for the reform of CFP, which expects the adoption and entry into force of the new law on January 1st 2013. Among the principal elements of the new proposals are identified: an action aimed at the reduction of overfishing and at assuring the productivity of fish stock; the preparation of multi-year plans designed with the principal of precaution in mind with an approach based on the ecosystem; a greater autonomy of the member states in the concrete carrying out of the measures and of the objectives assumed at the Community level; the support to small coastal fishing; a new and more effective legislative framework for aquiculture; new labelling, quality and traceability standards in support of the practices of sustainable fishing; a more modern and suitable financing instrument; a greater responsibility of the EU at the international level.

The CFP is part of the European Union's new integrated maritime policy, which calls for, as a fulcrum for carrying out the ecosystem approach, the recent framework Directive on the strategy for the marine environment (2008/56/EC) incorporated into Italian law by law no.190 of October 13th 2010, which proposes the objective of achieving a satisfactory state of the environment for European sea waters in 2020, as well as the already-mentioned habitat directive (92/43/EEC).

Numerous other initiatives, at times in the regional or local purview, are devoted to the study and the monitoring of the species and of the habitats, to restoration of the environment and to re-naturalization, to the creation of ecological networks, to the insertion of criteria of sustainability into the various production areas, to the certification of products, to environmental education.

Numerous other initiatives, at times at regional or local levels, are devoted to the study and the monitoring of species and of the habitat, to environmental restoration and to renaturalization, to the creation of ecological networks, to the insertion of susainability criteria in the area of the various production sectors, to the certification of products, to environmental education.

Among these, many have a direct or indirect relation to various initiatives that, at the local or national levels, are brought ahead by public or private agencies, by universities or other organizations. Monitoring is an important part of the conservation of biodiversity and is understood both as monitoring of the components of biodiversity, and of the categories of activity that can have negative impact on this. The Chart of Nature, born with the framework law on the natural protected areas mentioned, no. 394/1991, the monitoring networks of the agency system and the activities of reporting environmental data, such the ISPRA's yearbook of environmental data, derive directly or take part in determining fashion in the objectives tied to art. 7 of the CBD.

As an applied example one may note the indicator called "Ecological Value", which is calculated within the area of the Chart of Nature to a scale of 1:50,000. The Ecological Value is understood in its acceptance as natural value and is computed as an index for a set of indicators that can be traced back to three different groups. The first group refers to the so-called institutional values, pointed out in Community directives; the second takes into account the components of biodiversity and the third considers indicators typical of the ecology of the landscape.

The Ecological Value is important (high and very high) in 62% of the territory of the Valle D'Aosta, in 54% of the Friuli-Venezia Giiulia, in 34% of the Veneto and of the Abruzzo, in 32% of Sardinia, in 28% of Latium, in 26% of Sicily, in 20% of Umbria, in 16% of the Molise and in 14% of the Puglia, since these are the regions for which the Chart of Nature has been already completely created.

For conservation *in situ* there are envisaged, besides the institution of protected areas as brought out above, also the identification of areas in which to adopt special conservation measures. Falling within this objective are the protection measures envisaged in areas contiguous to the protected areas and the various initiatives, of which examples of considerable importance are had too in the national territory, for the formation of ecological networks, both on land and in the sea.

On the subject of the ecological network, very important for guaranteeing the ecological connectiveness between different ecosystems and territorial areas, it is interesting to verify the level of its incorporation into ordinary planning. In this regard, the response of the provincial administrations to the topic of ecological networks can be considered to be satisfactory, if it is considered that the references to the ecological network are found in 88.7% of the Provincial Territorial Coordination Plans (PTCP) in force or *in itinere*.

The Italian Network of germplasm banks for the conservation *ex situ* of spontaneous flora (RIBES) is another important initiative both for the conservation of germplasm, and for giving incentive to studies in this direction (art. 9 of the CBD). Recently, in the context of an initiative undertaken by ISPRA, together with BIOFORV (a working group for the Forest Biodiversity Nursery) and RIBES, a document was published that presents a summary of the situation of conservation *ex situ* of spontaneous species and those cultivated in Italy[64].

The document presents the state of the art of the conservation *ex situ* of the various categories of plants and for the individual sectors of research, but also brought to light are the critical points and listed are the principal actions to be taken to solve the most acute problems. Among the actions must be noted the peculiarity of the on-farm conservation, a particular type of conservation *in situ* that consists in maintaining under cultivation and stockraising the local varieties and breeds, that is, those populations of species cultivated and raised that derive from the selection made for centuries by the environment, by farmers and by stock raisers in a territory, bringing out the central role played by farms and ranches in the conservation of biodiversity.

Falling within the objective of durable use of the biological components (art. 10 of the CBD) there are, instead, the initiatives aimed at encouraging the habitual use of biological resources in conformity with compatible traditional cultural practices, carried out also through the involvement of the local populations in the design of actions for restoring biodiversity and by means of an improved cooperation between government authorities and the private sector. Important initiatives in this direction are the activation of the *Agendas 21*, the participational activites and those of access to information, the environmental certifications and the quality brands of local products that have various examples of application disseminmated at the local level throughout the nation's territory.

The Environmental Impact Assesment (EIA), the Strategic Environmental Assesment (SEA), the incidence evaluations of plans and projects, just as the investigations aimed at the evaluation of environmental damage, are actions envisaged by art. 14 of the CBD, for the purpose of evaluating and then minimizing the impacts that can harm biodiversity. Not last are the activities of research and training in the environmental field (art. 12 of the CBD) and of instruction and popularizing (art. 13 of the CBD). For these latter, in particular, the MATTM, together with the Ministry for Eduation, the University and Research, has made, with the INFEA (Information, Training and environmental Education) 1995 program for operation, a considerable effort to coordinate in order to channel the experience and the initiatives in parcels at the local level into the programs and structures at national level.

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[64] *La conservazione* ex situ *della biodiversità delle specie vegetali spontanee e coltivate in Italia. Stato dell'arte, criticità e azioni da compiere*, Piotto B., Giacanelli V., Ercole S. (A cura di), Manuali e linee guida ISPRA 54/2010.

In the forest sector is to be remarked the promotion of a series of forms of partnership and of cooperation between public and private, for the principal purpose of encouraging actions of informing, of raising consciousness and of disseminating instruments of the volunteer type, having as their aim the promotion of responsible forest management, and the development more generally, of practices marked with the social responsibility of the firm and with the countering of illegal processes. Among such instruments there are the compensatory investments made by firms that intend to counterbalance, at least partially, for example through the reconstitution of deteriorated natural areas or reforestation operations, the impacts deriving from their own business; forest certrification, both with reference to the management of forests to national scale and to the chain of custody and, therefore, to the employment of raw materials certified by companies working in the conversion of wood to paper

In the forest sector to be noted is the promotion of a series of forms of partnership and of cooperation between public and private ,for the principal purpose of encouraging actions of inforing, ,of raising consciousness and of disseminating instruments of the volunteer type.

In agriculture, after decades of rural development policies oriented toward specializaion and the intensification of agriculture, with the main objective of increasing agricultural productivity, during the nineties the Common Agricultural Policy (CAP) was directed toward the integration of the objectives of environmental policy into the agricultural policies of the market and of rural development, also to correct the environmental impacts brought about by the directions given to agriculture during the preceding years. In 2003, the medium-term reform of the CAP (Fischler reform) introduced a regimen of support to farmers no longer tied to the type of crop grown and to the amount produced, but to the exercize of agricultural activities there being assigned a “single payment per farm”. This payment was conditional on compliance with certain obligatory running criteria regarding environmental safeguarding, also defined by environmental directives concerning natural habitats, the wild flora and fauna (Birds and Habitat Directive) and the water (Nitrates, Underground waters, Purification slimes Directive), of food safety, of animals’ wellbeing, of biodiversity, as established by the Lisbon Agenda of March 2000, and in line with the interests and expectations of society. In November 2008, the Ministers of Agriculture of the EU found an agreement on the Health Check of the CAP. The Health Check, a revision of the medium-term reform started off in 2003, sets as its objective to better respond to six “new challenges”, that include climate changes, bio-energy, the management of the waters and biodiversity. Furthermore, it was also decided to increase the modulation and to transfer funds from the direct payments made to farmers and for market policies (Ist Column of the CAP) to Rural Development (IInd Column). The Health Check definitively excluded any set-aside measures.

From the medium-term reform of the CAP in 2003 and still more with the Health Check of 2008,in Italy and in the EU countries the expenditure for rural development was shifted from market measures to forms of support to farmers’ incomes, not only because of their productive role but also - especially - beause of their role played in the conservation of the landscape and the environment.

In the revision of the Community Strategic Orientations (Decision 2009/61/EC of the Council made on January 19th 2009) the objective of safeguarding biodiversity was strengthened, on the basis of which the arrest of the decline of biodiversity was identified as one of the most important Community goals to be achieved. In this direction, rural development takes on a strategic role, since the concept of biodiversity is indisputably tied to and dependent on agriculture and forest culture.

The most recent lines of action of the PAC assign a key role to the so-called High Nature Value (HNV) agriculture areas, of which Italy is especially rich..

Furthermore, the most recent lines of action of Community agriculture policy assign a key role to the so-called agriculture areas having High Nature Value, in the language of the European Commission, especially because of the aspects of conservation of biodiversity within the European agro-ecosystems. The HNV areas are those in which agriculture, conducted by having resort to low levels of outside input (fertilizers, pesticides, energy, etc.) is the prevalent form of use of the soil and where agriculture itself has custody of a large genetic variety, of species and of habitats of European concern. As already mentioned, Italy, together with Spain, Greece, northern Great Britain and Scandinavia possesses a high percentage of this peculiar type of agricultural area.

In Italy they are prevalently found in the less productive lands, where physical limitations tied to soil, topography, climate, distance, etc., have impeded the intensification of agriculture. Generally, the HNVs can be identified, among the semi-natural areas where an extensive agriculture is prevalently practiced (especially permanent meadows and pasturelands), where there exist particular habitats (eg. rice paddies) or natural elements like hedges, lines of trees, grassy bands, small woods formations and man-made items (ditches and dry stone walls).

Many regions, in the revision phase of rural development planning 2007-2013, have envisaged the use of measures for strengthening the safeguarding of biodiversity.

For this reason, in order to multiply the efforts to protect this natural and semi-natural heritage, many regions in the revision phase of the planning of rural development 2007-2013 have called for the use of a broad range of measures to strengthen the safeguarding of biodiversity.

Analysis of the financial resources allocated by the regions' Rural Development Plans, after the approval of the Health Check and of the Recovery Package, on the six "new challenges" brings out that the "biodiversity" challenge concentrates 86 million euros, 18.4% of the total; that of "Climate changes" 83 million, 17.7% of the total; that of "management of the waters" 88 million euros, 19% of the total[65]. The typologies of operations envisaged by the agro-environmental payments all have as their aim the safeguarding of genetic biodiversity, the conservation of types of vegetation with great varieties of species, the protection and maintenance of grassy formations, the protection of the birds and of other wild fauna, the improvement of the network of biotypes, the reduction of the presence of noxious substances in the surrounding habitats and the conservation of protected flora and fauna.

Furthermore, considering the close interdependence of biodiversity and climate changes, bio-energy and the management of the waters, a large part of the measures adopted by the regional plans will end up by having efficacy also in safeguarding biodiversity, although not directly addressed to it. Some examples are the operations to favour the adaptation to climate changes of the forest and agrarian ecosystems, the reconstitution of dry stone walls and of lines of

[65] Camaioni B. e Cicetti A. (2010). *La PAC di fronte alle "Nuove Sfide". Una analisi attraverso i piani finanziari dei Programmi di Sviluppo Rurale.* Agriregionieuropa 23: 1-10

trees to favour the waters coming up to regimen and erosion control, the measures for diversification of the rural economy and for support to family farms and to agritourism.

With regard to the maintenance or increase of the national size of the UAA, in international and national laws no specific objectives exist, even if the last two Programs for European action concerning the environment and *Agenda 21* pose some general objectives, such as the sustainable use of the territory, the protection of nature and of biodiversity and the maintenance of levels of productivity. These objectives are reconfirmed in the consequent theme strategies, in the legislative proposals associated with them and in numerous already-existing legislative provisions. The Community polices for the agro-environment envisage incentives for production systems having low environmental impact, such as integrated and biological agriculture, making production more extensive, the safeguarding of habitats having high naturalist value, the maintenance of biodiversity, the management of low-intensity pasturelands.

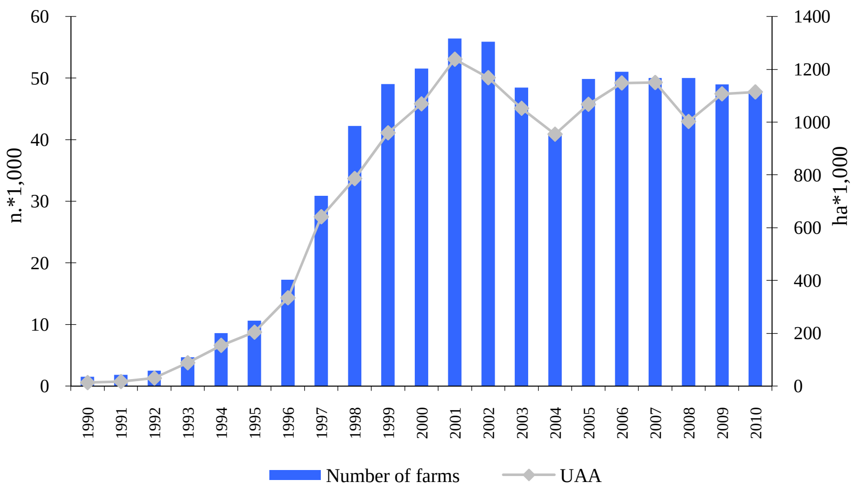
It is worthwhile pointing out that, with Ministerial decree 27417 of December 22nd 2011, since December 31st 2011 the obligation went into force to introduce buffer bands to protect watercourses. These are bands of vegetation five meters wide that limit the surface and underground flow of pollutants towards bodies of water. The standard was formulated in line with the Framework Directive on Waters and lays the bases for a possible future application of agro-environmental measures to the benefit of farms.

Quite as important are the national lines of action, oriented toward promoting generational replacement, the economic and social development of agriculture, and incentives for the recomposition of estates and farms.

Within this picture of measures and facilitations, especial attention is reserved to Italian biological agriculture (often indicated with the term "bio"),which represents a true case of success for European agriculture. At the end of 2010 the areas invested by bio and under bio conversion involved 1,113,742 hectares (+0.6% relative to 2009) or 8.6% of the nation's SAU. Fifty percent of the bio areas are in cereals, meadows, pasturelands and forage. Next come the orchards, olive in particular, grapes, citrus and fruit in general (24%).

In Italy the areas devoted to and under conversion to biological agriculture in 2010 involved1,113,742 hectares, 8.6% of the national SAU. "Bio" operators numbered 47,663.

The operators number 47,663, with a drop of 1.7% under 2009. Sicily, followed by Calabria and Puglia, has the most producers. Sicily, followed by Puglia and Basilicata, is in first place as regards biological SAU. Italy maintains within the EU its prominent position in biological products, as regards both the number of farms and the area involved, with evident benefits in terms of soils quality, carbon fixing, reduction of greenhouse gas emissions, the conservation of biodiversity and the reduction of passages into the environment of residues of pesticides and fertilizers.



In 2010 a slight increase in the land areas given over to biological agriculture was found, at the same time, however, the number of operators in this area decreased.

Figure 2.11: Evolution of the number of operators and of Utilized Agricultural Area (UAA), conducted according to the methods of biological agriculture[66]

During the decade 2000-2009, destined to the protection of biodiversity and of the landscape by public admministrations were a little more that 4000 million euros per year.

The various actions for safeguarding nature and biodiversity listed up to this point can find effective application only if supported by adequate financial resources. In this regard, the study of the data available, produced by ISTAT[67], shows that the expenditure of public administrations (for CLOFOG groups)[68] for the protection of biodiversity and of landscapes in 2009 amounted to 4978 million euros. In 2000 this expenditure was 2864 million euros with an increase, during 2000-2009, of 73.8%, confirming the attention given to the sector by public policies.

Among the responses given to the problem of the loss of biodiversity, besids direct safeguarding, a decisive role was also played by the conservative and sustainable handling of natural environments not strictly protected, both terrestrial and marine.

As has been seen up to this point the answers to the problem of the incessant loss of biodiversity and the forms of safeguarding natural and agricultural areas are various. They certainly include a growing designation of new protected areas, but also a further strengthing of the existing safeguarding instruments, with reference in particular to a greater application and spread of the controls, to the availability of greater financial resources, to confronting the emerging new problems such as, for example, the spread of allochthonous species and changes in climate.

Furthermore, a decisive role is played by the ever-greater diffusion of sustainable and conservative management even into natural environments not strictly protected, be they terrestrial or marine. Within this picture national agriculture too is of great importance, since called on to make a hard choice between the growing demand for both “conventional” and “new” products (first of all the bio-fuels) and the necessity to safeguard biodiversity and the environment, to which there can be offered, for example through bio-remediation, carbon sequestration etc., valid options for solving determinate current problems.

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[66] Source: SINAB

[67] Spending of government bodies by function, level II, Years 2000-2009

[68] *Classification Of Function Of Government*: at issue is a classification defined at the international level by the principal institutions that are concerned with national accounting.

GLOSSARY

Abiotic:

Indicates the absence of living organisms and therefore the absence of life. The term refers to the physical, chemical and physico-chemical factors that can influence the life of living organisms.

Allochthonous:

An entity imported into a geographic area not its own (non-autochthonous).

Protected marine area:

Any area in the domain of the sea, including the waters, the flora and the fauna, the historical and cultural characteristics that are preserved by law with the intention of partially or totally protecting the environment involved.

Birdlife:

Component of the bird fauna, considered in a determinate area or in a determinate period.

Bio-remediation:

Use of biological processes and agents to remedy environmental damage, caused in particular by pollution.

Bryology:

The branch of botany that studies the Bryophytes, that is, the terrestrial plants not differentiated into roots, stalk, leaves that to live need as yet an environment having high humidity (e.g. mosses and hepaticae).

Endemic:

Species having a circumscribed living area within a territory, generally one of limited extent. Native species.

Eutrophization:

An abnormal proliferation of vegetal biomass (microalghae). The term eutrophization, from the Greek *eutrophia* (eu = good, trophos = nutrient), in its origin indicated, in accordance with its etymology, a condition of wealth in nutritiional substances (nitrates and phosphates) in the aquatic environment. Today it is currently used to indicate the successive phases of the biological process consequent on such enrichment and that is the abnormal development of algae with consequences that are often deleterious for the environment.

Natural habitat:

In the meaning of the habitat Directive, they are zones, terrestrial or aquatic, that are distinguished owing to their geographic, abiotic and biotic characteristics, entirely natural or semi-natural.

Biodiversity hot-spot:

These are thirty-four places on the earth in which most of its biodiversity lives. To be qualified as a hot-spot a place must have at least 1500 native vegetals (0.5% of the planet's total) and must have undergone losses for at least 70% of the original habitat.

Ecosystem services:
These are, according to the definition of the *Millenium Ecosystem Assessment* (MA, 2005) "the multiple benefits furnished by ecosystems to humankind".

Set-aside:
In agronomy what is meant, according to Community laws, is the retirement from agricultural production of a given piece of land that is left fallow for more or less lengthy periods. For making this choice the European Community pays to the owner of the land an economic contribution.

Synanthropic species:
Animal species that live in the same environment as occupied by man (insects, birds, rats and other).

Ungulates:
A zoological group to which belong the mammals (such as horses, oxen, cows etc,.) furnished with a hoof that covers in its front the phalanxes of the fingers.

CHAPTER 3

AIR QUALITY

Introduction

The air addressed in this chapter is the air present in the lower layer of the Earth's atmosphere known as the troposphere. To be more precise, it is the air found in the lowest layer of the troposphere, in direct contact with the Earth's surface.
This air is often also called "ambient" or "*outdoor air*", to distinguish it from the air present inside the workplaces, homes and public areas (i.e. *indoor air*), which has different specifications and, in the case of the workplace, dedicated legislation[1], and is therefore not dealt with in this chapter.

Air is defined as polluted when it contains substances thatchange its natural composition.

Ambient air is defined as polluted when it contains substances that change its natural composition.
An exhaustive definition of air pollution that takes into account its effect on human health and on the environment as a whole is given in Italian DPR No. 203/88[2], as follows: "*any change in the normal composition or physical status of air, due to the presence in it of one or more substances in quantities and with characteristics such as to change the normal environmental and health-related conditions of air, and such as to constitute a direct or indirect hazard or risk for human health, to compromise the recreational use and any other legitimate use of the environment, and to alter the biological resources and ecosystems as well as public and private material goods*".
Non-polluted air cannot be easily measured because mankind, since its onset, has always released substances into the air in such quantities and of such quality as to change its original composition. The air that most resembles non-polluted air is the one found at the Earth's poles or at very high mountain altitudes, in the middle of oceans or in deserts.

Large quantities of pollutants continue to be released into the atmosphere.

The economic, industrial and demographic development of the past two centuries, together with the obvious improvement in the quality of life of human beings, has generated in-depth and rapid changes in the environment.
Enormous quantities of polluting substances coming primarily from combustion processes (transport, domestic heating, manufacturing industry, etc.) are continuously being released into the atmosphere. When the atmosphere's capacity to dilute the pollutants is exceeded by the quantity of emissions, the pollutants start accumulating and reach concentrations that are hazardous to human health and to the balance of the ecosystems.

[1] Legislative Decree No. 81 of 9 April 2008
[2] DPR 203/88 of 24 May 1988, Off. Journal No. 140 of 16 June 1988, S.O. Implementation of EEC Directives No. 80/779, No. 82/884, No. 84/360 and No. 85/203 about regulations regarding air quality, most specifically polluting agents and pollution generated by industrial plants, pursuant to art.15 of Law No. 183 of 16 April 1987

Atmospheric pollution is an extremely complex phenomenon, determined not only by the emission load resulting from anthropization, which is obviously the primary cause, but also by the chemical and physical interactions among substances present in the atmosphere and by the weather conditions, which play a key role in the dynamics of air pollutants.

Air pollution is an extremely complex phenomenon.

Over the last twenty years, the emissions of pollutants in Europe and in Italy have decreased considerably.
The quality of air, although improved (sulphur dioxide, carbon monoxide, benzene and lead today are no longer a problem except at local level and in given circumstances), continues to be an emergency due to very high levels of several pollutants that continue to be found in the atmosphere and due to the Earth's population's exposure to them.

Air pollution is an environmental emergency despite the fact that the emission of pollutants has decreased in Europe and in Italy over the last twenty years.

Atmospheric pollution is acknowledged as being one of the main environmental risk factors for human health.
At the 5th Ministerial Conference on Environment and Health that involved the 53 Member States in the WHO European Region (Parma, 2010), air pollution was listed among the core priority issues, together with greenhouse gas emissions, global heating and climate change.
The Conference's final report highlighted the fact that, in many areas of Europe, life expectancy has dropped by one year due to air pollution and that 90% of the population living in urban areas is exposed to unsafe levels of air pollution.

Air pollution is one of the main environmental risk factors for human health.

The emergency, therefore, mainly regards the large urban areas where land anthropization peaks, where pollution levels are high and where the population is more exposed to air pollutants.

The emergency especially regards large urban areas.

The pollutants that continue to be a problem in Italy and in Europe are particulate matter (PM_{10} and $PM_{2.5}$) and ozone, both acknowledged as being the greatest causes of negative effects on human health, and nitrogen dioxide (NO_2).

Particulate matter, ozone and nitrogen dioxide are the most critical pollutants.

Within this framework, the results of the air pollution Health Impact Assessment (HIA) programmes provide important assessment tools, highlighting the economic and health-related benefits deriving from sustainable development.
To achieve sustainable development the environmental and health planning and programming tools must contain and integrate multi-disciplinary competences regarding air pollution.
To this end, every effort should be made, at national level, to intensify actions such as cooperation on environmental and health issues between ISPRA and the Istituto Superiore di Sanità.

HIA provides significant health and economic assessment tools.

The realization by many Member States of the difficulties in achieving compliance with the regulatory objectives, within the attainment deadlines, has led to the possibility of applying for exemption from the obligation to apply the limit values of PM_{10}, of nitrogen dioxide and of benzene (Directive 2008/50/EC). The main reasons for which almost all Member States were unable to meet the regulatory objectives included: the increased number of vehicles, slower than expected motor vehicle fleet turnover and higher vehicle emissions, compared to the limits set out in the type-approval standards (Euro 3, 4 and 5).

Possible exemption from the application of limit values of PM_{10} and NO_2.

The transport sector, which remains one of the major causes of air pollution, especially in cities, is the target of most measures for the improvement for air quality.

The main legislative instruments for protecting air quality are Directives 2008/50/EC and 2004/107/EC, in Italy via Legislative Decree 155/2010, that pose limits to air pollutant concentrations and obligate Member States and autonomous regions/provinces to prepare air quality plans in case of non-compliance, the Gothenburg Protocol on the *Convention on Long-Range Transboundary Air Pollution* and Directive 2001/81/EC (the so-called "*National Emission Ceiling* or NEC" Directive), implemented by Legislative Decree No. 171/2004, which introduce limits to national emissions.

Main legislative instruments: Directives 2008/50/EC and 2004/107/EC, implemented in Italy via Legislative Decree 155/2010, the Gothenburg Protocol and Directive 2001/81/EC implemented in Italy via Legislative Decree 171/2004.

There are also specific regulations for the emission of principal pollutants from specific sources and sectors. Some of the main references are:

- The Directives introducing limits to vehicle emissions, including Regulations (EC) 692/2008 and 595/2009 that introduce the more recent standards (5 and 6);
- Directive 94/63/EC that regulates the emission of volatile organic components (VOC) in vehicle fuel stocking and distribution phases;
- Directive 1999/13/EC that limits VOC emission from solvents;
- Directive 1999/32/EC on the reduction of sulphur in liquid fuels;
- Directive 2003/17/EC on gasoline and diesel fuel quality;
- Directive 2010/75/EU (IPPC) that regulates industrial emissions.

The European Commission (EC) is currently conducting a revision of its thematic strategy for air quality that, in the light of the present situation (no or excessively weak signals of decrease in air pollutant concentrations, not always satisfactory effectiveness of implemented measures, emission ceilings exceeded, evidence of pollution impact on human health and on the environment), features the urgency of accelerating the air quality improvement process.

The EC is currently conducting a revision of its thematic strategy for air quality that features the urgency of accelerating the air quality improvement process.

Some of the main criteria and items on which this revision process is based are:

- Cooperation among Member States: evaluation of reasons for non-conformity, encouragement in exchange and experiences, improvement of reporting, putting in place of support activities also of a financial nature;
- PM_{10}, PM_1, micropollutants: revision of limit and objective values

and introduction, if necessary, of new limits, considering the most recent scientific evidence;

- $PM_{2.5}$: revision of limits, with the aim to define a legally binding national obligation , in the light of WHO considerations of the implementation status of the present legislative standards and of reduction potential;;
- Black carbon: recent studies and surveys call for greater attention to this component of particulate matter. Black carbon seems to be a better and more immediate indicator of traffic source than PM_{10}, of which it is a minor component and most probably one of the most toxic. It is also a *climate forcer* because, by absorbing solar radiation, it can contribute to the warming of the atmosphere. In particular, by depositing on the surface it can change the Earth's ability to reflect sunlight (albedo) and cause an acceleration in snow and ice melting.
- Introduction of new measures for reducing emissions from various sources. The focus is on limits to sulphur content in maritime fuels, vehicles and road transport, maritime and air traffic, machinery, small stationary sources, biomass combustion, agriculture;
- Emission ceilings: revision of pollutants and of national emission limits;
- Integration with issues regarding biodiversity and ecosystems, global pollution, noise, transport and energy and, in particular, synergy with policies regarding climate change. The impact that air pollution and climate change can have one on the other calls for strong synergy among respective policies, to prevent initiatives launched in favour of one from having negative effects on the other - as is occurring, for example, with the use of biomass for domestic heating that, promoted by reduction of greenhouse gas policies destined to be further boosted in the near future, features very high coefficients of particulate and benzo(a)pyrene emissions.

Particulate matter

The term 'particulate matter' (PM) denotes the solid and liquid airborne particles suspended in the air.

The term PM_{10} identifies particles with aerodynamic diameter up to 10 µm; $PM_{2.5}$ denotes fine particulate matter with a diameter up to 2.5 µm.

The chemical nature of particulate matter is especially complex and variable. It is capable of penetrating the human respiratory system, and the smaller its size the deeper its penetration, with negative consequences on human health.

Particulate is partly emitted as such (primary PM) and partly is formed in the atmosphere via chemical reactions among other species of pollutants (secondary PM).

PM has both a natural origin (erosion of rocks by wind, volcano eruptions, self-combustion of forests and woods) and an anthropic nature (forms of combustion and other sources).

Also of anthropic origin are many of the gases that contribute to the formation of PM, such as sulphur and nitrogen oxides, volatile organic compounds and ammonia.

<u>The state of the air quality: atmospheric level of particulate matter</u>

PM_{10}, 2009, Europe: the annual and daily limit values were exceeded in many Member States.

The situation in Europe of atmospheric air levels of PM_{10}, in 2009, is shown in Fig. 3.1[3].

Besides illustrating the exceedance of the annual limit value (40 µg/m^3), the map also provides information about the daily limit value (50 µg/m^3 that should not be exceeded for more than 35 times in one year) seeing that, based on the consolidated statistical analyses of the monitoring data, the daily limit value equals an annual average[4] of 31 µg/m^3.

$PM_{2.5}$, in 2009, the spatial coverage of monitoring stations in Europe is still insufficient .

Both limit values, i.e. the annual (red dots) and the daily (orange dots) have been exceeded in many Member States.

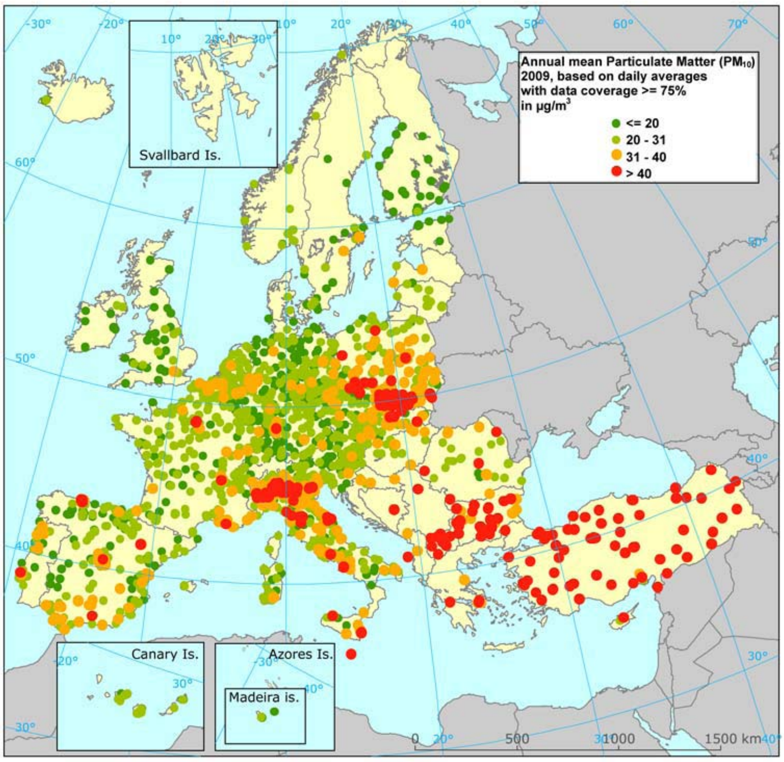
In Europe, in 2009, $PM_{2.5}$ data (there are 595 monitoring stations featuring a time coverage of at least 75% within the scope of EoI), although on the rise compared to 2008 (331) are still insufficient for accurate assessment.

PM_{10}, 1999-2009, weak downward trend in Europe.

In 1999-2009, PM_{10} in Europe showed a very weak downward trend in 83% of the stations (significant only in 42% of the stations considered).

[3] Monitoring data communicated by European member States within the framework of the *Exchange of Information* programme, Decision 97/101/EC referred to in Directive 2008/50/EC

[4] ETC/ACM, *The state of the air quality in 2009*, Technical paper 2011/1



PM_{10}, 2009, Europe: over 32% of traffic-oriented stations show exceedance of the daily limit values.

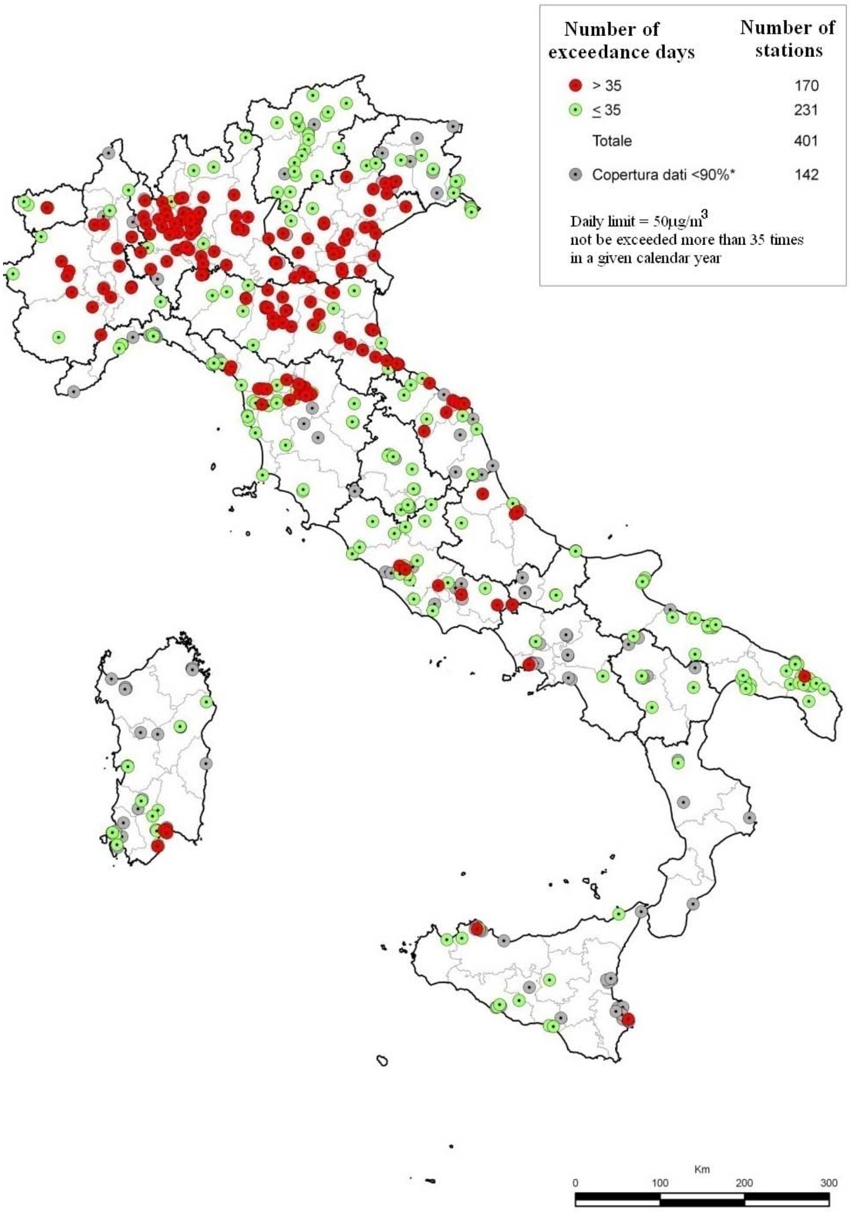
Fig. 3.1: PM_{10} – Annual mean concentration (limit value 40 µg/m³) (2009)[5]

PM_{10}, 2009, the Po Valley with the city of Milan is one of Europe's most critical areas.

As clearly seen in the map of Europe shown above, Italy is not in a very good position.
The Po Valley with the city of Milan is one of Europe's most critical areas[6], where to comply with limit values is difficult even in the event of a postponement of the deadlines set down for attainment of conformity.
The specificity of the Po Valley resides in its prevailingly adverse air pollutant dispersion characteristics, which cause rather high rural and urban background levels that are worsened by the addition of the contributions generated by traffic and other local sources.
The criticality of large Italian cities, especially those in the Po Valley, is shown in Fig. 3.2.
The daily limit value, that is more pressing than the annual one, in 2010 was exceeded in 42% of the stations.

[5] Source: ETC/ACM, *The state of the air quality in 2009*, Technical paper 2011/1.
[6] *Identification of critical areas for PM_{10} and NO_2*, Umweltbundesamt, Service Request No.3 under contract ENV.C.3/FRA/2009/2008, AEA. According to the report, the other critical areas are: Athens, Greece; Kosice, Slovak Republic; Krakow, Southern Poland, Poland; Lisbon, Portugal; London, United Kingdom; Paris, France; Sofia, Bulgaria; Stuttgart, Germany.

PM_{10}, 2010, Italy: 42% of monitoring stations shows the exceedance of daily limit values.



Legend:
*the 90% data coverage is net of data loss due to periodical calibration or ordinary maintenance

Fig. 3.2: PM_{10} – Monitoring stations and exceedance of daily limit values (2010)[7]

Fig. 3.3 shows for PM_{10} the trend from 2003 to 2010 of several descriptive statistics calculated on the annual means of a set[8] of monitoring stations distributed throughout Italy, showing weak downward trends.

In detail, one can see a clear decrease in maximum levels, especially starting from 2006, and the compacting of a large part of the data measured towards low values.

When interpreting correctly a graph of this kind, one should take into account the main role played by weather conditions and their inter-annual variability in determining pollutant concentrations and the differences that can be recorded in subsequent years.

[7] Source: ISPRA

[8] The set of stations is selected according to uniform time coverage criteria.

Consequently, in order to verify a true improvement in the quality of air it is necessary to define the trend's significance beyond inter-annual fluctuations due to variability in weather conditions.

PM_{10}: from 2003 to 2010, signs of a downward trend are observed.

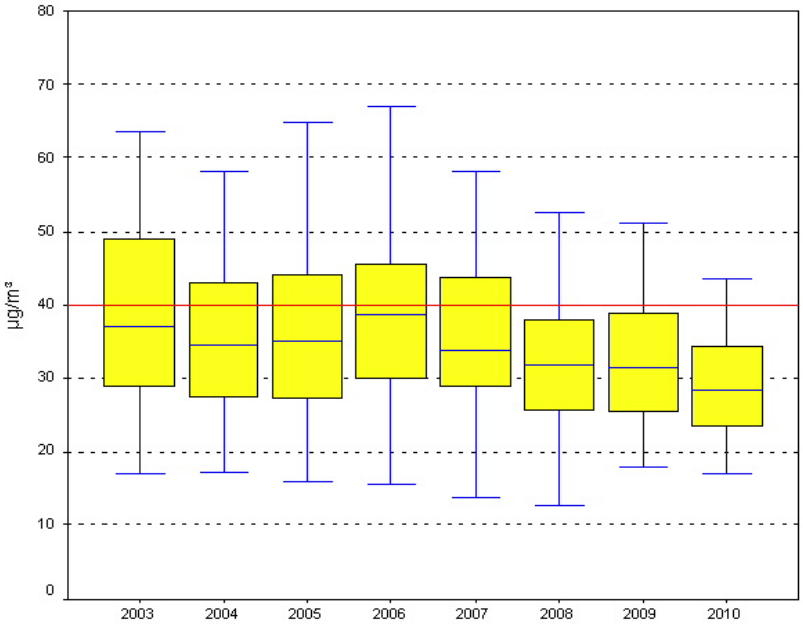


Fig. 3.3: PM_{10} – Annual mean – Descriptive statistics calculated on a selection of 56 monitoring stations distributed throughout Italy[9] [10]

Unlike the previous graph, that describes a situation illustrating the whole of Italy, Fig. 3.4 shows the trend in the number of days of exceedance recorded by several individual stations (excepted from the set used previously) located in the larger cities in Northern, Central, Southern Italy and its Islands. In this case, the downward trend recorded in all of the cities examined is clear.

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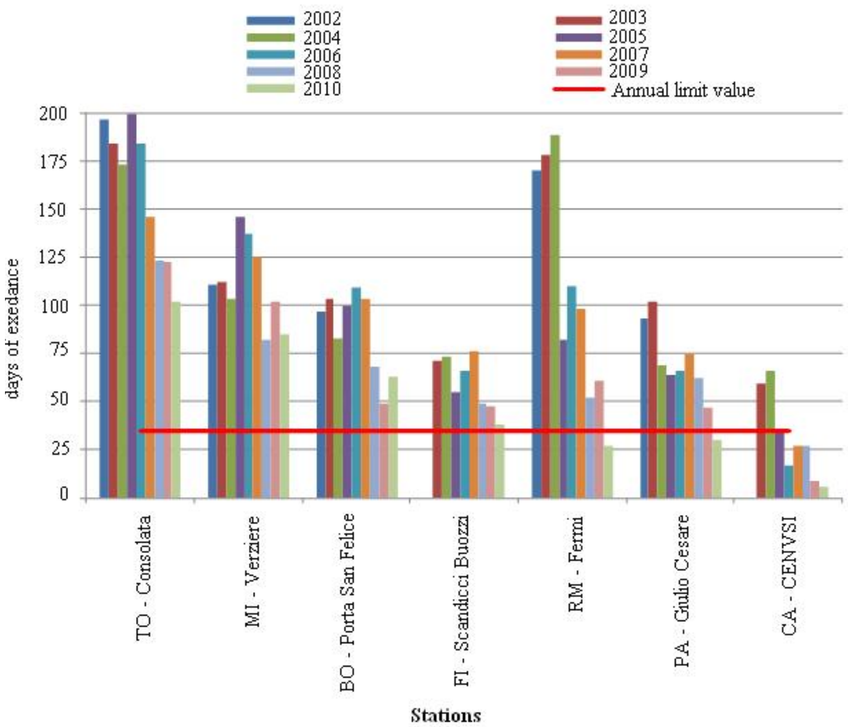
[9] Source: ISPRA

[10] The *box plot* is a compact graph method used to depict a statistical distribution. In the graph, the line inside the rectangle is the median, the top and bottom sides of the rectangle represent the first quartile (25th percentile) and the third quartile (75th percentile), respectively. The ends of the whiskers that reach out from the rectangle's borders represent the upper and the lower adjacent values, respectively. Most of the observations fall within the interval included between these two values. These data are defined as anomalous or outliers and must be analysed separately in order to assess the reasons that have caused them compared to data distribution



The downward trend observed in the cities examined is clear to see.

Fig. 3.4: PM_{10} – Trend in number of days in which limit values were exceeded in several monitoring stations

$PM_{2.5}$, Italy: information on the increase.

$PM_{2.5}$ data for 2010 (108 monitoring stations featuring an at least 75% time coverage) even if on the rise compared to 2009 (83), are still insufficient in terms of spatial coverage for accurate assessment. Anyhow, in 2010, most (82%) of the 94 stations with 90% time coverage have shown compliance with the 25 μg/m^3 objective value currently in force.

The main causes of air pollution: PM and precursor emissions

In order to comprehend air pollution, it is essential to know the emission load that is its primary cause. Regarding PM, one must consider the emissions and trends of PM and of its precursors: sulphur and nitrogen oxides (NO_x), VOC (volatile organic compounds) and ammonia.

PM, 2009, Europe: the main source of emissions was domestic heating.

In Europe, in 2009, the main source of emissions of PM_{10} and $PM_{2.5}$ was household fuel combustion (34% and 44%, respectively) followed by road transport (14% and 16%, respectively)[11].

Emissions of PM_{10}, 2009, Italy: household sector 35%, transport sector 29%.

In Italy, based on the information contained in the 2009 National Atmospheric Emissions Inventory, by ISPRA[12], the first source of PM_{10} pollution was the household sector, contributing 35% of the total, followed by the transport sector with 29% of which a little more than 2/3 came from the road transport sector, the industrial sector (16%) and agriculture (11%). In particular, about 91% of PM_{10} emissions coming from domestic heating originated from biomass combustion.

[11] EEA, *European Union emission inventory report 1990–2009 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP),* Technical report No. 9/2011

[12] http://www.sinanet.isprambiente.it/it/sinanet/serie_storiche_emissioni

As for $PM_{2.5}$, once again the household sector was the main source of emissions, with a 42% contribution, followed by the transport sector with 32% (approx. 2/3 coming from road transport), the industrial sector (12%) and the waste treatment and disposal sector (7%).

$PM_{2.5}$, 2009, Italy: the main source of emissions was domestic heating.

The key source of emissions of particulate matter precursors in Europe[13] in 2009, was transport, road transport in particular, responsible for 42% of NO_x and of 17% of non-methane volatile organic compounds (NMVOC).
The other main NO_x source of emissions were the production of electricity and district heating (17%), fuel combustion in industry (13%) and households (7%). In addition to road transport, the main sources of NMVOC were the use of solvents (40%) and the household sector (12%).
Regarding sulphur oxides (SO_x), the main source of emissions was the production of electricity and heating, amounting to approx. 52% of the total, followed by fuel combustion in industry (10%), the household sector (8%) and refinery combustion (7%).
On the other hand, 94% of ammonia (NH_3) emissions comes from agriculture, especially from non-dairy and dairy livestock and pig farms (56%), and from the use of synthetic fertilizers (20%).

PM precursors, 2009, Europe: transport was the key source of emissions for NO_x (42%); production of electricity and heating for SO_x (52%) and agriculture for NH_3 (94%).

Again, in Italy in 2009 the key source of nitrogen oxide emissions was transport (71%), slightly less than ¾ of which road transport. Industry contributes 12%, and energy production and households both contributing 8%. 41% of non-methane volatile organic compounds came from the use of solvents, 35% from transport and the remaining portion from households (11%), industry (6%) and other minor sectors.
The key sources of emission of sulphur oxides were the production of energy and heat sectors (20%), fuel combustion in industry (19%), refineries (16%) and maritime transport (16%). Regarding ammonia, the agricultural sector generated over 94% of national emissions, followed by road transport (3%) and waste management (2%).

PM precursors, 2009, Italy: transport was the main source of emissions for NO_x (71%) and NMVOC; electricity and heating production for SO_x (20%) and agriculture for NH_3(94%).

Emission trends in Europe from 1990 to 2009 dropped significantly. In the EU 27, PM_{10} and $PM_{2.5}$ emissions between 2000 and 2009 dropped by 14% and by 20%, respectively.
The most consistent reductions refer to the emissions of precursors: NO_x -44%, NMVOC -55%, SO_x -80%, NH_3 -26%.

From 1990 to 2009, in the EU 27, NO_x, COVNM, SO_x, PM_{10} and $PM_{2.5}$ and NH_3 emissions decreased.

In Italy, large reductions in the emissions of PM_{10}, SO_x, NO_x and NMVOC were recorded, especially from the mid-Nineties onward[14]. As illustrated in Fig. 3.5, as regards pollutants PM_{10} and NO_x the greatest contribution to the reduction in emissions comes from the energy sector and partly from road transport, while as regards NMVOC the sector that contributed the most in reducing emissions was road transport.

In Italy, the big reductions in PM_{10} and NO_x emissions are seen in the energy sector while those of NMVOC in road transport.

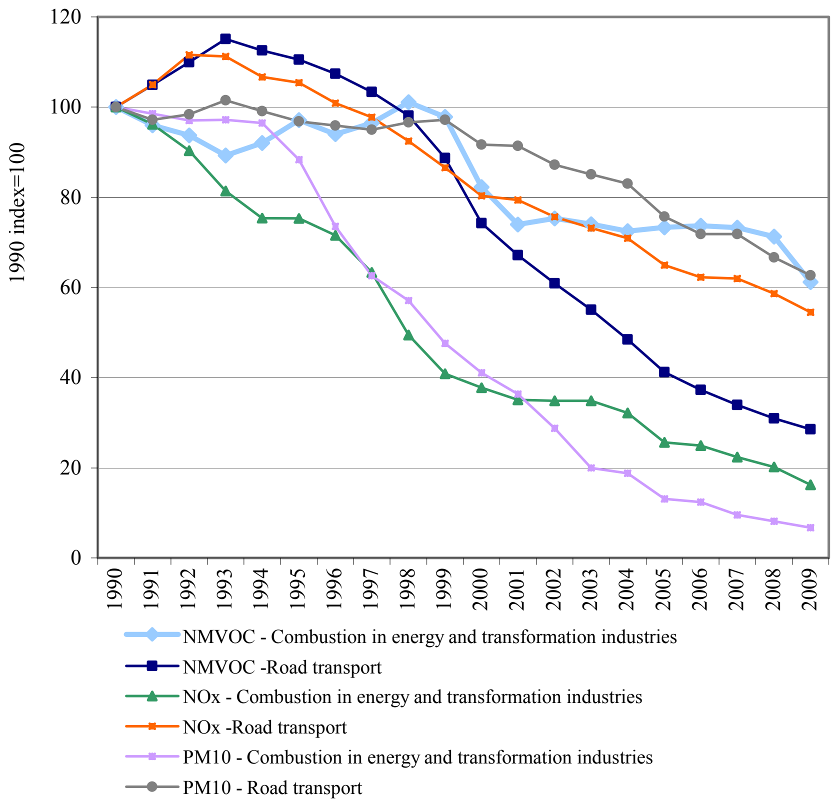
[13] EEA, *European Union emission inventory report 1990–2009 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP),* Technical report No. 9/2011
[14] http:// www.sinanet.isprambiente.it/it/sinanet/serie_storiche_emissioni

Regarding the decrease in PM_{10} emissions from road transport, the application to new vehicles of increasingly restrictive emission standards[15] was not such a decisive a factor when compared to their results on NO_x and NMVOC emissions, since the turnover seen in the car fleet featured a strong increase in diesel fuel motor vehicles that emit higher quantities of PM_{10} compared to gasoline fuel vehicles.

Motor vehicle fleet turnover was a decisive factor in reducing NO_x and NMVOC emissions.

In Italy, from 1990 to 2005 all of the regions and autonomous provinces showed a more or less significant reduction in the emissions of PM_{10} and of its precursors, based on the presence or lack of large industrial plants that in the Nineties were subjected to very severe limits on chimney stack emissions of SO_x, NO_x and PM_{10}[16].

In Italy, from 1990 to 2005, the emissions of PM_{10}, SO_x and NO_x decreased in all of the regions.



The greatest contribution to the reduction of PM_{10} and NO_x emissions comes from the energy sector, while that of NMVOC emissions comes from the road transport sector.

Fig. 3.5: National emission trends of NMVOC, NO_x and PM_{10} in the energy and road transport sectors[17]

The road transport, which in the last three decades has been the main response to the growing demand for mobility, is the sector most responsible for the very high concentrations of particulate matter. This is especially true in large cities, where population density and transportation volumes are highest. In 1990-2000, passenger transport demand increased by 2.4% annual mean (a.m.), at a rate that was higher than in the GDP increase (+1.6% a.m., measured

Road transport is the sector most responsible for high PM levels.

2000-2010:

[15] Said standards were applied in Europe starting on 1 January 1993 via Directives 91/441/EC (Euro 1) up until the EC regulation dated 7 May 2007 that introduced standards and deadlines for Euro 5 and Euro 6

[16] Min. Decree of 12/07/1990, "Guidelines for the containment of polluting emissions of industrial plants and fixing of minimum emission values"

[17] Source: ISPRA

with values linked to the reference year 2005). In the 2000-2010 period, demand remained stable while the GDP grew by 0.4% a.m.. Passenger transport demand was met mainly with the use of motor cars and motorcycles, at a rate of 80.6% in 2010, and the circulating fleet is continuously on the rise (2000-2010: +19.7%). In 2000 it amounted to approx. 82.2%. In the 2000-2010 period, the various transport modes evolved differently: rail transport demand decreased by 1.7%, car transport by 1.9%, while the demand for bus transport rose by +10.7% together with the total number of airplane landings and take-offs (51.6%).

passenger transport demand has remained stable. Private transport meets 80.6% of demand.

As for road haulage the trend of which is more directly correlated to the economic trend, in the 1990-2000 period the t-km transported over distances in excess of 50 km by national carriers increased by 1.4% a.m., at a rate slightly lower than that of the GDP; including all heavy vehicles >3.5t, the increase amounts to 2.9%. In the 2000-2010 period, the t-km transported by national carriers over distances > 50 km did not vary. If one includes foreign carriers and all heavy vehicles >3.5t, the increase amounts to 0.97%, a rate double that of the GDP.

From 2000 to 2010, goods transport, especially road haulage, increased by 0.73% annual mean (GDP +0.39%).

Despite how the various revisions in data measurement methods applied in the period considered may have impacted data coherence, the changes that have occurred in production processes (*just in time*, production delocalization/fragmentation in the EU 27) and in consumption models have certainly helped in increasing road haulage, at a rate higher than the increase in GDP, in the last few years.

In 2010, road transport (distances longer than 50 km) absorbed 63.3% of national demand, rail transport 8.4% and cabotage 23.1%. To these estimates one must add the distribution of goods (transport over distances shorter than 50 km) that occurs by road only.

The only estimate available for assessing the impact of distribution is the mileage of light vehicles, equivalent to about 3 times that of the vehicles that transport goods over distances >50km.

<u>Exemption from the obligation to apply the PM_{10} Limit Values</u>

Recognition of the fact that several Member States have particular difficulties in achieving compliance with the limit values for PM_{10} has led to the addition to Directive 2008/50/EC (art. 22) of the possibility to apply for excemption from obligation to apply the limit values for PM_{10}, (in force since 1 January 2005) to 11 June 2011.

The exemption regards individual zones or agglomerations of the Member State.

Time extensions are subject to Member State providing that *all appropriate measures at national, regional and local level* have been taken to meet the first deadline for limit values and compliance with the limit values will be achieved at the new deadline if necessary by the implementation of additional local and/or national measures.

Excemption as regards PM_{10} is possible when the exceedance of the limit values can be attributed to adverse climatic conditions, site-specific dispersion characteristics or transboundary contributions.

Table 3.1 shows, for each Member State, the number of zones in which PM_{10} limit values were exceeded and for which exemption was applied for, as well as the number of zones for which the excemption was granted. Notice that it was granted to only a very small number of zones in Europe[18].

Table 3.1: VL exceedance zones granted exemption[19]

In Europe, exemption was granted to only a very small number of zones.

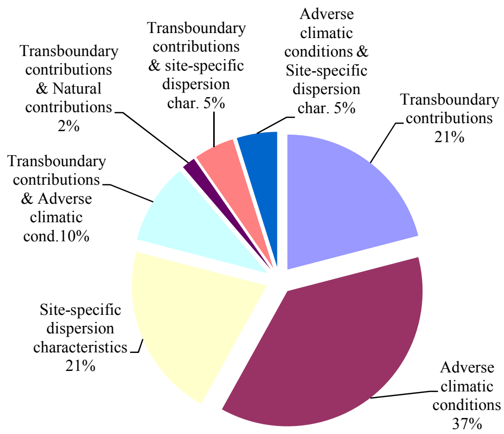
Member State	Total zones with limit value exceedance	Total zones exempted
Austria	11	7
Belgium	11	0
Bulgaria	6	0
Cyprus	1	1
Czech Republic	13	2
Denmark	3	0
Estonia	2	Exemption not requested
Finland	0	_
France	28	1
Germany	20	19
Greece	4	0
Hungary	8	7
Ireland	0	_
Italy	79	6
Lettonia	1	0
Lithuania*	2	Exemption not requested
Luxembourg	0	_
Malta	1	n.a.
Poland	91	5
Portugal	6	0
Romania	11	0
Slovakia	9	4
Slovenia	5	Exemption not requested
Spain	13	1
Sweden	2	Exemption not requested
The Netherlands	9	13
United Kingdom	9	1

Legend:
* LV exceedance was attributed to salt distribution in winter;
n.a. = data not available

In most of the zones granted exemption (37%), non-compliance with PM_{10} limit values was attributed to the persistence of adverse climatic conditions and, in decreasing order, to transboundary pollution (21%) and site-specific dispersion characteristics (21%) (Fig. 3.6a).
Details regarding single Member States (Fig. 3.6b), show that Italy has indicated as causes for non-compliance in the zones granted exemption the persistence of adverse climatic conditions, site-

[18] Bonanni P., Cusano M.C., De Santis A., Sarti C., 2011. *PM_{10} - Deroga all'applicazione dei valori limite.* ISPRA Reports 145/2011
[19] Source: ISPRA processing of data available on 13/04/2012 at the website http://ec.Europe.eu/environment/air/quality/legislation/time_extensions.htm

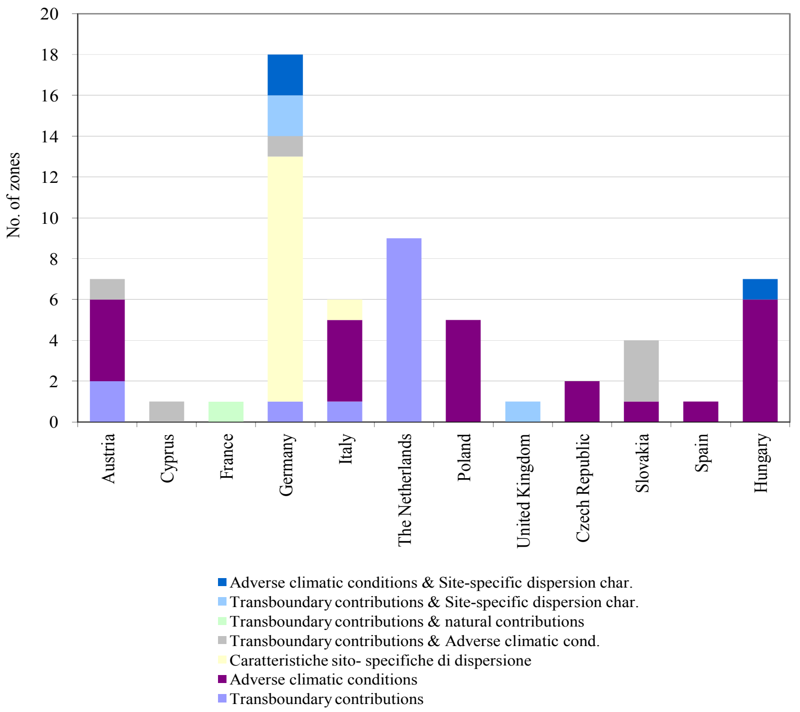
specific dispersion characteristics and transboundary contributions.



In most of the zones granted exemption (37%), the exceedance of PM_{10} limit values was attributed to the persistence of adverse climatic conditions.

Fig. 3.6a: Causes for exceedance of the PM_{10} limit values by zone granted exemption[20]

[20] Source ISPRA processing of data available on 13/04/2012 at the website http://ec.Europe.eu/environment/air/quality/legislation/time_extensions.htm



In the zones granted exemption in Italy too, the exceedance of PM_{10} limit values was attributed to the persistence of adverse climatic conditions, to site-specific dispersion characteristics and to transboundary contributions.

Fig. 3.6b: Causes for exceedance of PM_{10} limit values by Member State [21]

The fact that almost all Member States were unable to comply within the deadlines the limit values set for PM_{10} shows that the policies implemented at both European and national levels have failed to produce the expected results. Some of the main reasons that impeded compliance with the limit values set for PM_{10}[22] are: the increase in transport volume, the slower turnover of vehicles fleet, the difference between the vehicle emissions measured during normal driving conditions on the road and the limits prescribed by type approval standards for Euro 3, 4 and 5. Another element that has prevented with limit values compliance is the lack of integration between air pollution and climate changes policies. An example of this is the use of biomasses as fuel promoted for the reduction of greenhouse gas emissions that instead is a significant source of primary PM_{10}.

Italy obtained exemption for only 6 out of 79 zones it applied for.

As already illustrated in Table 3.1, Italy obtained exemption for only 6 out of the 79 zones it applied for.
Fig. 3.7 shows the Italian municipalities involved in PM_{10} limit value exceedance in 2005 (year of coming into force of the new limits) while Fig. 3.8 shows the 6 zones (located in Valle d'Aosta, Umbria, Marche, Lazio and Campania) granted exemption from the obligation to comply with PM_{10} limit values. The total surface area represented by these 6 zones amounts to about 3% of the surface area showing exceedance.

[21] *Ibidem*
[22] *Commission staff working paper on the implementation of EU Air Quality Policy and preparing for its comprehensive review*, SEC (2011) 342

Municipalities involved by the exceedances.

Fig. 3.7: Italian municipalities in which exceedance of PM_{10} limit values was recorded (2005)[23]

The 6 zones granted exemption are located in the Valle d'Aosta, Umbria, Marche, Lazio and Campania regions.

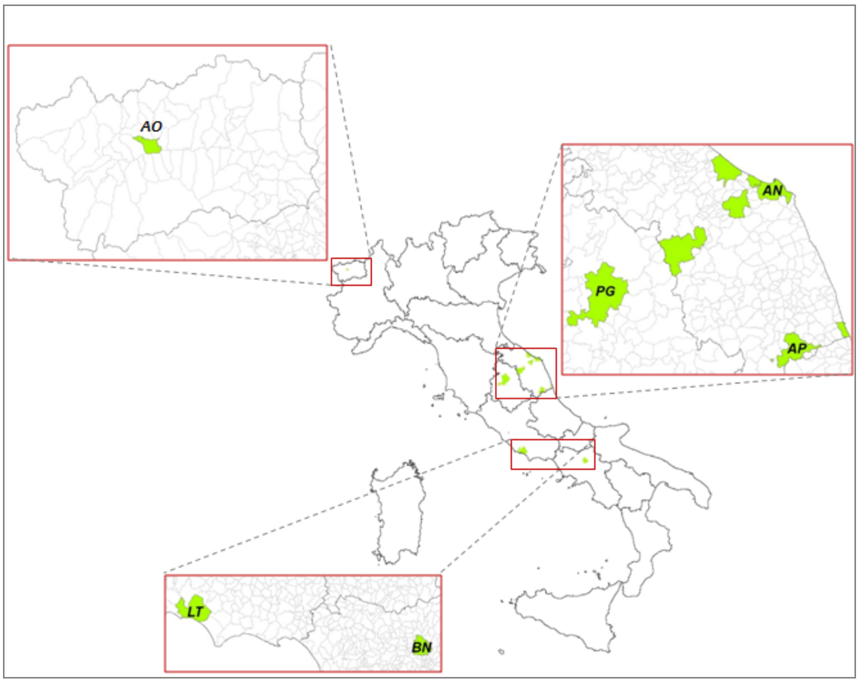


Fig. 3.8: Zones granted exemption from the obligation to apply PM_{10} limit values[24]

[23] Source: Data processed by the ISPRA and received from the regions and autonomous provinces

[24] Source: ISPRA processing of data available on 13/04/2012 at the website http://ec.Europe.eu/environment/air/quality/legislation/time_extensions.htm

In order to prepare the notification of exemption, it was necessary to carry out a set of assessments, including the identification of the sources of pollution contributing to exceedance and the estimate of the concentrations envisaged at the new deadline with and without the application of additional measures, that involved the cooperation of regional and national administrators and experts.
Here below are the results of these evaluations, provided by Italy to the European Commission according to the established notification procedure[25].
Fig. 3.9 shows the estimates[26] of transboundary, national and natural contributions, at regional background level[27] of PM_{10} used by the regions within the framework of regional planning of remediation policies and of the application for exemption (items Other and Natural[28] have been excerpted from the national contribution data).

Estimate of transboundary, national and natural contributions to PM_{10} levels.

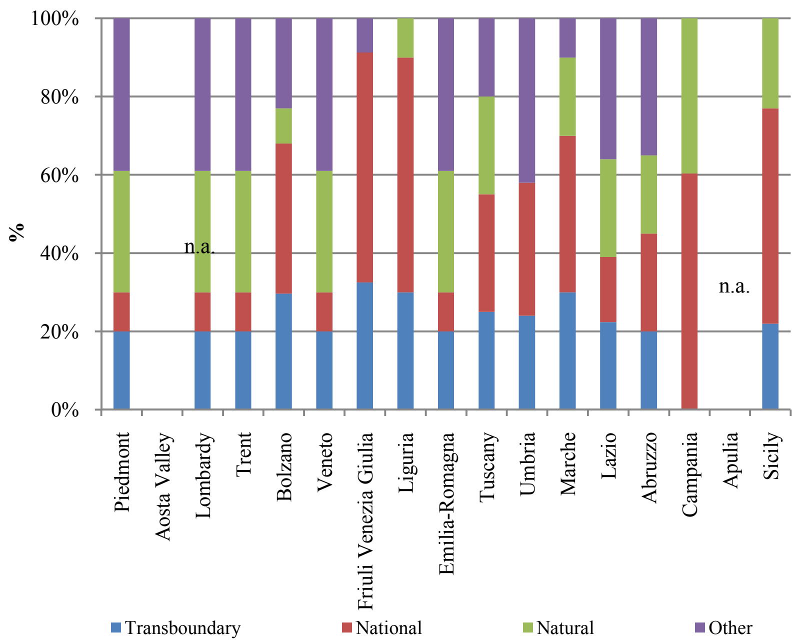


Fig. 3.9: National and natural transboundary contributions to PM_{10} concentrations[29]

[25] Staff working paper accompanying the communication from the Commission on notifications of postponements or attainment deadlines and exemptions from the obligation to apply certain limit values pursuant to article 22 of directive 2008/50/EC on ambient air quality and cleaner air for Europe (COM(2008)403final)
[26] This estimate was made using the modelling system designed by ENEA on a commission by the Ministry of the Environment within the framework of the MINNI (National Integrated Model) supporting the International Negotiation on Atmospheric Pollution
[27] The regional background level is the level estimated to occur in the absence of source of emissionss within a radius of approx. 30 km. For locations in a city, this would be the background level in the absence of the city. (*Notes on the Form 3A _staff working paper accompanying the Bruxelles*, 26/06/2008 SEC(2008) 2132)
[28] Pursuant to Directive 2008/50/EC (art. 20), where the Member State has given adequate evidence that exceedance of limit values for a given pollutant is attributable to natural sources, that exceedance shall not be considered as an exceedance for the purposes of that Directive
[29] Source: Data processed by the ISPRA and received from the regions and autonomous provinces

The contributions of the various sectors[30] to urban background levels[31] of PM_{10}, shown in Fig. 3.10, clearly illustrate the impact at city level of transports, of industry and of the commercial and residential sources, all of which on mean contribute by 75% to the total regional emissions of PM_{10}.

Estimate of contributions to PM_{10} levels by the various emission sectors.

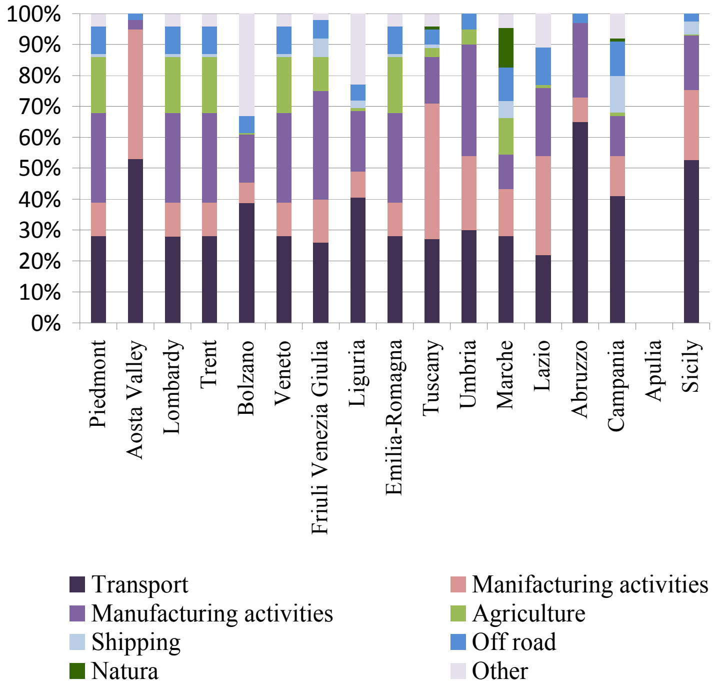


Fig. 3.10: Urban scale contributions to PM_{10} concentrations per sector[32]

Besides the measures envisaged in the air quality plans, Italian regions and autonomous provinces were obliged to identify a set of additional measures aimed at attaining the PM_{10} limit values by the new deadline. Fig. 3.11 shows the distribution by sector of such additional measures.

[30] The regions and autonomous provinces have used the data coming from the regional logs of emissions relating to 2005 for PM10 (lacking a regional log, the National log by ISPRA, disaggregated at provincial level and relating to the year 2005, was used) and to 2010 for NO_2.
[31] The total (urban) background level, that includes the regional background level, is the level estimated to occur in the absence of local sources
[32] Source: Data processed by the ISPRA and received from the regions and autonomous provinces

Most of the measures identified for attaining PM_{10} limit values concern the transport sector.

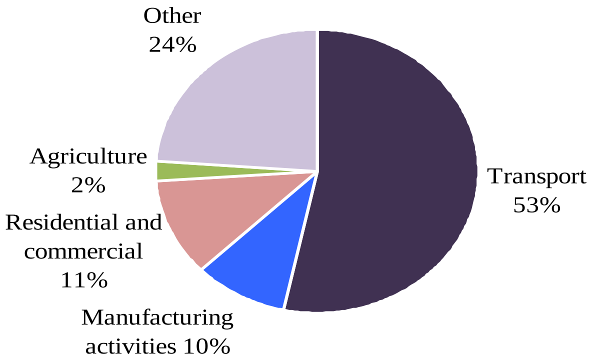


Fig. 3.11: Distribution by sector of the additional measures envisaged for attaining PM_{10} limit values[33]

Most of the additional measures, such as the measures envisaged in the air quality plans, involved the transport sector (promotion and diffusion of low environmental impact public and private means of transportation and actions in favour of alternative mobility). The details according to region are shown in Fig. 3.12.

Analysis of the additional measures at regional level shows the prevalence of actions regarding the transport sector.

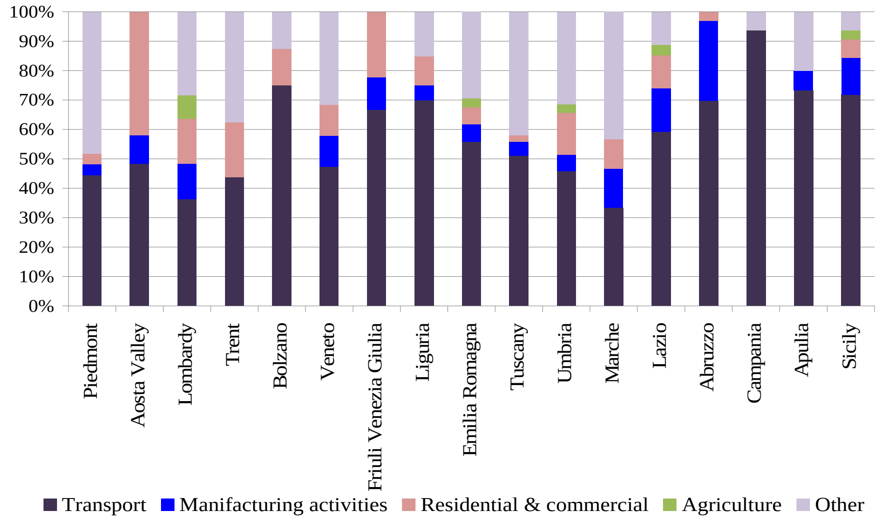
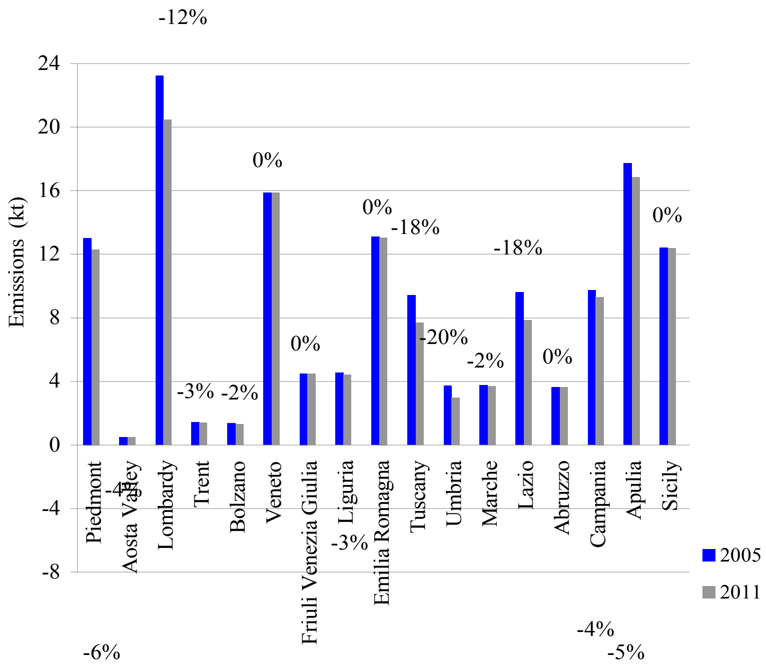


Fig. 3.12: Distribution by sector of the remediation measures envisaged, per region/autonomous province[34]

The reduction in PM_{10} emissions forecast for 2011 compared to 2005 as a result of the implementation of these measures is shown in Fig. 3.13.

[33] *Ibidem*

[34] Source: Data processed by the ISPRA and received from the regions and autonomous provinces



Estimate of the reduction in PM_{10} emissions forecast for 2011.

Fig. 3.13: Estimate of the reduction in PM_{10} emissions forcast by 2011[35]

[35] *Ibidem*

The impact on human health

WHO, 2006: cutting the annual average atmospheric levels of PM_{10} from 70 to 20 $\mu g/m^3$ (or of $PM_{2.5}$ from 35 to 10 $\mu g/m^3$) would make it possible to reduce the number of deaths from air pollution by 15%.

A great deal of scientific evidence on the effects of air pollution on human health has been collected in recent years. Numerous epidemiological studies have documented the broad range of acute and chronic outcomes, ranging from respiratory symptoms to cardiological, respiratory and cancer-related morbidity and mortality. The effects on human health are also consistently observed in relation to the levels of concentration of pollutants to which urban populations are exposed in various developed and developing countries worldwide. At the same time, the results of numerous clinical and toxicological studies have provided significant information on the possible mechanisms by means of which the pollutants carry out their effects on human health, strengthening the biological plausibility of the associations observed at the epidemiological level.

The growing availability and wealth of information on the levels of environmental contaminants, on human exposure estimates, on health data and the exposure-response relations for associations of interest, enables the quantification of a considerable health impact. This is hardly surprising, considering the enormously widespread nature of air pollution and the size of the population exposed to it. The World Health Organization (WHO)[36] had already highlighted, in 2006, that cutting the annual average atmospheric levels of PM_{10} from 70 to 20 $\mu g/m^3$ (or of $PM_{2.5}$ from 35 to 10 $\mu g/m^3$) would make it possible to cut the number of deaths for air pollution by 15% (Table 3.2).

Table 3.2: Objective and intermediate values for particulate matter (annual mean levels) set out in the WHO guidelines on air quality[37]

	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	Rationale for choice of level
Intermediate objective 1	70	35	These levels are associated to a increased risk of long-term mortality about 15% higher than the WHO-AQG objective values
Intermediate objective 2	50	25	In addition to the other health benefits, these levels reduce the risk of premature mortality by about 6% (2-11%) compared to the intermediate objective 1
Intermediate objective 3	30	15	In addition to the other health benefits, these levels reduce the risk of premature mortality by about 6% (2-11%) compared to the intermediate objective 2
WHO-AQG objective values	20	10	

[36] WHO-AQG, 2006, *WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide Global update 2005*. WHO Press, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland © World Health Organization 2006

[37] Source: WHO-AQG, 2006

Atmospheric air pollution, therefore, is one of the principal environmental risk factors of anthropic origin and is important, healthwise, for the toxicity of many of its constituents and because it is widespread at local, regional and planetary level.
Due to the large number of people exposed to airborne pollutants, especially in urban environments, its health impact can be high, even when the risk of any specific effects on human health setting on are rather limited.
Therefore, the "health impact" of airborne pollutants means the proportion of effects (respiratory symptoms, mortality/morbidity events) observed in the population of a certain area, which could be prevented if the current levels of the pollutant were reduced to a *reference level* (e.g. 20 µg/m^3 in the case of PM_{10}, the 10% reduction of the mean concentrations of PM_{10} in a city).

Atmospheric pollution is one of the principal environmental risk factors of anthropic origin.
The "health impact" of airborne pollutants means the proportion of effects observed in the population of a certain area, which could be prevented if the current levels of the pollutant were reduced to a reference level.

Among the pollutants of human health interest PM_{10} and $PM_{2.5}$ (the others are carbon monoxide, nitrogen dioxide and ozone) represent the most widely employed summary indicators for estimating the health impact of air pollution, because they are closely related to many other gas compounds and are still included among the pollutants most frequently associated with a long series of health outcomes, ranging from acute respiratory symptoms to mortality due to chronic effects.
These associations are, in all likelihood, also due to the specific chemical composition of particulate matter, which can contain both organic and inorganic substances, such as polycyclic aromatic hydrocarbons (PAHs) and metals, the physico-chemical, toxicological and, at times, carcinogenic properties of which make it particularly hazardous for human health.

PM_{10} and $PM_{2.5}$ are among the pollutants most frequently associated with a long series of health outcomes.

In 2002, the WHO[38], acting on the mandate of the Ministry of the Environment, estimated for the first time the health impact of air pollution on the population of the 8 largest cities in Italy (about 8 million inhabitants), based on the data collected by the urban monitoring stations in 1998-1999.
Using PM_{10} as the reference pollutant, the study estimated that approx. 3,500 deaths and 31,000 cases of infant chronic bronchitis could have been prevented, if the annual mean concentrations of PM_{10} had not exceeded 30 µg/m^3, when, on the contrary, the population-weighted mean value of PM_{10} was 52.6 µg/m^3.

In 1998-1999, in 8 Italian cities, the WHO estimated that the number of deaths and cases of infant chronic bronchitis could have been reduced if the annual mean value of PM_{10} had not exceeded 30 µg/m^3.

[38] Martuzzi M, Galassi C, Ostro B, Forastiere F, Bertollini R. (2002). *Health impact assessment of air pollution in the eight major Italian cities*. Copenhagen, WHO Regional Office for Europe, (EURO/02/5040650)

An update to the previous study was conducted on 2006[39] in 13 major Italian cities, with a total population of about 9 million, equal to 16% of the entire population of the country. The survey was based on the monitoring data collected in 2002–2004, with a population-weighted mean value – in the 13 cities – of 45.3 µg/m³.
The study estimated that compliance alone with the annual mean concentration of 40 µg/m³ for PM_{10}, set out in the 1999 directive, could have cut deaths from PM_{10} by 3,321, besides cutting hospital admissions for acute bronchitis in children aged below 15 by 9.5%.
With a reference value of 20 µg/m³, the quantified effects were higher, with a mean value of 8,220 deaths per year from concentrations of PM_{10} in excess of 20 µg/m³.
This estimate amounts to 9% of the mortality rate for all causes, except accidents, in the population aged over 30.
The long-term impact on mortality also included lung cancer (742 cases per year), heart attacks (2,562 cases per year) and strokes (329 cases per year).
With regard to short-term effects (within one week after exposure), the impact of PM_{10} above 20 µg/m³ produced 1,372 deaths, equal to 1.5% of the mortality rate of the entire Italian population.

Between 2002 and 2004, in 13 Italian cities, the WHO estimated that an annual mean value of 40 µg/m³ of PM_{10}, could have reduced the number of deaths by 3,321.

According to a study by the ISPRA aimed at assessing exposure to PM_{10} in several Italian cities, the percentage of population exposed to concentrations below the annual limit value (40 µg/m³) rose from 66% in 2006 to 83% in 2009, achieving 100% in 2010.
Taking into account the objective value recommended by the WHO guidelines for air quality (20 µg/m³), about 91% of the surveyed population was nevertheless exposed to higher levels.
Based on the results of the survey (about 44% of the surveyed population was exposed to concentrations in excess of 30 µg/m³), it can be estimated that about 40% of the population is exposed to concentrations in excess of the daily limit value.
The trends of exposure to PM_{10} for the population aged below 20 are similar to those for the entire population[40].

According to a study by the ISPRA, conducted in several Italian cities, almost the entire surveyed population was exposed, in 2010, to levels in excess of 20 µg/m³ (the objective value recommended by the WHO).

At European level, the EU's Clean Air for Europe (CAFE) program has estimated about 348,000 premature deaths, in 2000, due to the human-caused emissions of primary particulate matter and its precursors[41].
The study, converting the concentration values of PM_{10} and of the total suspended particulates (TSP) in the metrics of $PM_{2.5}$, has estimated, for 2000, a loss of 9 months of life due to fine particulate matter in Italy (compared to a loss of 8.6 months in Europe).
The estimates show, moreover, that if the policies envisaged by the European Community to reduce PM emissions had been implemented, by 2020 3.2 months of life for each European citizen,

The CAFE program has estimated about 348,000 premature deaths, in 2000, due to the human-caused emissions of primary particulate matter and its precursors.

[39] Martuzzi M. Mitis F. Iavarone I. Serinelli M., *Health impact of PM_{10} and ozone in 13 Italian cities*, World Health Organization-Regional Office for Europe. Copenhagen 2006. Disponibile presso: www.euro.who.int/document/e88700.pdf
[40] For more detailed and in-depth information about the study: ISPRA, Environmental Data Yearbook, Chapter on the Environment and Well-being, ed. 2011
[41] Amann M. et al. (2005). *Baseline Scenarios for the Clean Air for Europe (CAFE) Programme*

and 3.4 months for each Italian, could be saved.
This would make it possible to save 80,000 premature deaths and over a million years of life in the EU, which in Italy would translate into about 12,000 premature deaths less and 170,000 years of life more.

The implementation of emissions reduction policies would lead to important economic savings.
In the EU it has been estimated that preventing premature mortality would lead to savings of between 58 and 161 bn euros, while reducing diseases caused by airborne particulate matter would lead to savings of about 29 bn euros per year.
In Italy, the savings would be between 9 and 23 bn euros and up to 5 bn euros per year, respectively[42].

In 2009, in the European Union countries, about 20% of the urban population was exposed to levels in excess of the daily limit value for PM_{10}.
In 1997-2008, the percentage of urban population exposed varied between 18 and 49%, while as regards the value referred to in the WHO guidelines (20 μg/m^3), the percentage of exposure rose in the same period to 80-90%[43].
In particular, in 2005 it has been estimated[44] that about 28% of the European population was exposed, for more than 35 days, to concentrations of PM_{10} in excess of 50 μg/m^3.
The probability of exceeding the daily limit value of 50 μg/m^3 is higher than 75% in the Eastern European countries and in the entire Po Valley, while it ranges between 50 and 75% in the urbanized areas of Spain, Portugal, Greece, Italy, certain Balkan countries, Belgium and the Netherlands.
Overall, in the European Union countries an average of 830 premature deaths per million population has been estimated, which corresponds to a total of 373,000 premature deaths.
Two recent Europewide health impact assessment programs – the results of which were made available in 2011 – in which Italy too has participated, are the APHEKOM project (Improving Knowledge and Communication for Decision Making on Air Pollution and Health in Europe)[45] and the EBoDE project (Environmental Burden of Disease in European countries)[46].

In 2009, in the European Union countries, about 20% of the urban population was exposed to levels in excess of the daily limit value for PM10.
In 1997-2008, the percentage of urban population exposed varied between 18 and 49%, while as regards the value referred to in the WHO guidelines (20 μg/m3), the percentage of exposure rose in the same period to 80-90%.

[42] WHO, EURO/08/05 press release. Italy could save up to 28 bn euros per year by reducing the number of deaths due to air pollution. Berlin, Copenhagen, Rome, 22 June 2005.
[43] EEA, *Air quality in Europe – 2011 report*, Technical report 12/2011
[44] EEA, 2009, Spatial assessment of PM_{10} and ozone concentrations in Europe (2005). EEA Technical report 1/2009
[45] APHEKOM, 2011, - *Improving Knowledge and Communication for Decision Making on Air Pollution and Health in Europe* - www.aphekom.org. Summary report of the Aphekom project 2008-2011 (disponibile presso: http://www.invs.sante.fr/presse/2011/communiques/cp_aphekom_010311/Aphekom_summary_report.pdf)
[46] EBoDE, 2011, *Environmental Burden of Disease in European Region*. Jantunen M, Kollanus V, Leino O et al., 2011. *European perspectives on Environmental Burden of Disease: Estimates for nine stressors in six countries*. THL Reports 1/2011, Helsinki, Finland. 86 pp + 2 appendixes. - http://en.opasnet.org/w/Ebode (disponibile presso: http://www.thl.fi/thl-client/pdfs/b75f6999-e7c4-4550-a939-3bccb19e41c1)

These projects have highlighted the high economic and health impact of human exposure to airborne contaminants.

The APHEKOM study (25 large European cities) has shown how compliance with the WHO air quality values for PM10 would reduce hospital admissions for heart diseases, respiratory conditions and would also prevent many premature deaths.

The APHEKOM study, which covered 25 large cities, for a total population of about 39 million, using the Health Impact Assessment (HIA) method, has shown how compliance with the air quality guideline values proposed by the WHO for PM_{10} (20 $\mu g/m^3$ as the annual mean value) would prevent over 2,500 hospital admissions for heart diseases, over 5,300 for respiratory conditions and would also prevent 2,200 premature deaths.

The reduction of up to 10 $\mu g/m^3$ in the concentration of $PM_{2.5}$ (annual mean level of the WHO guidelines) would also increase life expectancy by 22 months, in the case of people aged over 30, preventing about 19,000 deaths per year, of which 15,000 alone for heart conditions.

Compliance with the WHO guideline values would also entail considerable economic benefits. In Rome, an annual mean concentration of $PM_{2.5}$ of 10 $\mu g/m^3$ would prevent 1,278 deaths, increasing by a year the life expectancy of 30-year-olds and ensuring economic benefits for over 2 bn euros.

Economically, the overall benefits from compliance with the WHO guideline values would amount to about 31.5 bn euros per year, including the savings in healthcare and days away from work, along with intangible costs such as well-being and the quality of life.

Regarding the Italian situation, if in a city like Rome, for example, the annual mean concentration of $PM_{2.5}$ were reduced to 10 $\mu g/m^3$, it would be possible to prevent 1,278 deaths (of which 997 for heart diseases) and the 30-year old population would gain a year of life, with an overall economic benefit in excess of 2 bn euros.

According to a further impact estimate, calculated within the framework of the APHEKOM study, for 10 European cities, living nearby a highly-trafficked road could be responsible for 15% of the cases of asthma in children and, probably, for the same – or a higher – percentage of other common chronic ailments in over-65-year olds, such as coronary or lung conditions.

In Rome, 23% of residents live at less than 75 metres from a highly-trafficked street.

In Rome, 23% of residents live at less than 75 metres from a highly-trafficked street. The results of the study show that 11% of the cases of aggravated asthma in children, 18% of acute problems in elderly people affected by chronic obstructive bronchopneumopathies (COBP) and 23% of acute problems in the elderly suffering from coronary diseases can be attributed to heavy pollution in the neighbourhood in which they live.

The process for estimating the Environmental Burden of Disease, (EBD)[47], developed within the framework of the European EboDE project, is part of the HIA activities.
The aims of the project are to update the prior EBD studies, related to exposure to environmental pollutants, identifying certain more significant contaminants for the European region and to introduce a harmonized method, among the participating countries, for estimating the burden of disease, so that it can be made available and foster the future inclusion of other countries.
The project involved 6 countries (Belgium, Finland, France, Germany, Italy and the Netherlands) and 9 risk factors (indoor benzene, passive smoking, formaldehyde, blood lead and dioxins, noise, radon, ozone and airborne particulate matter), selected based on their relevance for public health, the associated potential high risk, the degree of attention and/or possible high impact in economic terms.

The results of the European EboDE project reveal that the $PM_{2.5}$ risk factor is associated with the highest health burden.

The results show that $PM_{2.5}$ is associated with the highest health burden (followed by passive smoking, noise and radon).
Assuming the 2005 environmental data as a benchmark, $PM_{2.5}$ can be held responsible for the loss of between 6,000 and 10,000 healthy life years per million population per year, in the 6 participant countries, with an estimated 9,000 years lost in Italy.
The burden of disease includes a broad spectrum of effects, from mortality for heart-lung diseases and lung cancer to chronic bronchitis (BPCO) and reduced activity days (Rad).

Ozone

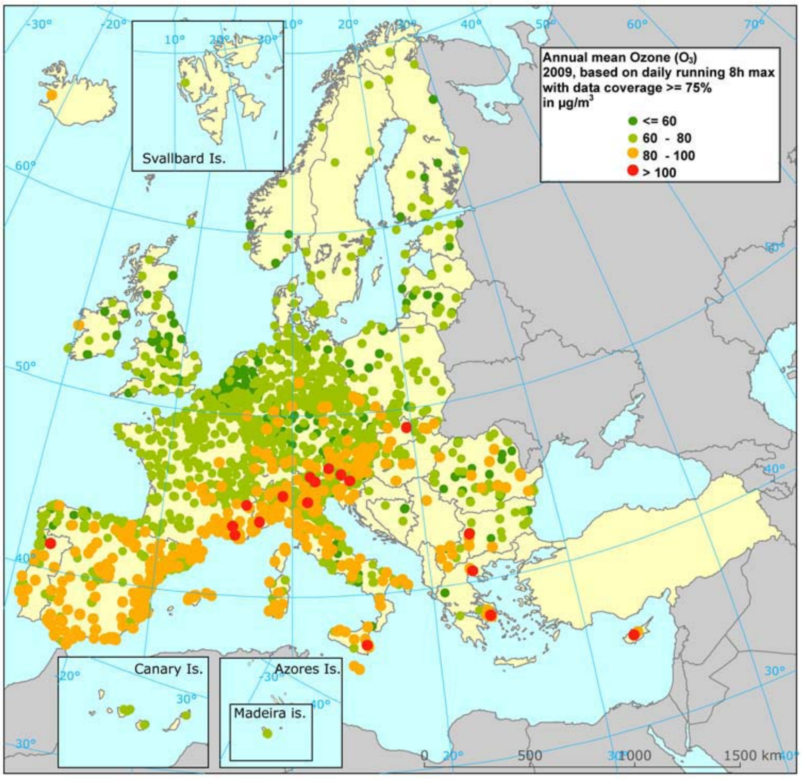
Tropospheric ozone (O_3)[48] is a secondary pollutant that forms by means of photochemical processes in the presence of primary pollutants, such as nitrogen oxides and volatile organic compounds (VOCs). It is the principal representative of the complex mix of substances called "photochemical smog".
Photochemical pollution, is both a local and a transboundary phenomenon, which can cover enormous areas.
The highest concentrations of ozone occur in the warmest months of the year and during maximum solar radiation.
In built-up areas ozone can form and transform quite rapidly, with a complex behavior that differs greatly from that of the other pollutants.
The principal source of emissions of ozone precursors are: road

[47] L'*Environmental Burden of Disease* (EBD) viene adottato per quantificare il ruolo dei fattori ambientali come determinanti dello stato di salute delle popolazioni e per orientare le azioni di sanità pubblica in campo ambientale.
L'WHO nell'ambito del Programma di stima dell'impatto dell'ambiente sulla salute umana ha predisposto linee guida *ad hoc* e ha calcolato l'EBD per molteplici fattori di rischio (http://www.who.int/quantifying_ehimpacts/en/). L'EBD è uno strumento che consente di confrontare con la stessa unità di misura il peso di effetti sanitari diversi, associati a molteplici fattori ambientali, in popolazioni diverse. L'EBD è infatti stimato attraverso un parametro, il DALY (*Disability Adjusted Life Years)*, che prescinde dal tipo di effetto studiato e dal determinante ambientale, in quanto misura gli anni di *vita sana* persi a causa di diverse condizioni patologiche per specifici livelli di esposizione. Il DALY unisce due indicatori: gli anni di vita persi a causa di morte prematura e gli anni vissuti con disabilità. Un DALY equivale a un anno di *vita sana* perso
[48] Tropospheric ozone is a pollutant present in the atmosphere, which should not be confused with stratospheric ozone, which is a natural component of the stratosphere

transport, domestic heating and energy production. Ozone can cause serious problems to human health and to the ecosystem, as well as to agriculture and material goods.

The state of the air quality: atmospheric ozone levels

Figure 3.14, which describes the atmospheric ozone levels in Europe updated to 2009[49], clearly shows a North-South gradient, with the highest concentrations in the Mediterranean countries. Unlike the other pollutants, the highest concentrations of ozone are generally recorded at rural stations[50], and at high-altitude stations.



Ozone, 2009, in Europe: the highest concentrations are found in the Mediterranean countries.

Figure 3.14: O_3 – Annual mean value based on the 8-hour maximum daily mean ozone concentration (2009)[51]

No significant trends can be observed, in Europe, with respect to ozone concentrations.

The long-term objective value for ozone for the protection of human health (120 µg/m^3), which is the regulatory value that best describes time-averaged pollution and population exposure situations, in summer 2011 (from April to September included) was exceeded at the majority of stations: only in 8% of the stations (26 out of 322 that supplied information for at least five summer months out of six) the objective value was not exceeded (Figure 3.15).

[49] Monitoring data delivered by the European countries, as part of the *Exchange of Information*, Decision 97/101/EC referred to in Directive 2008/50/EC

[50] In the urban and traffic stations, the ozone is chemically consumed by the NO_x emitted nearby

[51] Source: ETC/ACM, *The state of the air quality in 2009*, Technical paper 2011/1

Ozone concentrations, in summer 2011, Italy: 92% of the monitoring stations exceed the long-term objective value. The most critical situation is in the North.

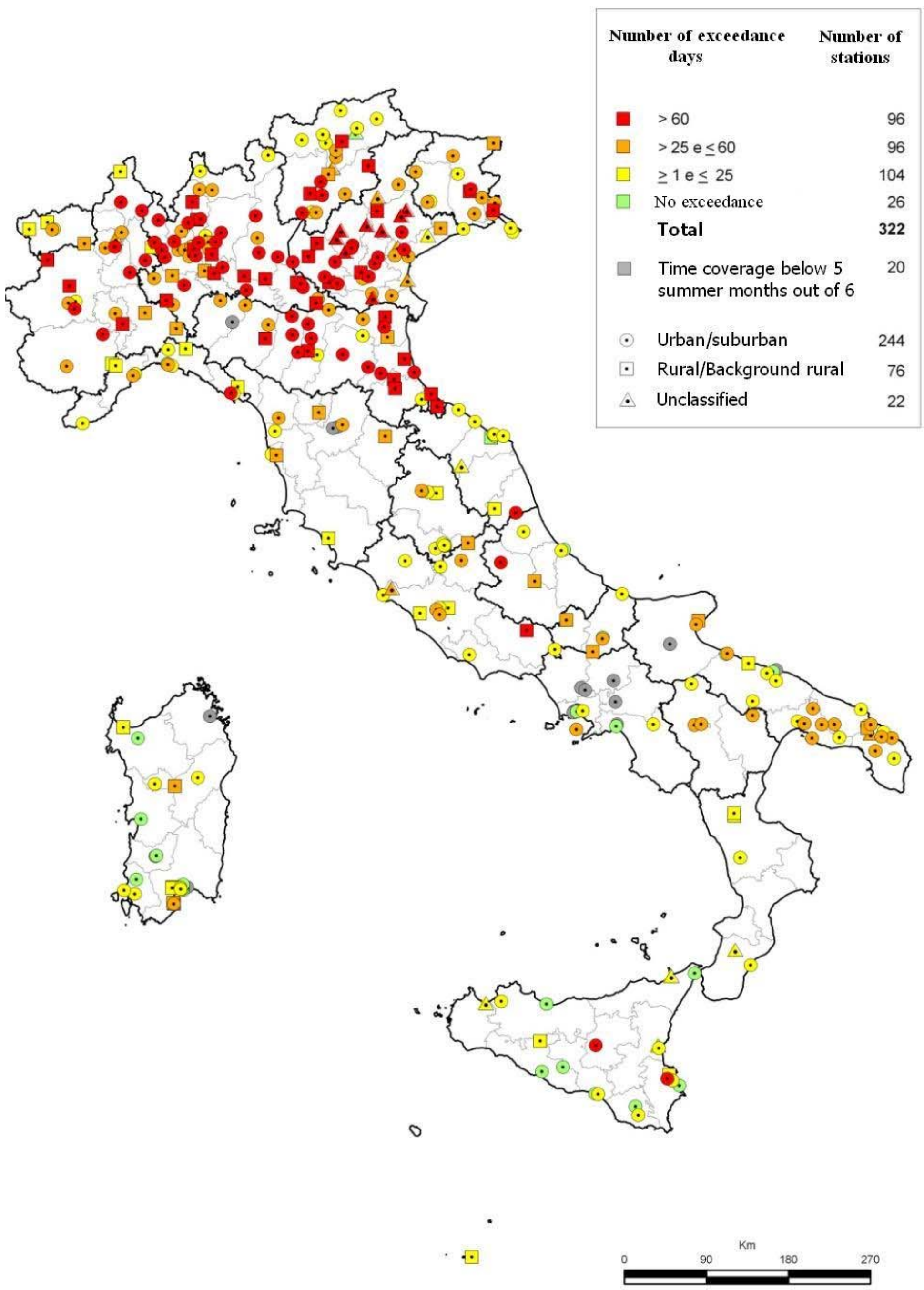
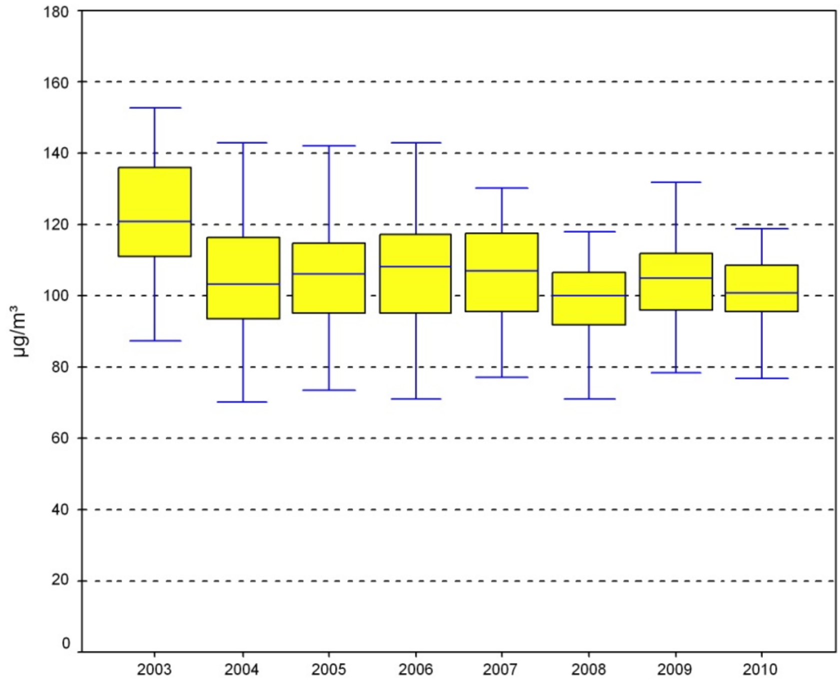


Figure 3.15: Summer O3 – Monitoring stations by classes of exceedance days, with respect to the long-term goal of human health protection (120 μg/m^3) (2011)[52]

Ozone trends appear to be stable over time. This is the conclusion that emerges from Figure 3.16, which illustrates, for the summer periods between 2003 and 2010, several descriptive statistics relating to the SOMO0 indicator, calculated for a set of monitoring stations selected on the basis of uniform criteria, with respect to the type of stations and the period of coverage.

52 Source: ISPRA



Summer ozone, Italy: ozone trends are stable over time.

Figure 3.16: Summer O_3, SOMO0 – Descriptive statistics calculated on a selection of 72 monitoring stations distributed throughout Italy[53 54]

The principal causes of air pollution: ozone precursor emissions

With regard to ozone, being a wholly secondary pollutant we need to consider the emissions of its precursors: nitrogen oxides and volatile organic compounds.

In Europe[55], in 2009, the principal source of ozone-precursor emissions was transport, road transport in particular, responsible for 42% of the NO_x and 17% of non-methane volatile organic compounds (NMVOCs). The other principal sources of NO_x emissions were electricity and heating (17%), industrial combustion processes (13%) and the civil sector (7%). The other principal sources of NMVOCs were the use of solvents (40%) and the civil sector (12%).

Europe, 2009: transport was the principal source of ozone-precursor emissions.

Based on the information contained in the Italian National Atmospheric Emissions Inventory for 2009, by the ISPRA[56], the principal source of nitrogen oxide emissions was transport, at 71%, with road transport accounting for slightly less than ¾ of the total; industry accounted for 12%, energy production and the civil sector for 8% each. In the case of NMVOCs, 41% came from the use of solvents, while transport accounted for 35%, followed by the civil sector (11%), industry (6%) and other lesser sectors.

In the EU27 countries, NO_x emissions were down by 44%, and emissions of NMVOCs by 55%.

Italy, 2009: transport was the principal source of nitrogen oxides; the use of solvents is the principal source of NMVOCs.

In the EU27 countries, the emissions of NO_x and NMVOCs have

[53] Source: ISPRA

[54] See note 10

[55] EEA, *European Union emission inventory report 1990–2009 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP),* Technical report n. 9/2011

[56] http:// www.sinanet.isprambiente.it/it/sinanet/serie_storiche_emissioni

In Italy too, as can clearly be seen in Figure 3.5, strong reductions in NO_x emissions have been recorded, most of which are caused by the energy sector, followed by road transport; in the case of NMVOCs, the largest single source of emissions is road transport.

In particular, the motor vehicle fleet turnover has had a decisive effect on the reduction of NO_x and NMVOC emissions after 1995.

Between 1990 and 2005, there was a strong reduction of tropospheric ozone-precursor emissions in all the regions, autonomous provinces to a greater or lesser extent, depending on the presence of large-scale industrial plants, with respect to which stringent limits on chimney stock emissions were imposed in the 90s[57]..

dropped.

In Italy too NO_x and NMVOCs emissions dropped; in the road transport sector in particular, following the decision to renew the vehicle fleet.

In Italy there was a reduction in ozone-precursor emissions between 1990 and 2005, in all the regions.

<u>The impact on human health</u>

Estimates of a significant impact on human health also concern exposure to ozone, albeit to a lesser extent that airborne particulate matter.

With regard to the previously mensioned study carried out in Italy in 2002-2004[58], in 13 major Italian cities, it has been estimated that over 500 deaths, equal to 0.6% of total deaths and corresponding to a loss of about 6,000 life years, were caused by ozone concentrations in excess of 75 $\mu g/m^3$.

It has been estimated that in Italy, between 2002 and 2004, in 13 major cities, over 500 deaths were caused by levels of ozone in excess of 75 $\mu g/m^3$.

According to an ISPRA study assessing exposure to ozone in several Italian cities, based on the SOMO35 indicator, between 2004 and 2009, the percentage of population exposed to higher concentrations (in excess of 7,000 $\mu g/m^3$ * day[59]), dropped from 73% to 45% (-28 percentage points); the largest reduction was recorded in 2008 with only 22%.

The same also applies to the population aged below 20, in which group the percentage of exposure to higher concentration values dropped from 76% to 45% (-31 percentage points), with the largest reduction being recorded in 2008 for 21%[60].

The CAFE program has estimated that, overall, the application of policies for cutting back the emission of ozone precursors could reduce the number of premature deaths, in Europe, from 22,000 to about 16,500 per year between 2000 and 2020.

In the same period, in Italy, over 1,000 premature deaths per year could be avoided.

According to an ISPRA study conducted in several Italian cities, between 2004 and 2009 the percentage of population exposed to higher O_3 concentrations dropped from 73% to 45%.

CAFÉ: the policies for cutting back the emission of ozone precursors could reduce the number of premature deaths, in the EU, from 22,000 to about 16,500 per year between 2000 and 2020.

[57] DM 12/07/1990, "Guidelines for the containment of polluting emissions from industrial plants and fixing of the minimum emission values"

[58] Martuzzi M. Mitis F., Iavarone I., Serinelli M., *Health impact of PM_{10} and ozone in 13 Italian cities.* World Health Organization-Regional Office for Europe. Copenhagen 2006. Disponibile presso: www.euro.who.int/document/e88700.pdf.

[59] The value of (7,000 $\mu g/m^3$ * day) refers to the upper threshold of the colorimetric scale adopted by the WHO (*Risks Of Ozone From Long-Range Transboundary Air Pollution. WHO-Europe 2008*) for assessing the risk of exposure by the population to ozone, and is therefore a higher-risk threshold for human health

[60] For more detailed and in-depth information about the study: ISPRA, Environmental Data Yearbook, Chapter on the Environment and Well-being, ed. 2011

In 2009, about 17% of the urban population in the EU was exposed to ozone concentrations in excess of the long-term objective value (120 μg/m^3 as the 8-hour maximum daily average over a calendar year).
In 1997-2008, the percentage of urban residents exposed varied between 13 and 61%, the percentage of exposure rose, in the same period, by over 95% in reference to the values set out in the WHO guidelines (100 μg/m^3)[61].
In Italy, the impact estimates associated with ozone exposure – valued at about one order of magnitude below those for PM – for 2005 correspond to about 75 cases of premature death per million population[62].
The European APHEKOM[63] project has shown that compliance with the WHO guidelines for O_3 would prevent 156 hospital admissions per year and 200 premature deaths[64].

In 2009, about 17% of the urban population in the EU was exposed to ozone concentrations in excess of the long-term objective value.

According to the APHEKOM project: compliance with the WHO guidelines for O_3 would prevent 156 hospital admissions per year and 200 premature deaths.

Regarding the EBoDE[65] project, already mentioned in the section on particulate matter (and to which reference should be made for details on the project), the effects on human health taken into account, in relation to ozone exposure, are total mortality (not including violent causes), restricted activity days (Mrad), coughing and symptoms of the lower respiratory system (LRS) in children aged between 5 and 14 years.
When estimating the effects of ozone on human health, it appears to be responsible for a loss of between 40 and 200 years of healthy life per million population in the 6 countries examined, of which approx. 140 years for the Italian population.

The EboDE project: shows that the O_3 risk factor is responsible for a loss of between 40 and 200 years of healthy life per million population.

Nitrogen dioxide

Nitrogen dioxide (NO_2) is a gas pollutant with a predominantly secondary component, because it is produced as a result of the oxidation of nitrogen monoxide (NO) in the atmosphere; only smaller amounts are emitted directly into the atmosphere. It is a widespread pollutant with negative effects on human health and, together with nitrogen monoxide, contributes to photochemical smog (it is a precursor for the formation of secondary pollutants, such as tropospheric ozone and fine secondary particulate matter),

[61] EEA, *Air quality in Europe – 2011 report*, Technical report 12/2011

[62] EEA, *Spatial assessment of PM_{10} and ozone concentrations in Europe (2005)*, Technical report No 1/2009

[63] APHEKOM, 2011 - *Improving Knowledge and Communication for Decision Making on Air Pollution and Health in Europe*- www.aphekom.org. Summary report of the Aphekom project 2008-2011 (available at: http://www.invs.sante.fr/presse/2011/communiques/cp_aphekom_010311/Aphekom_summary_report.pdf)

[64] M. Pascal, C. Declercq, M. Corso, C. Badaloni, G. Cesaroni, S. Henschel, K. Meister, K. Eshai, S. Medina on behalf of the Aphekom collaborative network. Health impact assessment of short and long-term exposure to ozone and PM in 25 European cities. *Abstract 727 presented at the 23rd Annual Conference of the International Society of Environmental Epidemiology (ISEE). September 13 - 16, 2011, Barcelona, Spain*

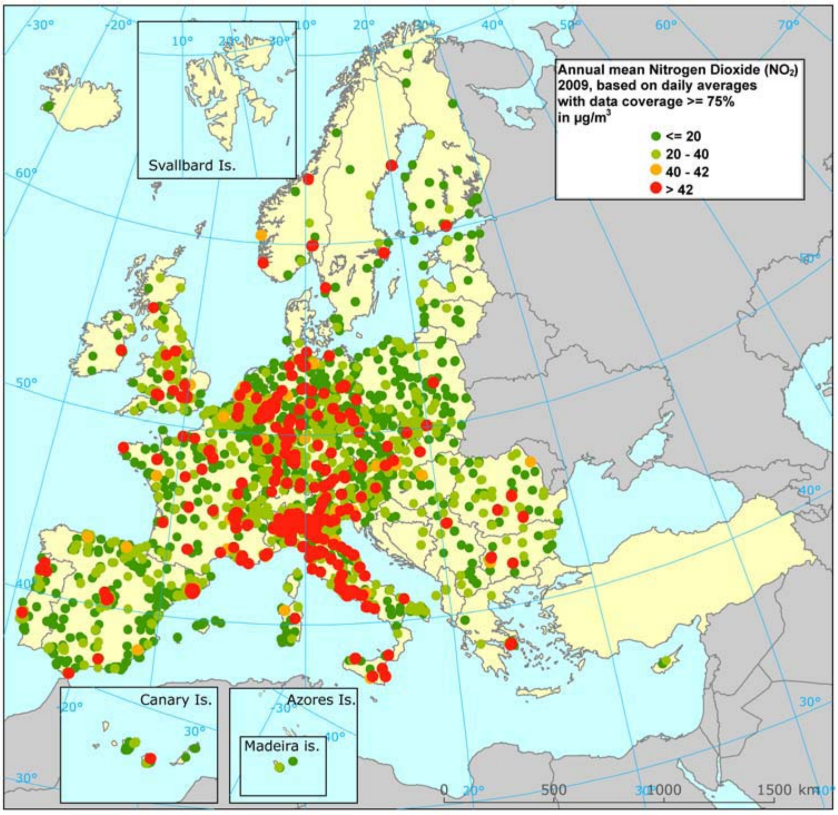
[65] EBoDE, 2011, Jantunen M, Kollanus V, Leino O et al., 2011. *European perspectives on Environmental Burden of Disease: Estimates for nine stressors in six countries*. THL Reports 1/2011, Helsinki, Finland. 86 pp + 2 appendixes. - http://en.opasnet.org/w/Ebode - disponibile presso: http://www.thl.fi/thl-client/pdfs/b75f6999-e7c4-4550-a939-3bccb19e41c1

eutrophication and acid rain. The principal source of emissions of nitrogen oxides ($NO_X=NO+NO_2$) is vehicle traffic.

The state of the air quality: atmospheric nitrogen dioxide levels

Figure 3.17 shows the levels of nitrogen dioxide in the atmosphere, in Europe, updated to 2009[66]; the annual limit value of NO_2 (40 $\mu g/m^3$) is exceeded in many countries.

Exceedances are more frequent in the traffic-oriented measurement stations, about 47% of which feature exceedances.



Nitrogen dioxide, 2009, Europe: 47% of traffic-oriented measurement stations feature exceedances of the annual limit value.

Figure 3.17: NO_2 – Mean annual concentration (limit value of 40 $\mu g/m^3$ at 2010) (2009)[67]

Nitrogen oxide concentrations featured a downward trend in Europe, in 1999-2009, although NO_2 decreased at a lower rate, compared to total nitrogen oxides and less significantly, especially at the traffic-oriented measurement stations: the growing number of diesel-fueled vehicles might be the reason for the increase in primary NO_2, which compensated the reduction of NO_X emissions from transport. In 2009, in the EU countries, about 12% of the urban population was exposed to levels in excess of the annual limit value for NO_2 and the value shown in the WHO guidelines (40 $\mu g/m^3$). In 1997-2008, the percentage of urban population exposed varied between 6 and 41%[68].

Nitrogen oxide concentration levels featured a downward trend, in Europe, in 1999-2009.

In 2009, in the EU countries, about 12% of the urban population was exposed to levels in excess of 40 $\mu g/m^3$.

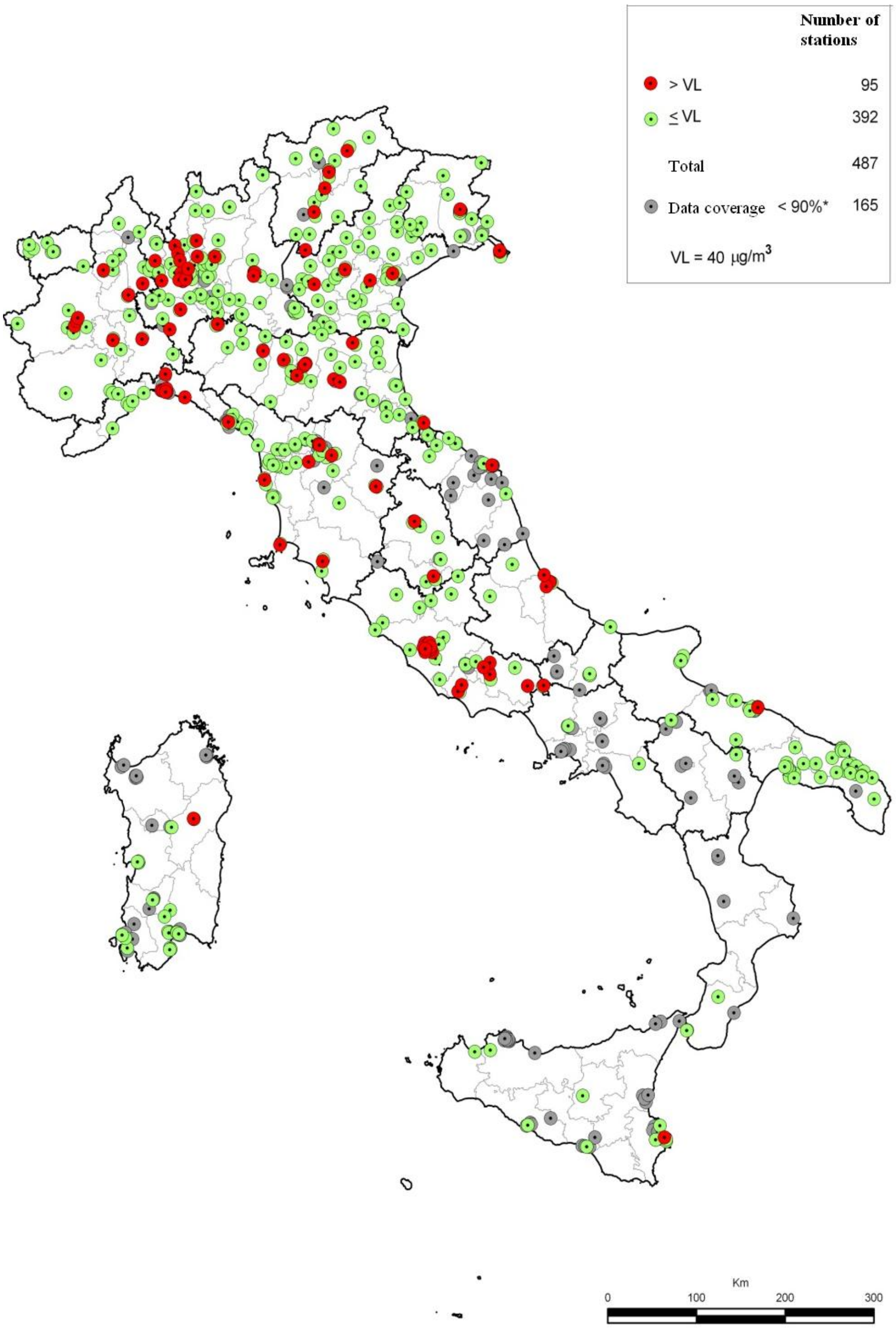
[66] Monitoring data delivered by the European countries, as part of the *Exchange of Information*, Decision 97/101/EC referred to in Directive 2088/50/EC

[67] Source: ETC/ACM, *The state of the air quality in 2009*, Technical paper 2011/1

[68] EEA, *Air quality in Europe – 2011 report*, Technical report 12/2011

As clearly shown in the European maps, Italy is in no reassuring position with regard to NO_2; Italy – and in particular the Po Valley and the city of Milan – appears as one of the most critical areas in Europe[69]. In 2010, in Italy, the annual limit value for the protection of human health, introduced in 2010, was complied with at 80% of the measurement stations (Figure 3.18).

Nitrogen dioxide, 2010, Italy: 20% of the measurement stations exceeded the annual limit value.



Legend:
* the 90% data coverage is net of the data loss due to the periodical calibration or ordinary maintenance operations

Figure 3.18: NO_2 – Monitoring stations and exceedance of the annual limit value (2010)[70]

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[69] *Identification of critical areas for PM_{10} and NO_2*, Umweltbundesamt, Service Request N.3 under contract ENV.C.3/FRA/2009/2008, AEA. According to the report, the other critical areas are: Athens, Greece; Kosice, Slovak Republic; Krakow, Southern Poland, Poland; Lisbon, Portugal; London, United Kingdom; Paris, France; Sofia, Bulgaria; Stuttgart, Germany

[70] Source: ISPRA

Regarding nitrogen dioxide, the graph in Figure 3.19 (which features descriptive statistics based on the annual mean values of monitoring stations, selected on the basis of uniform time coverage and geographical distribution criteria) shows a slightly decreasing trend in 2003-2010.
The same indications expressed with regard to the similar graph for PM_{10}, also apply to NO_2.

Nitrogen dioxide, Italy: from 2003 to 2010 there are signs of a slight decrease.

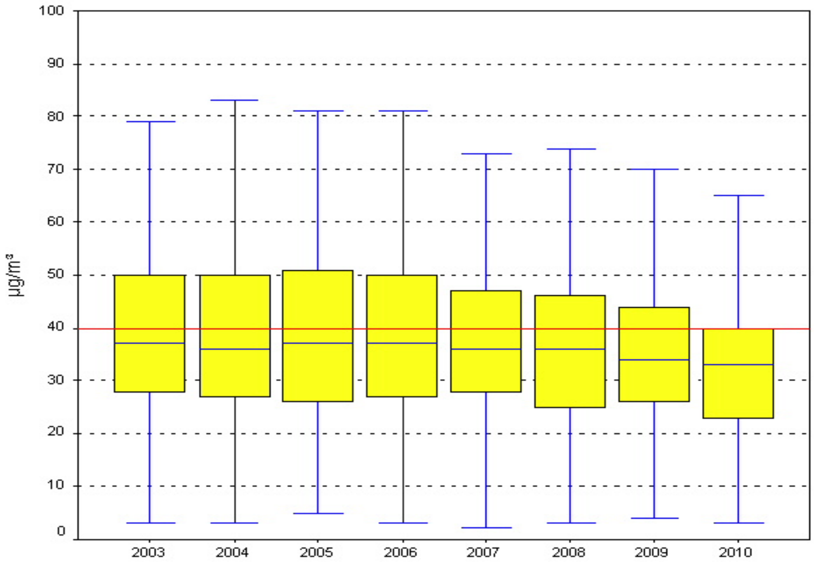


Figure 3.19: NO_2, annual mean – Descriptive statistics calculated on a selection of 121 monitoring stations distributed throughout Italy[71] [72]

The principal causes of air pollution: nitrogen oxides emissions

Europe, 2009: transport, and road transport in particular, was the principal source of NO_x emissions.

In Europe[73], in 2009, transport, and road transport in particular, was the principal source of NO_X emissions (42%).
The other sources were: electricity production and heating (17%), industrial combustion processes processes (13%) and the civil sector (7%).

In Italy too, in 2009, transport, and road transport in particular, were the principal source of NO_x emissions.

Based on the information contained in the Italian National Atmospheric Emissions Inventory for 2009, by the ISPRA[74], the principal source of nitrogen oxides emissions was transport, at 71%, with road transport accounting for slightly less than ¾ of the total; industry accounts for 12%, energy production and the civil sector for 8% each.

There has been a strong reduction in NO_x emissions in the EU27 countries.

In the EU27 countries, NO_x emissions were down by 44% between 1990 and 2009.

There was a strong reduction of NO_x emissions in Italy too. In Italy, the

In Italy too, as can clearly be seen in Figure 3.5, strong reductions in NO_x emissions have been recorded, most of which are caused by the energy sector, followed by road transport.

[71] Source: ISPRA
[72] See note 10
[73] EEA, *European Union emission inventory report 1990–2009 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP),* Technical report n. 9/2011
[74] http:// www.sinanet.isprambiente.it/it/sinanet/serie_storiche_emissioni

Between 1990 and 2005, there was a strong reduction of NO_x emissions in all the regions, autonomous provinces to a greater or lesser extent, depending on the presence of large-scale industrial plants, with respect to which stringent limits on chimney stock emissions were imposed in the 90s[75].

reduction of NO_x emissions between 1990 and 2005 was recorded in all the regions.

Exemption from the obligation to apply the nitrogen dioxide Limit Values

As in the case of PM_{10}, the opportunity was introduced in Directive 2008/50/EC (art. 22), for member States, to apply for an exemption from the obligation of applying the limit values of nitrogen dioxide (in force from 1 January 2010) until 1 January 2015, with respect to given zones or agglomerations, provided that the applicant member State can show that it has taken *all appropriate measures at national, regional and local level* to meet the deadlines and that it will be able to attain the limit values within the new deadline, through additional local and national measures.

The increased number of vehicles, slower than expected motor vehicle fleet turnover and higher vehicle emissions, compared to the limits set out in the type-approval standards (Euro 3, 4 and 5) are the main reasons identified by the European Commission behind the failed attainment of the regulatory objectives[76].

In particular, with regard to the last item, the European transport policies have proved unable to ensure the expected reduction of polluting emissions from vehicles, especially with regard to nitrogen oxides.

Experimental studies conducted at European levelS[77] have highlighted, in fact, that the average emissions of Euro 3 vehicles (especially NO_X), in actual driving conditions, are not lower than those of pre-Euro vehicles; similar results have been obtained with regard to Euro 4 and 5 vehicles.

With regard to the procedure for exemption from the obligations relating to NO_2 emissions, following the notification by the Italy of 47 zones (September 2011), the Commission has requested supplementary information.

Italy has applied for an exemption with respect to 47 zones.

Figure 3.20 shows the Italian communes concerned by the exceedance of the limit values of NO_2, in the municipalities year after their entry into force.

75 DM 12/07/1990, “Guidelines for the containment of polluting emissions from industrial plants and fixing of the minimum emission values”

76 *Commission staff working paper on the implementation of EU Air Quality Policy and preparing for its comprehensive review*, SEC (2011) 342.

77 NO_2 *Workshop Brussels* - 14-15 April 2010

Municipalities where the limit values have been exceeded.

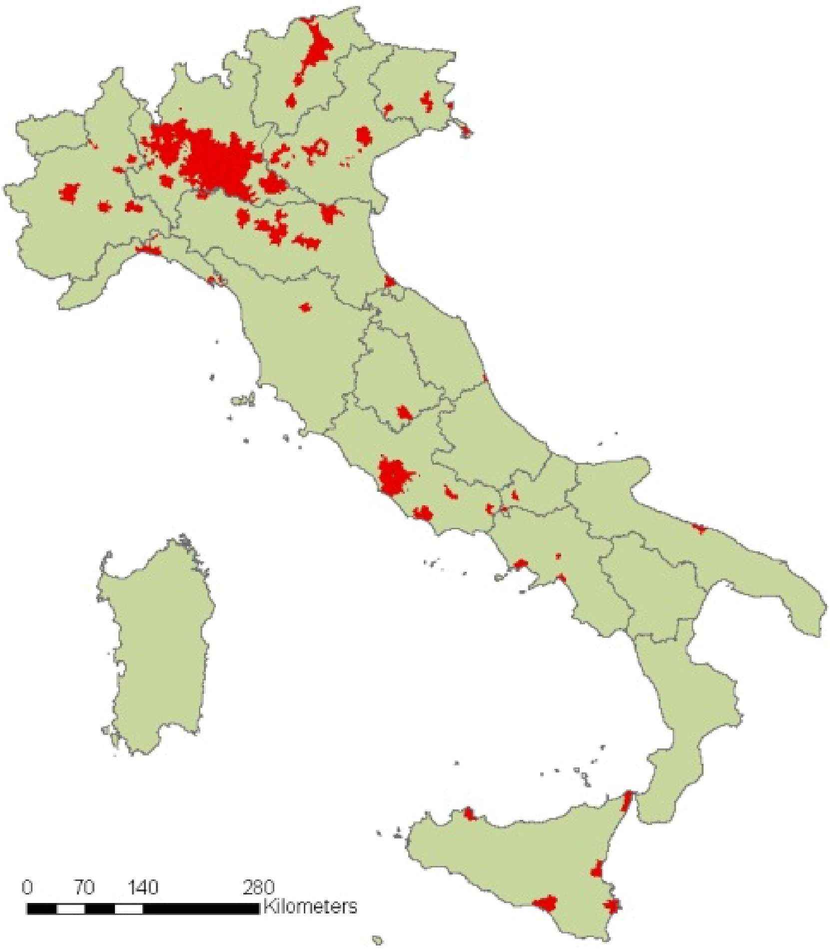


Figure 3.20: Italian municipalities where the NO_2 limit values have been exceeded (2010)[78]

Like in the case of exemptions from the obligation to apply the PM_{10} limit values, in this case too a series of assessments was conducted, such as the identification of the source of emissions responsible for the exceedances and the estimated levels of NO_2 at the new deadline, following the application of the additional measures.

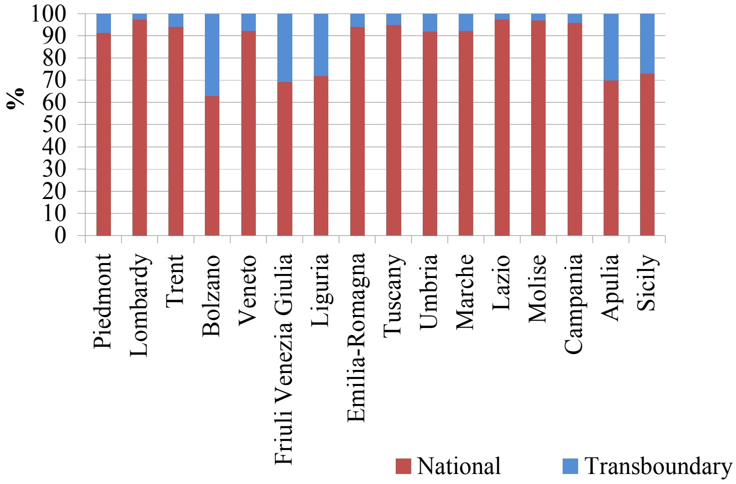
Figure 3.21 shows an estimate[79] of the transboundary and national contributions to the regional background levels[80] of NO_2 used by the regions, within the framework of the regional air quality plans and of the notification of excemption.

It can be observed how the transboundary contribution, in the majority of cases, is below 10%, except in the case of several regions, such as Friuli-Venezia Giulia, Liguria, Puglia, Sicily and the Autonomous Province of Bolzano, where the value is in the region of 30%.

[78] Source: Data processed by the ISPRA and received from the regions and autonomous provinces

[79] To carry out this estimate, a model developed by ENEA, on the request of the Ministry of the Environment and in connection with the MINNI project (National Integrated Model in support of International Negotiations on the issues of atmospheric pollution) has been used

[80] The regional background level is the estimated level in the absence of any sources of emission within a radius of about 30 km. In the case of inner city sites, this level corresponds to the background level existing outside the cities. (*Notes on the Form 3A _STAFF WORKING PAPER accompanying theBruxelles*, 26.6.2008 SEC(2008) 2132)



Estimated transboundary and national contribution to the levels of NO_2. In the majority of cases, the transboundary contribution to the concentrations of NO_2 is below 10%.

Figure 3.21: Transboundary and national contribution to NO_2 concentrations[81]

Figure 3.22 shows the contributions of the various sectors[82] to the urban background levels[83] of NO_2, featuring the clear impact – in urban areas – of transport, industry and the commercial and residential sources, which contribute, on average, to the total regional emissions of NO_2 by 91%.

The estimated contributions by the various emission sectors to the levels of NO_2 highlight that the impact, in urban areas, of transports, industry and the commercial and residential sources which contribute – on average – to the total regional emissions of NO_2 by 91%.

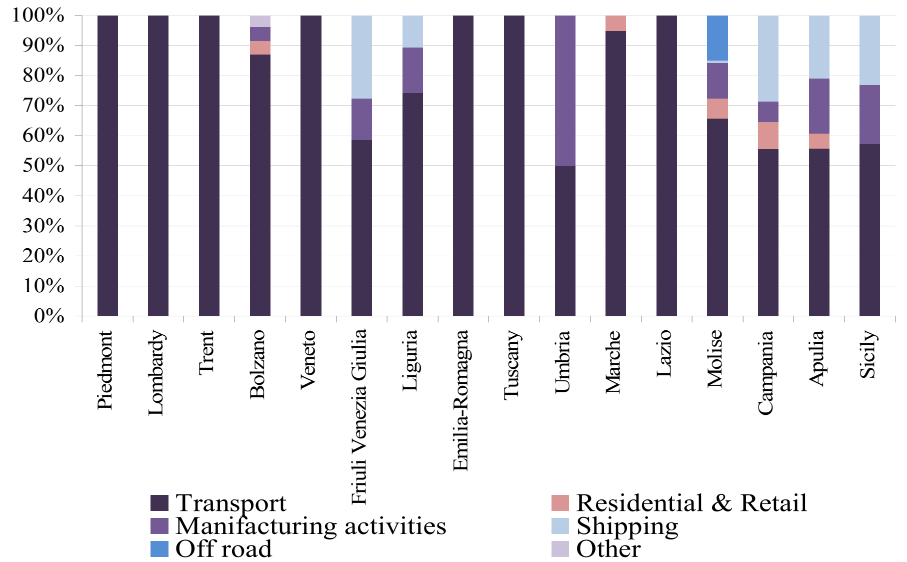
Figure 3.22: Contribution by urban areas to the concentrations of NO_2[84]

[81] Source: Data processed by the ISPRA and received from the regions and autonomous provinces

[82] The regions and autonomous provinces have used the data contained in the regional atmospheric emissions inventories for 2010

[83] The urban or total background level, which includes the regional background level, is the expected level in the absence of any local sources

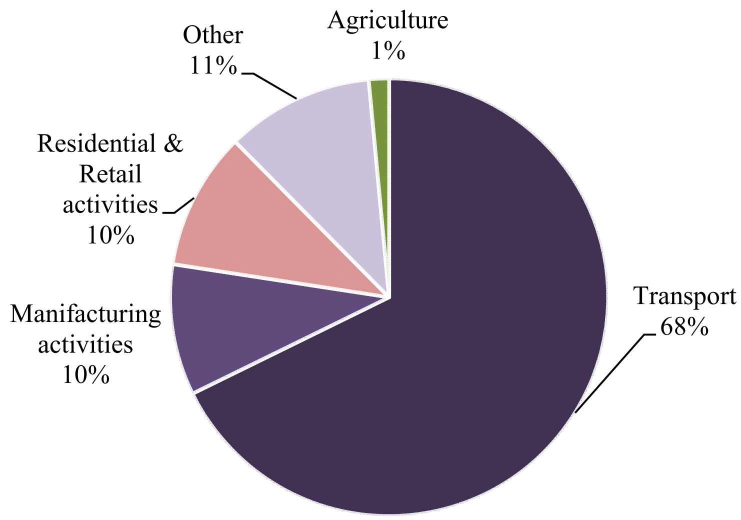
[84] Source: Data processed by the ISPRA and received from the regions and autonomous provinces



At the local level too the transport sector is the major contributor to the concentration of NO_2.

Figure 3.23: Contribution at the local level, by sector, to the concentrations of NO_2[85]

Figure 3.23 shows the local contribution[86] to NO_2 concentration levels.
Besides the measures provided for in the air quality remediation plans, the regions and autonomous provinces have also been required to identify a set of additional measures for attaining the NO_2 limit values. Figure 3.24 shows the sectorial distribution of these measures.



Most of the measures for exemption purposes concern the transport sector.

Figure 3.24: Sectorial distribution of the additional measures for attaining the limit values of NO_2[87]

[85] *Ibidem*
[86] The local contribution identifies the contributions by the nearby sources
[87] Source: Data processed by the ISPRA and received from the regions and autonomous provinces

Most of the additional measures, like the measures provided for in the air quality plans, has concerned the transport sector (structural measures for mobility and actions supporting alternative forms of mobility) (Figure 3.25).

The regional disaggregation of the measures presents a clear predominance of the those concerning the transport sector.

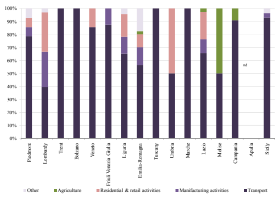


Figure 3.25: Sectorial distribution of the proposed remediation measures, by region/autonomous province, for NO_2 exemption purposes[88]

The estimate of the percentage reduction of the NO_2 emissions at 2015, following the implementation of these measures, is shown in Figure 3.26.

Estimated reduction of NO_2 emissions forecasted for 2015, following the application of the additional measures.

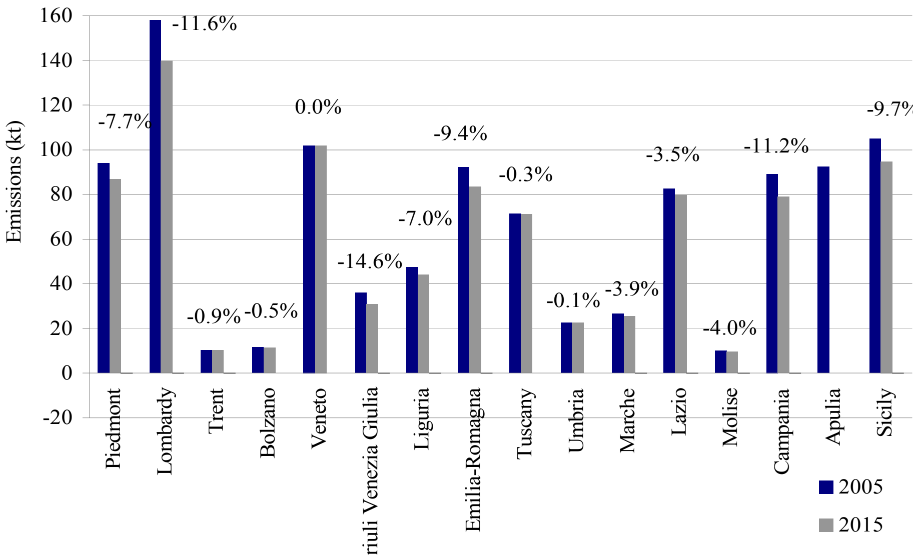


Figure 3.26: Estimated reduction of NO_2 emissions between 2005 and 2015[89]

[88] Source: *Ibidem*

[89] Source: Data processed by the ISPRA and received from the regions and autonomous provinces

Micropollutants

Micropollutants are a group of organic and inorganic substances present in the atmosphere in the form of aerosols in very small concentrations, compared to the total (generally speaking, with a mass ratio below 1000). They are primarily originated by industrial combustion processes. Some of these are attentively monitored for human health reasons, because they are genotoxic carcinogenic agents for human beings, for which no threshold has been established, below which they do not represent a risk for human health, in the case of inhalation: benzo(a)pyrene (BaP) (used as a marker for the carcinogenic risk of the class of polycyclic aromatic hydrocarbons (PAHs) and compounds of arsenic, cadmium and nickel.
The current legislation has established objective values for the total annual mean of these substances in the PM_{10} fraction to be attained within 2012: 1.0 ng/m^3 for BaP, 6.0 ng/m^3 for arsenic, 5.0 ng/m^3 for cadmium, 20.0 ng/m^3 for nickel.

In Europe, in 2009, the available monitoring data for arsenic, cadmium and nickel (the information is limited, but values are rising: in 2009, there were 170 monitoring stations measuring micropollutants, including BaP, compared to 120 in 2008) indicate, except for certain industrial situations, levels that are generally below the objective values.
In the case of BaP, in particular, the available data indicate a rather large number (37% of the stations) of exceedances of the objective value, concentrated in Central and Eastern Europe and the UK.

In Europe, in 2009, the levels of arsenic, cadmium and nickel are generally below the objective values.

In Europe, in 2009, about 37% of the stations recorded BaP levels in excess of the objective value.

Verification of compliance with the objective value should have been carried out annually throughout the country, since 2008 (pursuant to D.Lgs. 152/2007, subsequently incorporated in D.Lgs. 155/2010); however, the monitoring has not yet been carried out in many southern regions and the islands (Abruzzo, Molise, Campania, Sicily and Sardinia). In the rest of Italy, the assessment was made, in 2010, by means of measurements carried out in fixed sites, with the integration, combination or exclusive use of indicative measures, models and objective estimates.
In the case of arsenic, cadmium and nickel, in 2010 no particularly critical situations were recorded and, in the majority of cases, the annual mean values surveyed are well below the respective objective values.

Limited monitoring, especially in the South and Islands.

Italy, 2010: the annual mean values of arsenic, cadmium and nickel are generally below the objective value.

The situation differs with respect to benzo(a)pyrene: cases of exceedance have been recorded in Piemonte, Lombardy, Veneto, Umbria and Puglia, in areas where the stationary industrial sources are the principal sources of emissions, or in zones where the principal source is represented by the combustion of biomasses for domestic heating purposes.

In the case of B(a)P, in 2010 various cases of exceedance of the objective value were recorded in Lombardia, Veneto, Umbria and Apulia.

In Italy in 2009, 23% of emissions of PAHs are from steelworking combustion and processes, approx. 39% from the combustion of biomass for domestic heating and about 27% from the incineration of agricultural waste in the fields.

According to the National Atmospheric Emissions Inventory for 2009, by ISPRA[90], polycyclic aromatic hydrocarbons (benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and indeno(1,2,3-cd)pyrene) approx. 23% of emissions are from steelworking combustion and processes, approx. 39% from the combustion of biomass for domestic heating and about 27% from the incineration of agricultural waste in the fields.

GLOSSARY

Precursor:
This term defines a substance that transforms and generates (an)other polluting substance(s), by means of chemical and photochemical processes that occur in the atmosphere.

Troposphere:
The lower layer of the atmosphere in which most meteorological phenomena occur and in which the biosphere develops, from 10 km high (at the poles) to 18 km high (at the equator).

Photo-chemical smog:
This term describes the mixture of oxidising compounds found in the lower layers of the troposphere, which forms as a result of complex photo-chemical reactions that, in the presence of solar radiation, involve such principal precursors as non-methane volatile organic compounds (NMVOCs) and nitrogen oxides (NOx). Photo-chemical smog contains a broad variety of substances affecting the environment, the most important of which are ozone, nitrogen dioxide and other reactive organic compounds. All of these are pollutants having negative effects on human health and on the ecosystems.

SOMO0 (***Sum of Ozone Means Over 0 ppb***):
An exposure indicator corresponding to the sum of the daily maximum mobile 8-hour means divided by the number of days for which the 8-hour mean is available.

SOMO35 (***Sum of Ozone Means Over 35ppb***):
An accumulated exposure indicator corresponding to the yearly sum of the daily maximum of 8-hour running average over 35 ppb (70 $\mu g/m^3$), divided by the number of days for which the 8-hour mean is available.

Exchange of Information (**EoI**):
This term describes the reciprocal exchange of information and data by the air pollution monitoring networks and stations set up in the Member States, pursuant to the applicable regulations (Decision

[90] http:// www.sinanet.isprambiente.it/it/sinanet/serie_storiche_emissioni

97/101/EC, Decision 2001/752/EC and Directive 2008/50/EC), which envisage an information flow composed of metadata and hourly and daily concentration data of primary pollutants.

Health Impact Assessment (**HIA**):
Assessment tool that helps decision-makers target the available resources on policies for promoting human health. This process is used, for example, to quantify the role played by environmental factors in determining the human health status of populations and for guiding public human health actions. The WHO has set up a dedicated website (http://www.who.int/hia/en/) to illustrate the meaning, methods and fields of application of the HIA.

CASE STUDY

Erosion of the architectural heritage of Rome

Outdoor air pollution and climatic factors work in synergy to accelerate the natural deterioration processes affecting the materials out of which historical and cultural monuments (HCM) are made.

Generally speaking, the types of deterioration, the effects of which are measurable and visible on cultural heritage monuments, depend on the intrinsic composition of the HCM materials and on the climatic, environmental and topographical characteristics of the area in which the monuments are located.

This case study, carried out by the ISPRA (Istituto Superiore per la protezione e la ricerca ambientale – *National Institute for Environmental Protection and Research*) and the ISCR (Istituto Superiore per la Conservazione e il Restauro – *National Institute for Conservation and Restoration*), reports the data related to the analysis of the erosion of limestone monuments in Rome.

Loss of material has been assessed at the air quality monitoring stations, using the meteorological parameters (rainfall and relative humidity) and environmental parameters (concentration of air pollutants) measured in the city in 2009.

By superimposing the erosion maps and the maps showing the location of the sites and monuments, it was possible to evaluate which parts of the city were affected by more aggressive conditions and which HCM materials were potentially at greater risk.

Erosion of limestone materials

Limestone erosion is the result of deterioration due to mechanical and physico-chemical processes caused by the weather and other environmental factors.

Loss of material (surface recession) of limestone HCM materials is generally caused by either the mechanical action of the wind, or the combined action of rainfall and air pollutants.

The most aggressive pollutants for limestone heritage assets are sulfur oxides, nitrogen oxides and airborne particulate matter (PM). Whereas the concentration of sulfur dioxide present in the atmosphere has decreased over the last few years, the effect of nitrogen oxides and PM on the deterioration processes is still quite significant.

In particular, nitrogen dioxide plays an active role in the formation of nitric acid (HNO_3)[91], which has corrosive effects on limestone, for example, according to the following reaction:

$$CaCO_3 + 2\,(HNO_3) \rightarrow Ca\,(NO_3)_2 + H_2O + CO_2$$

[91] Nitric acid is produced in the atmosphere during photochemical smog events due to the reaction between nitrogen dioxide and hydroxyl radicals (OH).

The resulting nitrates ($Ca(NO_3)_2$) can trigger salt migration and crystallization, which is generally responsible for the break-up and lack of cohesion of the structural elements of the heritage asset.
To quantify the potential erosion of a stone monument, specific algorithms reported in the literature are used to evaluate loss of material according to the rainfall and deposition of air pollutants.
The equation used for this study is the formula of Kucera[92]:

$$R = 4 + 0{,}0059 \cdot [SO_2] \cdot RH_{60} + 0{,}054 \cdot Rain \cdot [H^+] + 0{,}078 \cdot [HNO_3] \cdot RH_{60} + 0{,}0258 \cdot PM_{10}$$

Where
- R = erosion (expressed in µm/year);
- $[H^+]$: concentration of H^+ (mg/l);
- $[SO_2]$: concentration of SO_2 (µg/m^3);
- $[HNO_3]$: concentration of HNO_3 (µg/m^3);
- PM_{10}: concentration of PM_{10} (µg/m^3);
- RH_{60} = (RH – 60) when RH (relative humidity) is >0; otherwise RH_{60}=0;
- Rain: rainfall (mm/year);

Method for calculating erosion

Erosion calculation is based on meteorological data and the concentration of the relevant air pollutants, measured in Rome in 2009.
Table 1 shows the annual temperature, relative humidity and rainfall at each station.

Table 1: Metereological/climatic data in Rome (2009)[93]

Station	T	UR	Rainfall
	°C	%	mm
Francia	16	67	-
L.go Magna Grecia	17	68	-
Saredo	17	63	703
Villa Ada	13	72	731
AVERAGE	**16**	**68**	**717**

Table 2 shows the data related to the concentration of the relevant pollutants for the evaluation of loss of material.
In particular, data related to nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2) and airborne particulate matter (PM_{10}) measured in 2009 at the Rome air quality monitoring stations and collected and processed by ISPRA as part of the European Exchange of Information procedures[94].

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[92] *Model For Multi-Pollutant Impact And Assessment Of Threshold Levels For Cultural Heritage (Multiassets)* - Report 2005
[93] Source: ARPA Lazio (Agenzia Regionale per la Protezione Ambientale – Lazio Regional Office for Protection of the Environment)
[94] *Exchange of Information on air* (EoI), Decisions 97/101/CE and 2001/752/CE

Table 2: Annual mean concentration of air pollutants measured in Rome (2009)[95]

Station	NO_2	O_3	SO_2	PM_{10}
	μg/m³			
Arenula	65	-	-	34
L.go Perestrello	51	43	-	35
Francia	82	25	-	40
L.go Magna Grecia	72	30	-	37
Cinecittà	48	42	-	34
Villa Ada	38	37	1.1	27
Castel di Guido	17	56	-	-
Tenuta del Cavaliere	33	36	-	-
Fermi	78	-	-	39
Bufalotta	48	37	1.3	28
Cipro	54	37	-	31
Tiburtina	70	-	-	38

In order to calculate potential erosion, not only in the area surrounding the monitoring stations, but throughout the city, the data recorded in the stations can be spatially mapped over the entire territory by means of geo statistical interpolation methods.
This kind of mapping requires a large amount of input data.
As can be seen on Table 2, all four pollutants required for the erosion calculation were measured in only two of the twelve stations being considered (the station of Villa Ada and the one in via della Bufalotta); consequently, the available data is not sufficient to build a statistically significant map. herefore, in order to apply the interpolation techniques, the series of missing or incomplete data of some stations have been obtained based on an objective evaluation method[96]. In particular, the missing data about concentrations of sulfur dioxide, airborne particulate matter and ozone were evaluated.
The missing PM_{10} e SO_2 data were obtained using a dependent variable as a function of two independent variables based on the conventional *stepwise* multiple linear regression evaluation model[97].
For what concerns ozone, for the reference year, the data related to Corso Francia, Largo Magna Grecia and Fermi stations were evaluated according to the ozone concentrations measured at the Tenuta del Cavaliere station, by means of a simple linear regression model[98].
The final result is shown on Table 3[99].

[95] Source: ISPRA
[96] G. Cattani, A. Di Menno di Bucchianico, D. Dina, M. Inglessis, C. Notaro, G. Settimo, G. Viviano, A. Marconi, *Evaluation of the temporal variation of air quality in Rome, Italy from 1999 to 2008*, Ann ISS 2010 - Vol. 46, No. 3: 242-253
[97] This data was based on the total of the annual average concentrations measured at the 12 air quality monitoring stations in Rome, between 2003 and 2008.
[98] G. Cattani, A. Di Menno di Bucchianico, D. Dina, M. Inglessis, C. Notaro, G. Settimo, G. Viviano, A. Marconi, *Evaluation of the temporal variation of air quality in Rome, Italy from 1999 to 2008*, Ann ISS 2010 - Vol. 46, No. 3: 242-253
[99] ISPRA, *Valutazione degli effetti dell'inquinamento atmosferico sui beni culturali di Roma,(Assessment of the effects of air pollutants on the cultural heritage of Rome)* ISPRA Report 147/2011

Table 3: Concentrations of air pollutants measured and imputed (red numbers) in Rome (2009)[100]

Station	NO_2	O_3	SO_2	PM_{10}
	µg/m³			
Arenula	65	**35**	**2.1**	34
L.go Perestrello	51	43	**1.9**	35
Francia	82	**25**	**3.8**	40
L.go Magna Grecia	72	**30**	**2.5**	37
Cinecittà	48	42	**1.7**	34
Villa Ada	38	37	1.1	27
Castel di Guido	17	56	**0.7**	**26**
Tenuta del Cavaliere	33	36	**1.2**	**30**
Fermi	78	**21**	**3.2**	39
Bufalotta	48	37	1.3	28
Cipro	54	37	**2.5**	31
Tiburtina	70	**34**	**2.6**	38

Calculation of erosion at the stations

The meteorological data and the concentration of the air pollutants were entered in the algorithm of Kucera[101], in order to calculate the erosion rates (R, expressed in µm/year) at each of the 12 stations in Rome (Table 4).

Table 4: Erosion of limestone materials (R, µm/year) in Rome (2009)[102]

Station	R
	µm/year
Arenula	6.3
L.go Perestrello	6.2
Francia	6.4
L.go Magna Grecia	6.3
Cinecittà	6.1
Villa Ada	5.8
Castel di Guido	5.6
Tenuta del Cavaliere	5.8
Fermi	6.2
Bufalotta	5.9
Cipro	6.1
Tiburtina	6.4

Generally speaking, based on the results obtained during evaluation, it can be said, on first approximation, that the erosion calculated for the twelve sites in the city of Rome ranges from a minimum of 5.6 µm/year in Castel di Guido (rural background station) to a maximum of 6.4 µm/year at the stations of Francia and Tiburtina (urban traffic stations).
According to the specifications of *The International Co-operative*

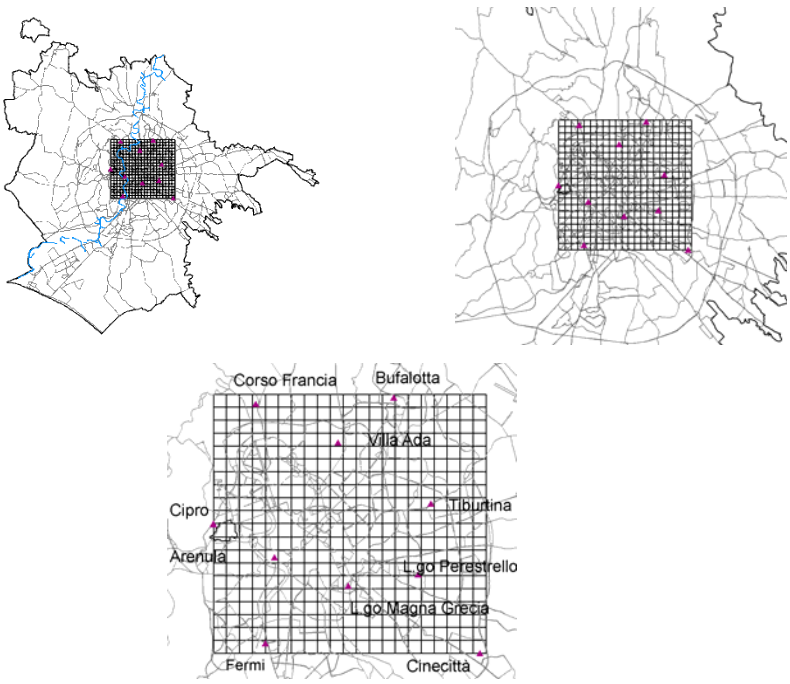
[100] Source: ISPRA
[101] *Model For Multi-Pollutant Impact And Assessment Of Threshold Levels For Cultural Heritage (Multiassets)* - Report 2005
[102] Source: ISPRA

Programme on Effects on Materials (UNECE HCM materials *Programme*), the tolerable[103] erosion rate for limestone materials is 8 µm/year[104].
Therefore, the evaluation of data measured or obtained at the monitoring stations demonstrates that the erosion of limestone materials results to be inferior to the limit specified by the ICP materials *Programme.*

Spatial mapping

The concentrations measured in the 12 stations were mapped according to the *Ordinary Kriging*[105] geo-statistical interpolation technique.
The mapping was carried out considering the part of the city located within the circular motoway greater ring road (GRA) around Rome (about 105 km^2).
In this mapping process the data related to the concentrations of Castel di Guido and Tenuta del Cavaliere were excluded; the data measured or obtained at the other 10 stations was used.
The area was divided into cells measuring 500 x 500 m (Fig. 1).

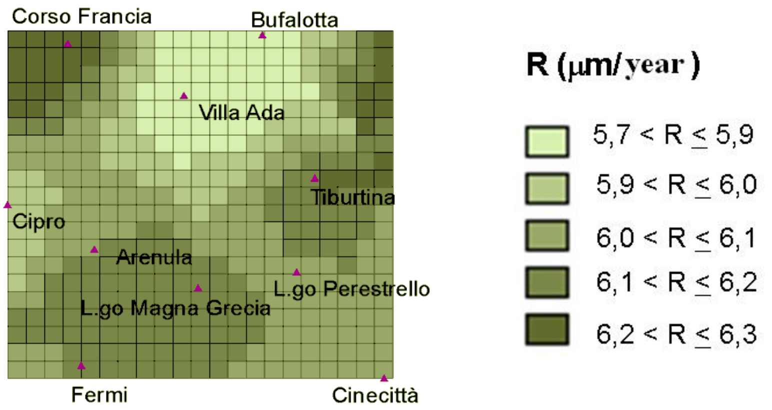
Fig. 1: Area of spatial mapping of the concentrations of the analysed pollutants[106]



[103] The definition of the tolerable erosion rate was determined on the basis of two components: "*tolerable corrosion before action*" component derived from the deterioration stage of the material before restoration works are undertaken, and "*tolerable time between maintenance*" component which indicates the acceptable time between subsequent restoration/maintenance operations.
[104] http://www.corr-institute.se/ICP-Materials/web/page.aspx?refid=12
[105] R. Beelen, G. Hoek, E. Pebesma, D. Vienneau,Kees de Hoogh, D. J. Briggs, *Mapping of background air pollution at a fine spatial scale across the European Union*, Science of the Total Environment 407 (2009) 1852 – 1867
[106] Source: ISPRA

The data related to the mapped pollutants was used to calculate the loss of material according to the formula of Kucera, in each of the cells that the surveyed area is divided into.

Fig. 2: Surface recession (R, μm/year) in the area bound by the stations[107]



Rome's cultural heritage

At the present time there are 3,762 (Fig. 3) architectural and archaeological cultural heritage assets listed in the Sistema Informativo Territoriale (SIT)[108] (*Geographic information System* - GIS) of the Cultural Heritage Risk Map[109].
Most of the monuments are located in the city centre, in the area inside the Rome ring road (GRA).
Between 1995 and 2000, the ISCR created a conservation datasheet of 77 architectural objects (Fig. 4) listed in Table 5, which made it possible to calculate the vulnerability[110] of the heritage items (its conservation condition).
The resulting data (expressed in arbitrary unit) indicates the state of preservation of the monument under analysis.
The vulnerability data was divided into 5 classes (class 1 corresponds to the lowest vulnerability and class 5 to the highest).
The lower the vulnerability class of the monument, the better the conservation condition.

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[107] Source: ISPRA

[108] La Cartografia Tematica, 1996, *Carta del Rischio del Patrimonio Culturale, Ministero per i Beni Culturali ed Ambientali* (Thematic Cartography, 1996, *The Risk Map of Cultural Heritage, Ministero per i Beni Culturali ed Ambientali)* – Ufficio Centrale per i Beni Archeologici, Architettonici, Storici ed Artistici – Istituto Centrale per il Restauro, Vol.1- A.T.I. Maris

[109] La metodologia per il calcolo del rischio, 1996, Carta del Rischio del Patrimonio Culturale, Ministero per i Beni Culturali ed Ambientali (Risk Calculation Methodology, 1996, *The Risk Map of Cultural Heritage, Ministero per i Beni Culturali ed Ambientali)* – Ufficio centrale per i beni archeologici, architettonici, storici e artistici - Istituto Centrale per il Restauro,vol.2- A.T.I. Maris.

[110] The *vulnerability* referred to cultural heritage assets is a function indicating the level of exposure of the heritage asset to the aggression of environmental territorial factors according to the state of preservation of said heritage asset. Vulnerability is calculated using metric evaluations of the constituent elements and the deterioration factors affecting the structure; said data is specified on a preservative card specifying the state of preservation of the 12 structural and ornamental elements constituting the heritage asset.

Fig. 3: Items located in Rome[111]

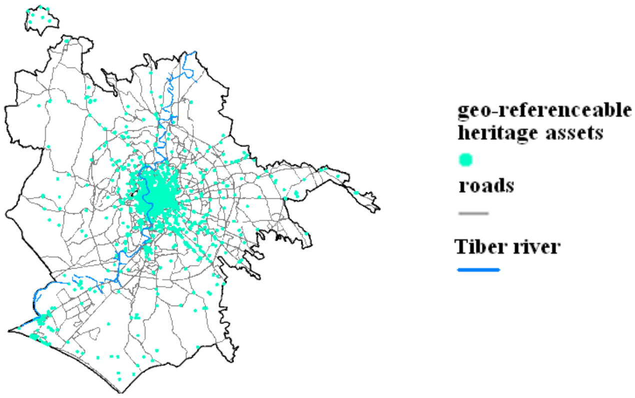
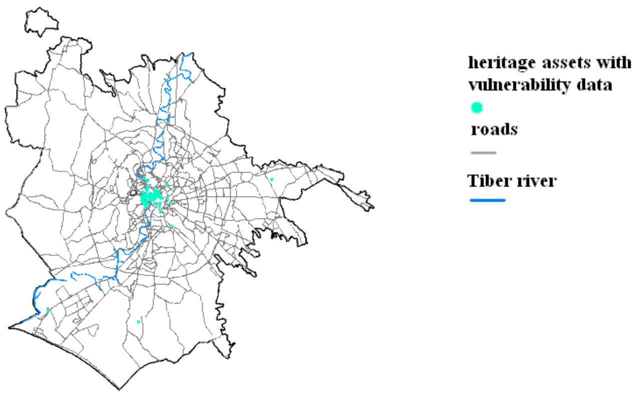


Fig. 4: Items with preservative cards[112]



[111] Source: ISCR
[112] Source: ISCR

Table 5: List of heritage assets with available vulnerability data[113] (expressed in u.a.) and the corresponding vulnerability class[114]

Bene	V (u.a.)	Classe V	Bene	V (u.a.)	Classe V	Bene	V (u.a.)	Classe V
Chiesa dei SS. Ambrogio e Carlo al Corso	-1,43	1	Chiesa di S. Cesareo de Appia	-0,57	1	Chiesa di S. Maria in Campitelli	0,43	2
Chiesa di S. Vitale	-1,19	1	Museo Nazionale Preistorico ed Etnografico	-0,54	1	Chiesa di San Agostino	0,43	2
Museo dell'Alto Medioevo	-1,16	1	Chiesa di S.S. Quirico e Giulitta	-0,50	1	San Girolamo dei Croati	0,44	2
Chiesa di S. Bernardo alle Terme	-1,16	1	Chiesa di S. Maria in Monticelli	-0,47	1	Oratorio di S. Francesco Saverio detto del Caravita	0,44	2
Chiesa di S. Andrea al Quirinale	-1,13	1	Chiesa di S. Lorenzo in Panisperna	-0,45	1	Convento Chiesa S. Maria della Concezione	0,45	2
Villino Ximenes	-1,12	1	Palazzo Corsini	-0,44	1	Chiesa Santa Maria della Scala	0,46	2
Complesso Villa Giulia - Palazzo	-1,07	1	Chiostro di S. Maria della Pace	-0,41	1	Chiesa di S. Maria della Pace	0,54	3
Museo di Palazzo Venezia	-1,03	1	Chiesa di S. Pantaleo	-0,38	1	Complesso Aracoeli - Chiesa S. Maria in Aracoeli	0,57	3
Casa Madre dei Mutilati	-0,98	1	Santa Maria dei Miracoli	-0,36	1	Palazzine ex Gil	0,67	3
Farmacia di S. Ignazio	-0,98	1	Chiesa di S. Callisto	-0,24	1	Chiesa di S. Clemente Basilica inferiore	0,69	3
Oratorio di S. Giuseppe dei Falegnami	-0,97	1	Chiesa di S. Margherita	-0,23	1	Chiesa di S. Rocco	0,69	3
Chiesa di S. Maria in Via	-0,92	1	Palazzetto Leroy	-0,22	1	Chiesa di S. Urbano	0,74	3
Oratorio Mariano	-0,89	1	Cimitero dei Cappuccini	-0,13	1	Appartamento Secchi	0,87	3
Chiesa di S. Maria in Aquiro	-0,86	1	Chiesa di S. Maria in Trivio	-0,11	1	Chiesa di S. Nicola da Tolentino	0,88	3
Chiesa di S. Marcello al Corso	-0,85	1	Chiesa di S. Croce e S. Bonaventura dei Lucchesi	-0,11	1	Palazzo Barberini	0,92	3
Chiostro di S. Clemente	-0,84	1	Chiesa di Santa Maria Sopra Minerva	-0,04	1	Basilica Paleocristiana di S. Aurea	0,93	3
Chiostro di Santa Maria Sopra Minerva	-0,82	1	Chiesa di S. Clemente Basilica Superiore	-0,04	1	Chiesa di S. Pudenziana	1,00	3
Museo degli Strumenti Musicali	-0,81	1	Chiesa di S. Bonaventura al Palatino	-0,02	1	Villa Sarvognan di Brazz	1,01	4
Galleria Doria Pamphilj	-0,80	1	Chiesa di S. Stefano del Cacco	0,02	2	Chiesa di Santa Maria in Montesanto	1,24	4
Chiesa di S. Silvestro al Quirinale	-0,80	1	Chiesa di S. Caterina a Magnanapoli	0,04	2	Chiesa di San Crisogono	1,27	4
Museo Nazionale delle Arti e Tradizioni Popolari	-0,79	1	Tempietto di S. Andrea	0,05	2	Chiesa di S. Tommaso in Parione	1,57	5
Chiesa Nostra Signora del Sacro Cuore	-0,73	1	Complesso di S. Ignazio - Chiesa	0,05	2	Chiesa di S. Marco	1,70	5
Chiesa di S. Eligio degli Orefici	-0,66	1	Chiesa di S. Maria Maddalena	0,26	2	Chiesa di S. Cecilia in Trastevere	1,87	5
Oratorio del Gonfalone	-0,65	1	Cappella del Crocifisso	0,29	2	Chiesa di S.Martino ai monti	1,90	5
Chiesa di S. Dorotea	-0,61	1	Chiesa di S. Agata	0,33	2	Chiesa di S. Filippo Neri	2,57	5
Chiesa di S.Bibiana	-0,59	1	Chiesa di S. Stefano Rotondo al Celio	0,40	2			

Note:
The heritage assets listed in Table 5 have been divided into 5 classes according to the pertinent degree of vulnerability.
Class 1 heritage assets correspond to monuments characterized by a better state of preservation and, therefore, a lower vulnerability, whereas class 5 heritage assets indicate a worse state of preservation and consequently a higher vulnerability.

Risk indicators

The erosion data calculated according to the *kriging* function inside the GRA area and the data regarding the conservation condition of the heritage assets were used to evaluate the territorial risk and the individual risk.

The "territorial risk" is "the degree of susceptibility to the deterioration processes typically present in the area in which the aggregation of heritage assets is located". This indicator is calculated according to the potential attack of a given area and the characteristics of the aggregation of heritage assets being analysed (for example, the number, type, etc. of monuments).

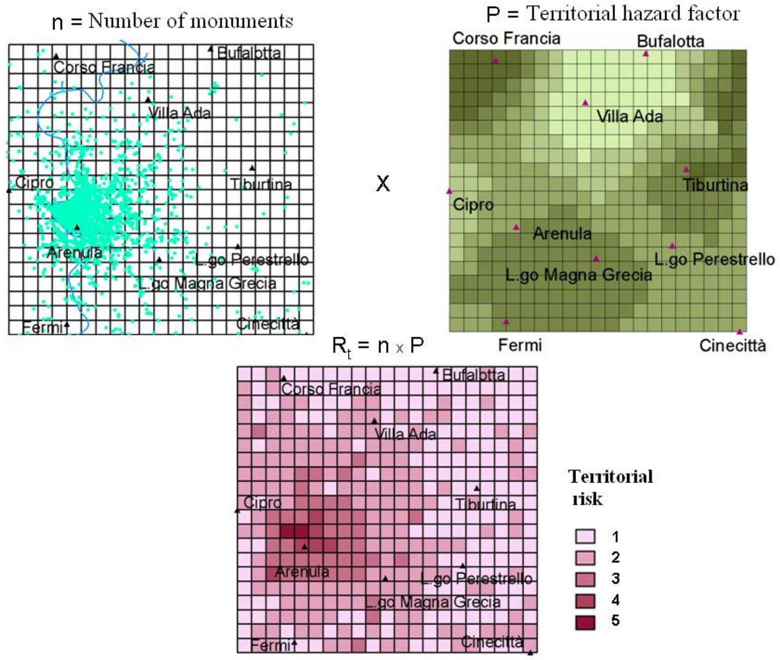
The "territorial risk" is "the degree of susceptibility to the deterioration processes of the single heritage asset" and is the product of the territorial hazard factor (TH) and the individual vulnerability (V_k) of the k-th asset located in a certain municipality. To calculate the territorial risk, the erosion map described in the above paragraph was superimposed on the geo-referenced map of the heritage assets listed in the Risk Map (Fig. 5). The indicator can be obtained by multiplying the number of monuments (n) present in a given cell by

[113] In the statistical definition of the weights to be assigned to the damage, based on the 12 constituent elements of the heritage asset, some are negative; this entails the possibility of negative final vulnerability values, since it is not possible, at this time, to carry out normalization processes. If an ordinal scale of values were available, the negative data would tend to represent the class of low vulnerability.

[114] Source: ISCR

the territorial hazard factor (TH, represented in this specific case by the level of erosion) calculated for the cell being analysed.

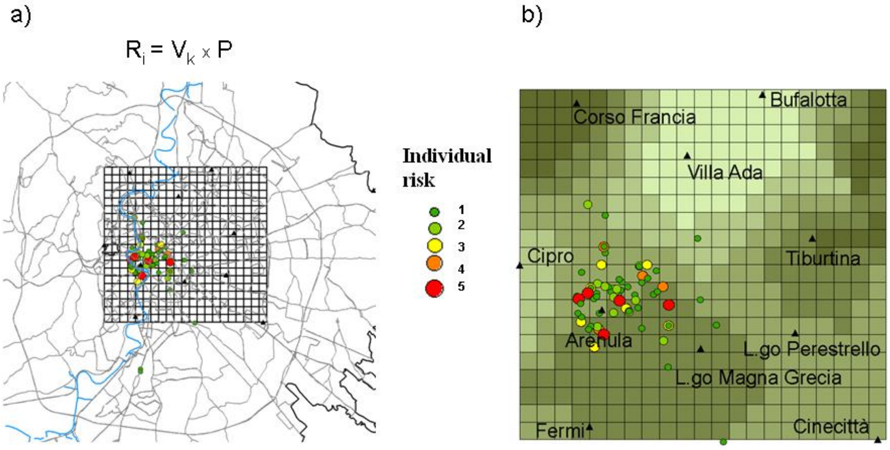
Fig. 5: Territorial Risk[115]



The territorial risk values obtained (expressed in n•µm/year) were divided into five classes. Cells in which no heritage assets are located have a zero territorial risk value and belong to class 1.
Class 5 corresponds to the highest risk and has been assigned to the grids containing between 156 and 215 assets.
Since territorial risks mainly (and obviously) depend on the distribution of the heritage assets, the cells located in the city centre, containing a larger number of monuments, are exposed to a higher risk of erosion.
The individual risk calculation was based on the surface vulnerability data of the 77 heritage assets listed in Table 5.
The individual risk was calculated by multiplying the erosion level of the cell in which a given heritage asset is located by the vulnerability data of the asset being analysed.
Like in the previous case, the data obtained was divided into 5 classes (Fig. 6): low risk heritage assets belong to class 1, whereas higher risk heritage assets belong to class 5.

[115] Source: ISPRA and ISCR

Fig. 6: a) Individual Risk for monuments in Rome
b) Superimposition of the individual risk map onto the erosion map[116]



Heritage assets featuring below-zero vulnerability, given the model used and the significant contribution of the vulnerability data, are low risk and belong to class 1; heritage assets featuring a higher vulnerability (over 1.5 u.a.) are higher risk and belong to class 5. Fig. 6b shows that the heritage assets, even if located in cells characterized by small differences in erosion values (from 6 to 6.2 µm/year), belong to very different risk classes. In fact, in the grids characterized by equal erosion, the individual risk mainly depends on the conservation condition of the heritage asset. Therefore, where local hazard conditions are equal, the individual risk is greatly affected by vulnerability.

Based on the results obtained in this experimental study, the monuments featuring the highest risk levels are the churches of S. Marco, S. Martino ai Monti, S. Tommaso in Parione, S. Filippo Neri and S. Cecilia in Trastevere, situated in the city centre near the Tiber River and characterized by a worse conservation condition.

[116] Source: ISPRA and ISCR

CHAPTER 4

INLAND WATER QUALITY

Introduction

The EU Water Framework Directive 2000/60/EC (WFD), transposed into Italian law (Legislative Decree 152/2006), has radically changed the procedures for controlling and classifying water bodies. The WFD is applied through the analysis and definition of four key aspects:

1. Typology: Member States are required to identify the distinct and significant characteristics of the WBs, based on their hydromorphology and physico-chemical characteristics.
2. Reference conditions: for each typology, Member States must establish a set of reference conditions reflecting, as far as possible, undisturbed natural conditions, i.e. featuring no or a neglectable human impact on the Biological Quality Elements (BQEs), as well as the hydromorphological, chemical and physico-chemical quality elements.
3. Monitoring networks: each Member State must set up monitoring networks, for the purpose of classifying the water bodies into one of the 5 classes of ecological status, namely “high”, “good”, “moderate”, “poor”, “bad”; and highlighting any changes in the ecological status of river basins defined as being “at risk”. The monitoring programs shall comply with the need of highlighting how the BQEs respond to any impacts, distinguishing the space/time variables, relating to the background levels, from any changes due to the human pressures of the system.
4. Classification system: the conditions shown for each BQE must be compared with the reference conditions. The WBs are classified as belonging to one of the 5 ecological status classes depending on their deviation from the reference conditions (*Ecological Quality Ratio*, EQR).

In order to provide specific guidelines for tackling each of the above mentioned application aspects of the WFD, three ministerial decrees (DM) have been issued implementing Legislative Decree 152/06, as follows:

- DM 131/2008, setting out the technical criteria for the characterization and typification of the water bodies;
- DM 56/2009 containing the procedures for monitoring and identifying the reference conditions for the water bodies;
- DM 260/2010 concerning the procedures for classifying the status of surface water bodies.

DM 260/2010 has, to all intents and purposes, introduced an innovatory approach to assessing the quality status of water bodies, integrating the chemical and biological aspects. The assessment of the ecological status is therefore conducted based on the study of the biological elements (composition and abundance), supported by the hydromorphological, chemical, and physico-chemical elements.

Another change introduced concerns the planning of the monitoring operations. Three different types of monitoring are provided for: surveillance, operational and investigative monitoring, according to the “risk” status, based on the assessment of the capacity the water body has of achieving the environmental quality objectives set for 2015, i.e. the attainment/conservation of a “good” environmental status, or the conservation of a “high” status, where this already exists.
Over the years, alongside this directive – which represents a significant milestone in EU policy on “water” – other complementary directives have been approved and communications have been issued by the European Union, addressing and providing detailed requirements, with respect to certain specific related thematic areas:

- the Groundwater Directive 2006/118/EC, implemented in Italy by Legislative Decree 30/2009, which sets out the criteria for identifying and characterizing groundwater bodies, laying down the standards and criteria for assessing the good chemical status of groundwater, with a view to determining and reversing the significant increasing pollution trends;
- the Floods Directive 2007/60/EC, implemented by Legislative Decree 49/2010, the aim of which is to reduce the destructive effects of floods by assessing and managing the related risks, consistently with the time schedules set out in the directive itself: the completion of a preliminary flood risk assessment by 2011; the completion of flood hazard/risk maps by 2013; the completion and publishing of flood risk management plans for the river basin districts by 2015;
- the Communication on Drought and Water Scarcity [COM(207)414], and subsequent annual reports prepared by the European Commission, which define the strategic sectors in which the Member States must intervene to improve the efficient use of water resources, including a common strategy for defining the indicators that need to be introduced to monitor drought and water scarcity.

The quality status of inland water bodies

The ecological status of the surface water body is classified based on the biological elements, supporting physico-chemical elements, and supporting chemical elements.

The ecological status of the surface water bodies can be classified based on the lowest class, resulting from the monitoring data, relating to the biological elements, the supporting physico-chemical elements, and the supporting chemical elements (other non-priority substances). In the case of operational monitoring, for the 3-year period classification, the worst average value calculated for each year is used; in the case of surveillance monitoring, the average value of each year is used.
If the overall status is found to be “high”, this result must be confirmed by examining the hydromorphological elements. If the outcome is negative, the water body is downgraded to “good”.
According to the chemical status classification, a water body that satisfies all the environmental quality standards with regard to the priority substances (according to section 2, letter A.2.6 table 1/A,

or 2/A, in the appendix to DM 260/2010), is classified as having a "good chemical status". Otherwise, the water body is classified as a water body of which is not acknowledged the good chemical status.

State of implementation of the Directive 2000/60/EC.

In December 2011, ISPRA published the results of the survey on the "Progress in the implementation of Directive 2000/60/EC in Italy – Results of the survey conducted by the ARPA/APPA entities"[1]. The data collected has been used to build a general picture of the implementation progress made by ARPA/APPA, with respect to the obligations set out in the WFD, as transposed into national law by the above mentioned decrees, for the various water bodies (rivers, lakes, groundwater, transitional waters, coastal waters), as well as the single operational phases (typification, identification of the water bodies, risk analysis, definition of the monitoring networks, completion of the monitoring plans, calculation of the measurements for classifying quality status, reporting). It was also possible to highlight the degree of involvement of the ARPA/APPA entities, either independently or in partnership with other institutional organizations, in the entire implementation process.

The data collected through dedicated questionnaires concerned the ARPA/APPA, except for those of Molise, Lazio, Basilicata and Sardinia, which failed to send in any data.

Following is an overview of the significant elements emerging from the analysis of the various phases.

Typification has been completed by almost all the ARPAs/Regions.

The typification process has been completed by almost all the ARPAs/Regions. The number of river typologies defined by the single regions does not appear to be correlated to the number of regional Hydroecoregions, with obvious anomalies in Campania, Veneto, Friuli-Venezia Giulia and Trento. This figure may be the result of peculiar regional characteristics, but may also be due to different interpretations of the typification method set out in DM 131/2008.

The water bodies have been defined by almost all the ARPAs/Regions.

The process of definition of the water bodies has been completed by almost all the ARPAs/Regions. The number of water bodies defined in the single regions does not appear to be correlated to the area of the region and/or density of the river network, as is clearly the case, for example, in the number of water bodies identified by the Autonomous Provinces of Trento and Bolzano (respectively, 412 and 270). Here again the result may be due to the different approach used to define the water bodies. The data also feature certain dissimilarities in the identification of temporary water bodies, probably due to the different methods and/or information used. The artificial network (canals) has been separately considered, as in the case of the Po Valley River Basin District, as can be evinced from the number of artificial water bodies identified in the regions of Piemonte (17), Lombardy (149), Emilia-Romagna (231), and Veneto (126). The data relating to heavily modified water bodies is affected by the fact that some regions have failed to report their number (Piemonte), because they have not been

[1] ISPRA, Reports, no. 150/2011

officially designated by the regional authorities, while others have reported the number of those designated by the region (Liguria), and yet others the number of those proposed for designation.

The risk analysis has been completed or launched in 76% of cases.

The risk analysis has been completed or launched in 76% of cases. The approach used is uniform and provides for the qualitative and quantitative analysis of the pressures. Instead, the assignment of the water bodies to the three proposed risk categories (at risk, not at risk, probably at risk) did not follow a uniform approach, as highlighted, for example, by the number of "at risk" water bodies in Veneto (10%) and Tuscany (50%).

The monitoring network has been defined and the plan of activities prepared by approx. 50% of the regions.

The definition of the monitoring network, and the preparation of the plan of activities, have been completed by approx. 50% of the regions. The monitoring activities have been launched according to different timescales in the different regions, although in over 50% of cases they were launched in 2010. Both chemical and biological monitoring has been deployed in almost all the regions, while morphological-hydrological monitoring in half. The selection of the chemical parameters and biological components to be monitored was made, in almost all the cases, based on the criteria set out in DM 260/2010. However, there are clear dissimilarities in the distribution of the number of water bodies subject to biological monitoring (1 or more components), compared to those subject to pollutant monitoring. The planning of the monitoring activities highlights how dissimilarities remain in the interpretation of the meaning of the various types of monitoring activities set out in the WFD, also in relation to the different levels of detail achieved in identifying the risk categories.
With regard to rivers and lakes, based on the results contained in the above mentioned Report and relating to the monitoring activities conducted in 2010, the following table shows the data reported in useful time, limitedly to three biological indicators, by Piemonte, Friuli-Venezia Giulia, Tuscany and the Autonomous Provinces of Trento e Bolzano (Table 4.1-4.2).

Table 4.1: Monitoring stations[2]

Region/Autonomous Province	**River stations**		**Lake stations**
	macroinvertebrates	**diatoms**	**phytoplankton**
	no.		
Piedmont	178	92	26
Bolzano	24	24	2
Trent	21	26	8
Friuli-Venezia Giulia	155	261	
Tuscany	146	119	
TOTAL	**524**	**522**	**36**

[2] Source: ISPRA, Reports, no. 150/2011

Table 4.2: Biological monitoring, breakdown into quality classes (2010)[3]

Region/Autonomous Province	High	Good	Moderate	Poor	Bad	TOTAL
Lake phytoplankton						
	Class					
Piedmont	8	12	6			**26**
Bolzano	2					**2**
Trent		1	6		1	**8**
TOTAL	**10**	**13**	**12**		**1**	**36**
River diatoms						
	Class					
Piedmont	43	32	9	8		**92**
Bolzano	17	5				**22**
Trent	24	1		1		**26**
Friuli-Venezia Giulia	134	41	27	15	3	**220**
Tuscany	44	59	14	2		**119**
TOTAL	**262**	**138**	**50**	**26**	**3**	**479**
River macroinvertebrates						
	Class					
Piedmont	18	64	68	20	8	**178**
Bolzano	12	4				**16**
Trent	7	2	5	1	6	**21**
Friuli-Venezia Giulia	7	58	54	10	1	**130**
Tuscany	16	78	36	15	1	**146**
TOTAL	**60**	**206**	**163**	**46**	**16**	**491**

The partial data coverage means that it can hardly be used for the purpose of determining the status of the water bodies at national level. Moreover, due to the stratified monitoring, the biological data cannot yet be integrated with the chemical / hydromorphological data - due to differences in time and space - as a result of which it is impossible to provide the overall (ecological and environmental) status of the water body.
More significant data coverage, with a greater amount of data, will be available after the completion of the first 6-year monitoring cycle (2010-2015).

The Groundwater Chemical Status defines the quality of this water resource. It is obtained through the analysis of the presence of both anthropic pollutants and chemical substances naturally present in the groundwater.

Groundwater quality is represented using the SCAS index (acronym of *Stato Chimico delle Acque Sotterranee*, Groundwater Chemical Status), which highlights the environmentally critical areas due to the chemical impact of human activities on the groundwater bodies. It is important to define the chemical status of each groundwater body, because, along with the quantitative status, determined by the removal and natural renewal of the groundwater due to the weather cycle, it enables the definition of the overall status of the water body. The impact on the chemical status of the groundwater is periodically quantified through the chemical analysis of the water, with a view to identifying the pollutants and

[3] Source: ISPRA, Reports, n. 150/2011

whether they have increased in time. There is a large number of undesired or polluting substances present in the groundwater, which can impair its use as drinking water, for example, although undesired substances are not always of man-made origin. Groundwater, in fact, naturally contains many chemical substances and elements, of geological and not man-made origing. For example, in deep and bordering aquifers, in flat areas, metals such as iron, manganese, arsenic, or substances such as ammonium ions, can easily be found, even in large concentrations, due to the anaerobic deterioration of buried organic substances (peat). In these contexts, the presence of chlorides (water salination process) can also be due to the "fossil" marine waters. Moreover, in volcanic environments (Tuscany, Lazio, Campania), groundwater can naturally contain sulphur, fluoride, boron, arsenic and mercury compounds. Metals such as hexavalent chromium can also be of natural origin in metamorphic environments, such as the Alps and the Appenines, in ophiolite (greenstone) areas, for example. On the contrary, the presence of pesticides, organic micropollutants, medium-to-high concentrations of nitrates, saline intrusions are undoubtedly of human origin. The chemical status of groundwater, therefore, is influenced by the anthropic component alone of the undesired substances found in it, once the natural components have been discriminated through the quantification of the background level for each groundwater body.

According to Legislative Decree 30/2009, the chemical status of groundwater bodies can be classified as either "good"or "poor".

The SCAS index – for each groundwater body monitoring station – can be either "good" or "poor". Until 2009, there were 5 status classes (Legislative Decree 152/99), one of which, class 0, comprising water with a low chemical status for natural causes, while the other 4 classes reflected a growing anthropic impact, from 1 to 4. Therefore, the current "good" chemical status class includes groundwater containing a concentration of pollutants or undesired substances below the quality standards set out in the European directives, or the threshold values established at national level. The latter may be changed by the regional authorities, with respect to both the substances and each water body, if the background concentrations drop below the threshold limit. In other words, the "good" status comprises all groundwater bodies with no evidence of an anthropic impact and those featuring undesired substances or contaminants of natural origin. On the contrary, the "poor" status comprises groundwater bodies that cannot be classified as "good" due to human impairment.

The chemical monitoring of groundwater bodies is conduced by means of increasingly organized measurement campaigns, based on (surveillance and operational) monitoring programs and networks, subject to ongoing improvement, with a view to accurately complying with the guidelines for calculating the SCAS index and monitoring anthropic impact.
The full implementation of the European Directives 2000/60/EC and 2006/118/EC, through the promulgation of Legislative Decree

30/2009, began with the 2010 monitoring campaign and, therefore, it is expected that the problems related to the consolidation of the monitoring networks will be solved within the next few years. Figure 4.1 shows the percentage breakdown of the typologies of monitoring programs, in respect of the Regions/Autonomous Provinces that have reported their data: the Autonomous Provinces of Trento and Bolzano and Lazio have not yet set up any stations featuring an operational program, unlike in Lombardy where, at present, they are all part of the operational program alone. Campania and Liguria have prepared a surveillance and operational program for all the stations, while the remaining regions feature mixed situations.
In 2010, all the regions launched the new chemical monitoring program, which, compared to the past, provided for multiannual sampling frequencies and the grouping of water bodies.
This determined, in 2010, a partial overview of the national context, which will be completed over the 6-year management period (Figure 4.2).

The Autonomous Provinces of Trento and Bolzano and Lazio have no stations featuring an operational program. In Lombardy, at present, all the stations are part of the operational program alone. Campania and Liguria have prepared a surveillance and operational program for all the stations.

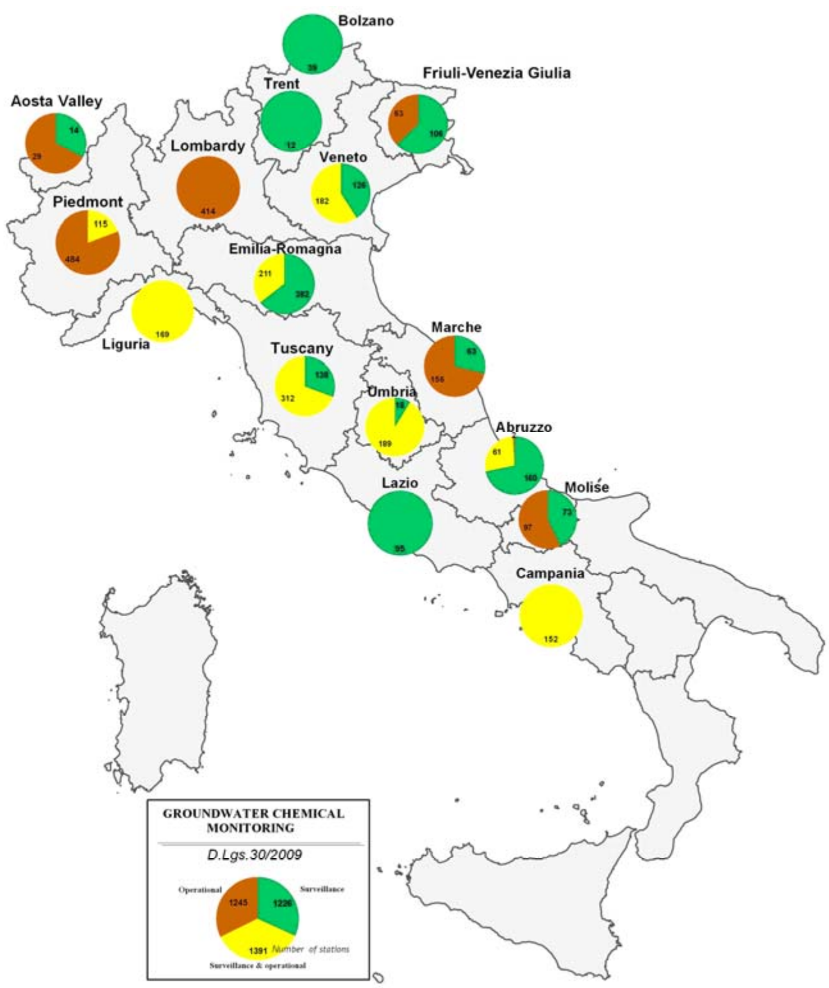
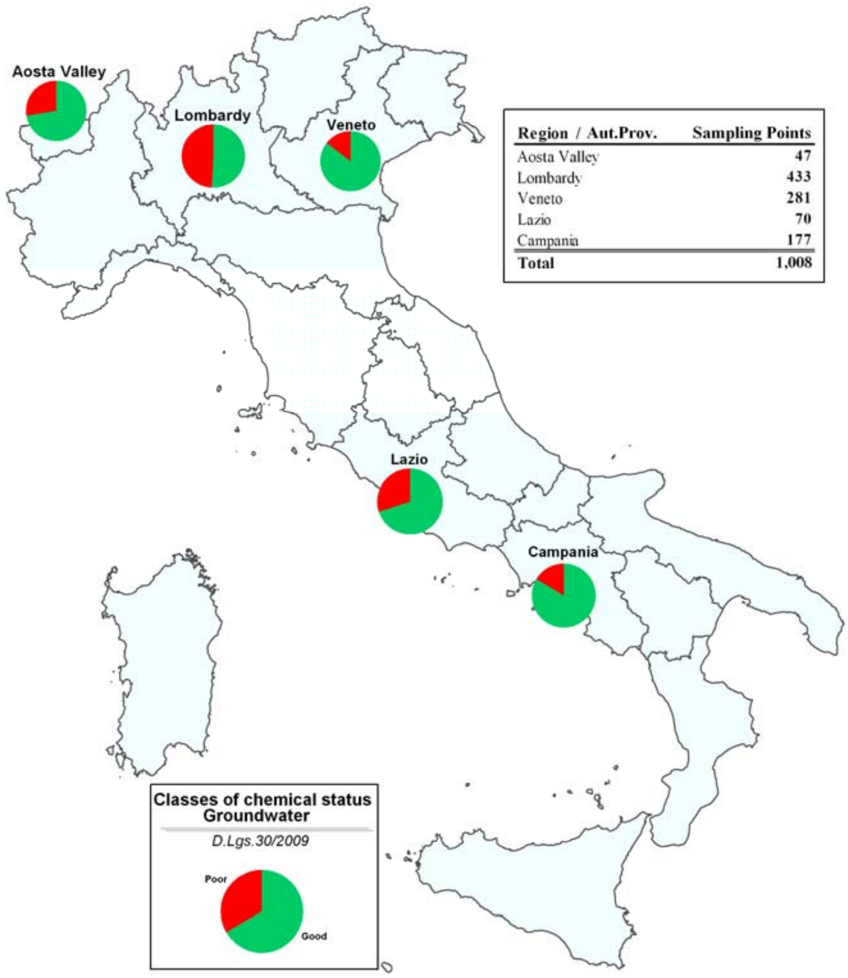


Figure 4.1: Geographical breakdown of the type and extent of the chemical monitoring of groundwater bodies (Legislative Decree 30/09)[4]

[4] Source: Data reported by the Regions, Autonomous Provinces and ARPA/APPA processed by ISPRA.

In 2010, the SCAS index was only partially available, awaiting its completion over the 6-year management period.



Region / Aut.Prov.	Sampling Points
Aosta Valley	47
Lombardy	433
Veneto	281
Lazio	70
Campania	177
Total	**1,008**

Note:
Quality judgement assigned to the classes (Legislative Decree 30/2009)
Good – The chemical composition of the groundwater body is such that the concentrations of pollutants do not feature the effects of saline intrusion, do not exceed the environmental quality standards and the established threshold values, and, lastly, do not prevent the achievement of the environmental objectives set out for the related surface waters, do not entail the significant deterioration of the ecological or chemical quality of the bodies, and do not significantly impair the land ecosystems that depend directly on the groundwater body.
Poor – When the groundwater body does not comply with the good chemical status conditions.

Figure 4.2: Chemical status of the groundwater bodies (2010)[5]

The systematic measurement and analysis of the hydro-meteorological variables, such as temperature, rainfall and river discharge, play a key role in land management fact-finding, with respect to the determination of the water balance, the study and prevention of extreme and human-induced events (flooding, drought, landslides, etc.), and for general climate assessment purposes.

The systematic measurement and analysis of the hydro-meteorological variables, such as temperature, rainfall and river discharge, play a key land management fact-finding role, with respect to the determination of the water balance, the study and prevention of extreme events.

The monitoring process also complies with specific environmental requirements. An example of this is the monitoring of river discharges, for measuring a river basin's response capacity to a weather event, necessary for soil protection purposes and for complying with Legislative Decree 49/2010, implementing the EU Floods Directive, and for assessing the water balance and the

[5] Source: Data collected by the regions, autonomous provinces and ARPA/APPA and processed by ISPRA/ARPA Emilia-Romagna

ecological status of the water bodies, as laid down in Legislative Decree 152/2006 and in the FWD.
These measurements are generally carried out by the regional bodies that have taken over the functions of the former local sections of the National Hydrology and Tidal Centres SIMN, and by the Air Force, regional weather forecasting services and the operators of the agricultural weather forecasting networks. Quantitative monitoring is conducted according to specific standards, protocols and procedures, such as the guidelines published by the SIMN in the brochure containing "Technical guidelines for collecting and processing hydrometeorological data – parts I and II", and according to the rules set out by the *World Meteorological Organization* (WMO).

The discharges measured in 2010, the relevant annual volumes recorded at the three catchment area outlets of the Tiber at Ripetta, the Adige at Boara Pisani, and the Po at Pontelagoscuro, are higher than both those recorded year over year.

With regard to the river discharges measured in 2010, the relevant annual volumes recorded at the three catchment area outlets of the Tiber at Ripetta, the Adige at Boara Pisani, and the Po at Pontelagoscuro, are higher than both those recorded year over year, and the average volumes calculated over the ten-year reference period 2001-2010 (Figure 4.3).
This is clearly a reversal of the trend recorded for the Tiber basin at Ripetta, where, in 2009, the recorded discharges were slightly below those relating to the previous decade.
However, the discharge data con be compared with the past only by taking into account the human-based activities affecting the water regimen, such as, for example, the construction of offtakes, branch canals and dams.

To measure the changes in flow rate in a waterway, compared to the reference period, it is necessary to analyze the normalized value of the average monthly discharge, as the ratio of the average monthly discharges recorded in 2010 to those calculated based on the average values of the previous decade (2001-2010).
In this case, we can observe how, at the Boara Pisani gauging station on the Adige river, in the first few months of the year (except January) and in July, the average monthly discharge values were lower than the average for the decade, but never below 25% of the reference discharge value (Figure 4.4).

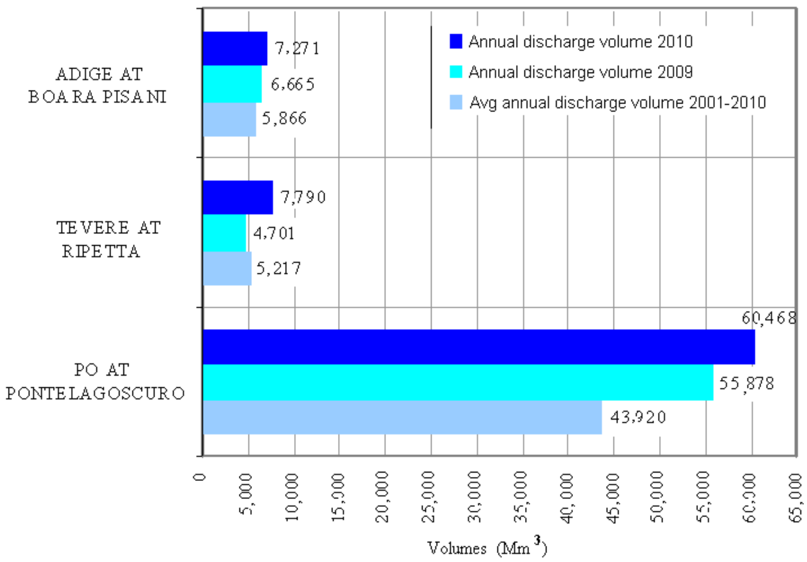
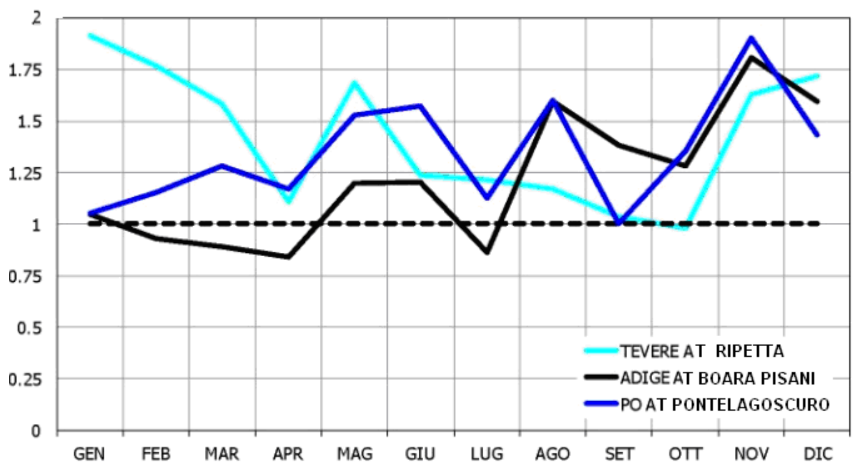


Figure 4.3: Comparison of annual discharge values in 2010, at the outlet of several national/interregional drainage basins, and the discharges recorded year-over-year and over the last decade, respectively[6]



at the Boara Pisani gauging station on the Adige river, in the first few months of the year (except January) and in July, the average monthly discharge values were lower than the average for the decade, but never below 25% of the reference discharge value.

Figure 4.4: Ratio of the avg monthly discharge in 2010, at the basin outlets of the Tiber at Ripetta, Adige at Boara Pisani, and Po at Pontelagoscuro (continuous lines) to the avg monthly discharge calculated over the 2001-2010 decade (dotted line)[7]

Having regard to the rainfall values in 2010, the theme map of the total annual rainfall (Figure 4.5), obtained based on the spatial comparison of the measured rainfall, provides nationwide information on the volumes of water flowing into the Italian drainage basins.

The map is based on the spatial interpolation (kriging method, using 1 km grids) of the values recorded by 1,505 rain gauge

In 2010, most of Italy featured intense rainfalls, especially in eastern Sicily, in the central-northern Appennines, and in the Po River valley and Veneto.

[6] Source: ISPRA, ARPA/APPA, regions and autonomous provinces

[7] Source: ISPRA, ARPA/APPA, rgions and autonomous provinces

stations located across the country.
The ratio of total precipitation recorded in 2010 to the average annual precipitation in the 30-year reference period, 1961-1990, provides a clear indication of the surplus rainfall that characterized most of Italy in 2010 (Figure 4.6). In 2010, it was exceptionally rainy in eastern Sicily, in the central-northern Appennines, and in the Po River valley and Veneto.
On the contrary, below-average rainfall was recorded along the Alpine Arc, especially in the western section, along part of the low Adriatic coastline, and in the eastern part of Sardinia.

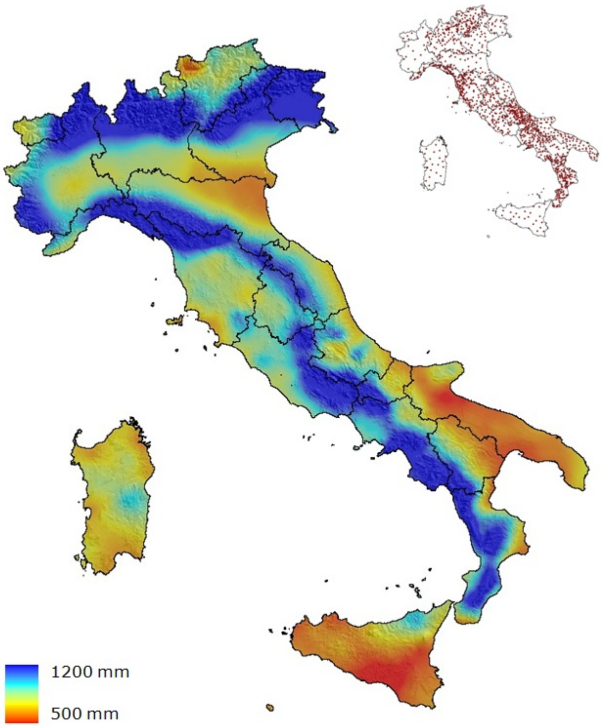
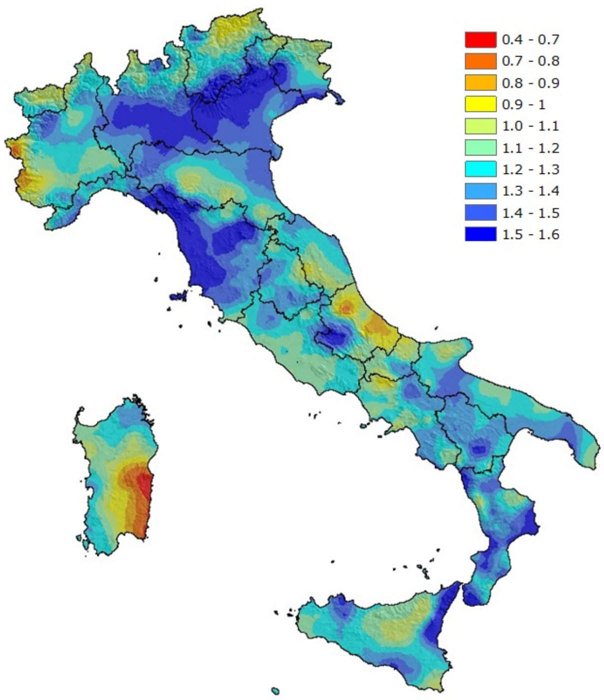


Figure 4.5: Total annual rainfall showing the location of the rain gauge stations used (2010)[8]

[8] Source: ISPRA, ARPA/APPA, regions and autonomous provinces



In 2010, it was exceptionally rainy in eastern Sicily, in the central-northern Appennines, and in the Po River valley and Veneto. On the contrary, below-average rainfall was recorded along the Alpine Arc, especially in the western section, along part of the low Adriatic coastline, and in the eastern part of Sardinia.

Figure 4.6: Ratio of total annual rainfall in 2010 to the avg total annual rainfall in the 1961-1990 30-year period[9]

Drought.

In this edition we have introduced drought assessment too. Drought is a temporary condition resulting from limited rainfall, defined as a deviation compared to the average weather conditions at a certain location. Its impact on the environment depends on the length of the drought conditions. A prolonged lack of rainfall (6-12 months) tends to affect river discharge values; if there is no rainfall for an even longer period (one or two years) this can significantly affect groundwater levels as well. In the light of the EU Communication COM(2007)414 addressing the challenge of water scarcity and droughts, the European Commission (through the Joint Research Centre), in partnership with the Member States, has set up a European Drought Observatory[10] (EDO) and defined a set of indices and tools for the Europe-wide assessment, monitoring and forecasting of drought.

Drought is monitored using the Standardized Precipitation Index *(SPI), which quantifies the rainfall deficit or surplus, compared to the climatological average.*

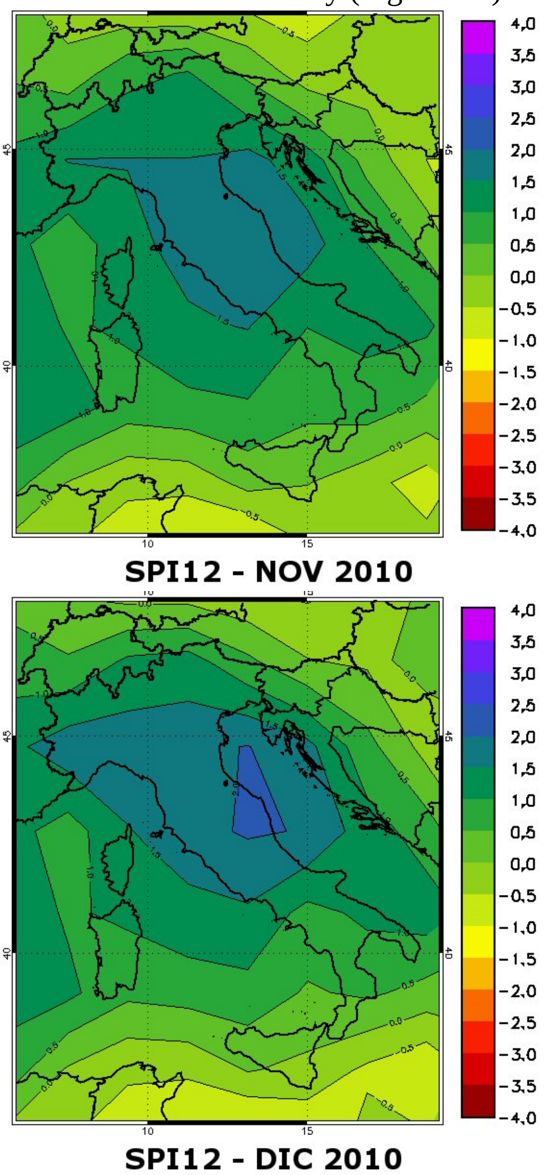
One of the indices used in the EDO bulletin for monitoring drought is the Standardized Precipitation Index (SPI). This index is commonly used, both nationally and internationally, for statistically quantifying – on a time and space scale – the rainfall deficit or surplus, compared to the climatological average. Monitoring by the EDO, based on a Europe-wide sub-sample of rain gauge stations, is carried out alongside monitoring on a national and regional scale, which is necessary to provide greater details on drought conditions. Several ARPAs (such as for example ARPA Emilia-Romagna, ARPA Piemonte and ARPA Sardegna), have been consistently including SPI-based drought monitoring, for some years now, in their hydrological bulletins. At national level, ISPRA provides monthly nationwide drought monitoring data (also including

[9] Source: ISPRA, ARPA/APPA, regions and autonomous provinces
[10] http://edo.jrc.ec.europa.eu/

several special areas of the continent and the Mediterranean Basin), by mapping SPI at 3, 6, 12 and 24 months, using precipitation data based on the reanalysis made on 2.5° grids of the National Centers for Environmental Prediction/Department of Energy (NCEP/DOE reanalysis). Over a total useful period of 12 months, for drought monitoring purposes, the SPI maps – calculated on the basis of the climatological reference period of 1948-2009 – do not highlight any drought events for 2010 (SPI < 0) such as to affect the discharge of rivers or the availability of groundwater. On the contrary, in 2010, especially in November and December, a surplus of rainfall was recorded (1.5 < SPI < 2.5), compared to the climatological average, in certain areas of central-northern Italy (Figure 4.7).

In 2010, a surplus of rainfall was recorded in certain areas of central-northern Italy.

In 2010, a surplus of rainfall was recorded (1.5 < SPI < 2.5), compared to the climatological average, in certain areas of central-northern Italy.



Legend:
>2 extremely humid; 1.5 to 1.99 very humid; 1.0 to 1.49 moderately humid; -0.99 to 0.99 almost normal; -1 to 1.49 moderately dry; -1.5 to 1.99 severely dry; <-2 extremely dry

Figure 4.7: The Standardized Precipitation Index at 12 months (November and December 2010)[11]

The principal causes of change

[11] Source: NCEP/DOE *Reanalysis data* processed by ISPRA, ISPRA drought bulletin (http://www.isprambiente.gov.it/pre_meteo/siccitas/index.html)

Water used for domestic, agricultural, livestock breeding and industrial purposes often contains substances that can modify the ecosystem, for which reason it cannot be discharged directly into the waterways and the ground.
The most common polluting agents contained in water are fecal pollutants, toxic and harmful inorganic substances, non-natural organic substances, oils and emulsifiers, suspended solids, heat, etc..

Water pollution is primarily caused by human-based activities.

The massive anthropization and industrialization of urban areas often produces the discharging of untreated residential sewage, residual raw materials and intermediate/final industrial products, as well as the waste and polluting substances running off concrete surfaces.
In some cases, the waste collection and treatment processes are insufficient or unsuited (from the point of view of their potential, levels of treatment, lack of rainwater tanks) to mitigate the polluting load of the residential/industrial wastewater volumes produced in urban areas.
To this we must also add the problems in controlling industrial drainage, and the limited sensitivity towards these problems by a number of businesses.

Industrial plants produce chemical and heat pollution.

Large industrial plants besides producing pollution due to toxic and harmful inorganic substances (ions of heavy metals such as Cr^{6+}, Hg^{2+}, Cd^{2+}, Cu^{2+}, CN^{-}, phosphates and polyphosphates) and non-natural organic substances (acetone, trichlor, benzene, toluene, etc.), also produce heat pollution, which, by modifying the temperature of the water alters the chemical and biochemical balance of the water bodies, reducing the solubility of the dissolved oxygen and causing pathological alterations, the disappearance of certain living species, or the development of other normally absent species.

The presence of polluting gases in the air produces "acid rainfall", with either direct or indirect consequences on aquatic organisms, besides damaging human health.

Industrialization is also responsible for acid rain, caused by the contamination of rainwater by the gases present in the atmosphere (carbon dioxide, sulphur dioxide, nitrogen dioxide, etc.), which have harmful effects on aquatic ecosystems.
The consequences on aquatic organisms can be either direct, due to the toxicity of the water, or indirect, due to the disappearance of certain plant species, or of the elements of the food chain most sensitive to acidification.

The acid content of rivers and lakes, in fact, can modify the community of diatoms and brown algae, and may also affect the distribution and variety of the fish fauna.
Moreover, it can also indirectly damage human health, through eating food products harvested from acid water, such as, for example, fish that have accumulated large quantities of toxic metals in their bodies (aluminium, manganese, zinc, mercury, cadmium).

Overexploitation of water and water resources also has harmful effects. Areas with high population densities feature a significant degree of criticality due to their enormous demand of water for residential, industrial, agricultural and recreational purposes. Lastly, overexploitation of water aquifers in coastal areas can determine the penetration of seawater into the aquifer, as a result of which the saline content of the groundwater increases and it becomes no longer suitable for its legitimate uses.

Areas with high population densities feature a significant degree of criticality, due to their enormous demand of water.

The presence of intensive livestock breeding activities generates a great deal of environmental pressure too, due to the organic waste produced and its discharge into the environment by surface runoff. The massive use in agriculture of fertilizers and plant protection substances can also impact aquatic life and modify the nature of surface and groundwater for potable use.

Livestock breeding and the massive use of plant-protection products and fertilizers in agricolture can impact aquatic life.

An emerging problem in freshwater basins is the formation of potentially toxic algal blooms.

Algal blooms.

Freshwater basins are among the most important resources for human life, because of the activities that take place around them, and because they are important reservoirs of water that can be directly exploited.

Due to the constant increase of industrial and agricultural activities in Italy (and the rest of the world, for that matter), these reservoirs of water have generally been affected by a process of "eutrophication", which means an increase in the amount of nitrogen and phosphorus, in the form of nitrates, nitrites, ammonium and inorganic phosphates.

The excessive use of fertilizers, over the years, has increased the amount of organisms such as algae, which, when they multiply beyond a certain limit produce a so-called 'algal bloom'.

The excessive use of fertilizers has increased the amount of algae in the environment.

In the most highly eutrophied river basins, where the aquatic environment is most deteriorated, so-called "frontier species" can prevail, capable of producing highly toxic substances.

The presence of cyanobacteria, or green-blue algae, in freshwater bodies is a considerable health hazard, due to their capacity to poduce toxic substances (cyanotoxins), to which human beings can be exposed in a number of ways.

The presence of cyanobacteria is a considerable health hazard, due to their capacity to poduce toxic substances for human beings.

The blooming of species such as *Microcystis aeruginosa*, *Planktothrix rubescens*, *Anabaena flosaquae*, and other toxin-producing cyanobacteria, have been reported for many decades now all over the world, and especially in the USA, Australia, Japan and South Africa.

In Italy, algal blooms of toxic cyanobacteria are causing both ecological and health problems.

To date, the literature records their presence and blooming in no less than 61 lakes and artificial reservoirs[12].

The most frequently detected toxins – called microcystins – are, to all intents and purposes, are new tumor-promoting substances that need to be carefully followed, with respect to their environmental

[12] ISTISAN Reports 11/35 pt 1 and 2, 2011, *Cianobatteri in acque destinate al consumo umano. Stato della conoscenza per la valutazione del rischio*

"destiny" and their presence in the food chain.
The presence of cyanobacteria in surface waters is of natural origin. However, increased eutrophication has favored their widespread growth, with the consequent formation of blooms visible even to the naked eye.
The presence of cyanobacteria blooms in freshwater bodies used for human consumption is becoming a widely felt problem worldwide, also as a result of global warming, which contributes to increasing the concentration of nutrients in reservoirs used for water supply, and which are not sufficiently replenished due to diminished rainfall.
The presence of a toxic species in lake phytoplankton is not, in itself, an environmental risk indicator, although the increased concentration of nutrients, combined with other factors, such as water temperature, lake depth, sudden reductions in the amount of water, due to increased use of water for producing electricity, for example, can trigger eutrophication events.
Moreover, the lakes that hosts bloomings of toxic species can also produce a new hazard, the incidence of which we are still unable to exhaustively assess.
The toxins produced can, in fact, percolate through the geological strata and reach the surrounding soil and the aquifers that concur in creating the lakes themselves, thus contaminating the drinking water reserves and wells and, ultimately, the water supply systems.

Another hazard is represented by the percolation of the toxins, produced by the algal blooms, into the soil and aquifers, reaching the drinking water reserves and therefore contaminating the water supply systems.

The instruments for protecting the quality and quantity of water: evolution and state-of-the-art

The evolution of the instruments developed for protecting the quality and quantity of water in Italy should be viewed within the framework of the overall adaptation of domestic legislation to the Community regulations governing water, and especially the WFD.
The cornerstone of the WFD is the integrated management of all the water bodies present in the catchment area, according to an approach the aim of which is to focus on the general biological aspects of the area as a whole, going beyond a purely administrative rationale.
The directive's objective is to protect, improve and restore the status of all surface water bodies, which are expected to achieve a "good status" within the time horizon of 2015.
A good status is a condition whereby the values of the biological quality elements, associated with a certain type of surface water body, are not unduly distorted as a result of human activities and, consequently, differ only slightly from those generally associated to that typology of water body in unaltered conditions[13]. This entails that, in order to achieve these objectives, an integrated approach is needed aimed at protecting and, indeed, restoring all the factors that contribute to the very definition of the status of the water body. Ultimately, the general objective of the WFD Directive is to ensure that the water body is conserved in – or restored to – a quality status as far as possible close to conditions unaffected by human impact.
Against this backdrop, the directive strictly defines a phased process culminating

The District Management Plan is the tool for planning, implementing and monitoring the measures for protecting, rehabilitating and improving the

[13] Therefore, a good status must feature hydromorphological, physical and physico-chemical conditions consistent with those established for the biological elements.

in the introduction of a special instrument for governing catchment areas, subject to periodical evaluation and updating, the so-called District Management Plan. This is the operational tool for planning, implementing and monitoring the protection, rehabilitation and improvement of surface and groundwater bodies, while promoting the sustainable use of all water resources[14].

water bodies.

The most innovatory aspects of the Management Plan, compared to the more conventional approaches, essentially consist in the fact that it:

Innovatory aspects of the Management Plan.

- encompasses and harmonizes, in a single tool, all the actions required by other directives relating to other fields and sectors (agriculture, soil protection, protected areas, etc.);
- requires the specific evaluation of the technical and, above all, economic sustainability of the decisions based on ad hoc instruments, such as economic analyses, cost-benefit analyses, and cost-effectiveness analyses;
- has been developed based on the activation of public participation mechanisms.

In Italy, the process for implementing the WFD into national law took a significant leap forward with the promulgation of Legislative Decree 152/2006 (as amended), which modified and integrated the existing legal framework – essentially based on Laws 183/1989 and 36/1994, and on Legislative Decree 152/1999 – which, generally speaking, already anticipated certain innovations introduced by Directive 2000/60/EC.

The WFD was implemented within a regulatory framework that already featured some of its more innovatory aspects.

Law 183/1989, in fact, 11 years before the WFD, introduced the concept of river basin planning, launching the implementation of an integrated basin-wide management and protection system. In this framework, the Regional Water Protection Plan (PTA – introduced under Legislative Decree 152/99), which anticipated several of the contents of the WFD[15], had been conceived as a functional part of the broader River Basin Plan, with a twin-pronged approach defining the set of actions aimed at, (i) ensuring the achievement, or conservation, of the water-body quality objectives, and (ii) pursuing the qualitative and quantitative protection of the water system as a whole.

Based on the principle of subsidiarity, and consistently with the objectives and priorities identified by the River Basin Authorities, the regional authorities were made responsible for developing, adopting, improving and implementing the PTA. In the hierarchy of regional land management instruments, PTA – as constituent parts of the river basin plans – have been designed as higher-level instruments, which all the national, regional and local plans and programmes relating to economic development, land use, and environmental protection should coordinate with and conform to.

The transposition into national law of the WFD, and the ensuing reconfiguration of the land management governance instruments and levels, has also entailed the partial redefinition of the role of the PTA. Legislative Decree 152/06 (as

[14] With regard to protection actions, the core of the Management Plan consists of a programme of measures designed so as to integrate all the water protection aspects, taking into account the characteristics of the river basin district, the impact of human activities on the surface water/groundwater, and the economic analysis of water use. The measures are grouped into “basic measures” (implementing the Community regulations and aimed also at the recovery of the costs of water services and ensuring the efficient and sustainable use of the water) and "supplementary measures", namely those measures designed and implemented in addition to the basic measures, with the aim of achieving the environmental quality objectives.

[15] Legislative Decree 152/1999, in introducing a reform of the measures for protecting water resources, based on environmental requalification, preservation and sustainability, was inspired by the draft WFD, which, at the time, was already in an advanced state of development, even though it contains some significant differences.

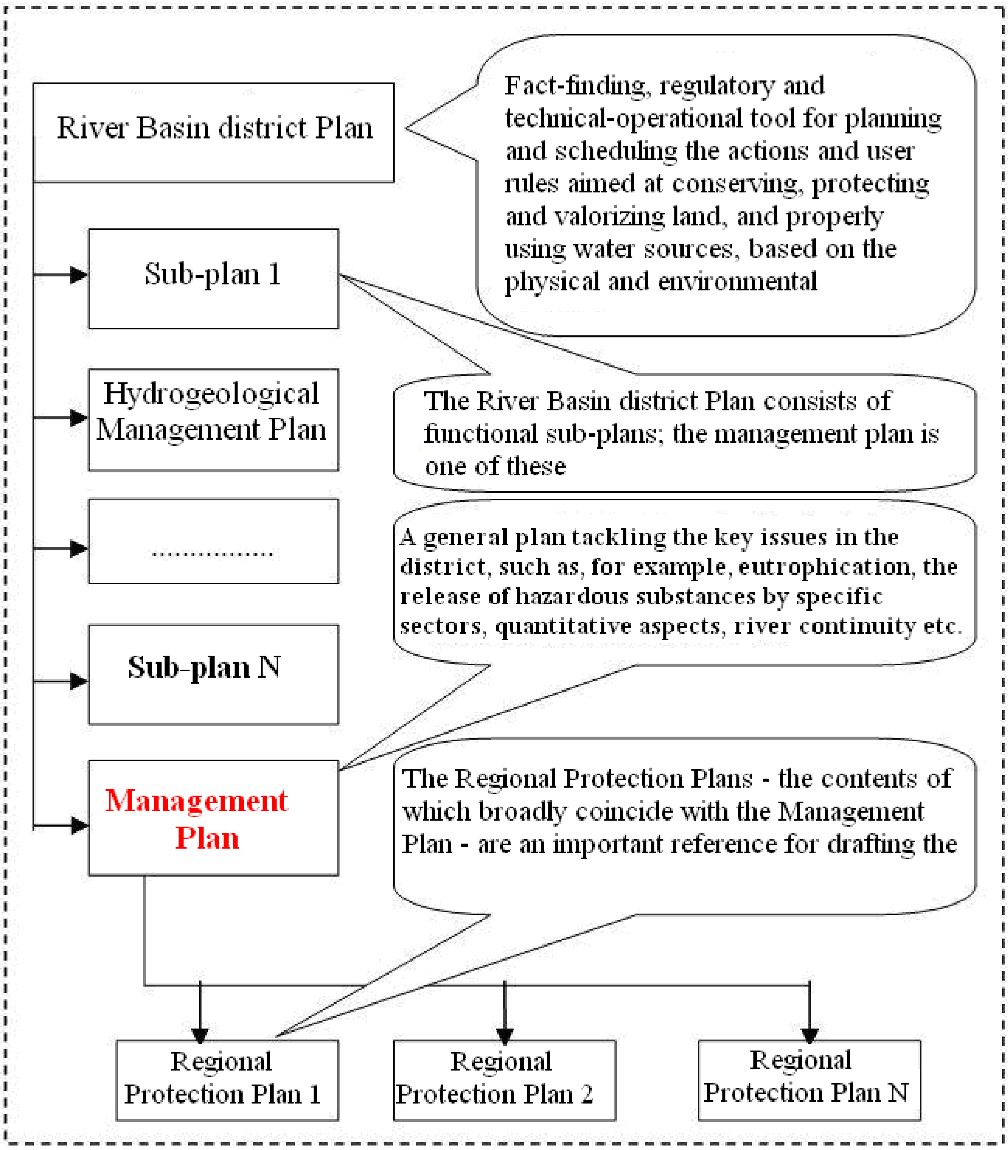
amended), which transposed the directive, divides the country into 8 river basin districts, providing for a Management Plan for each district.
The river basin districts are: Eastern Alps, Po River Valley, Northern Appennines, Serchio River, Central Appennines, Southern Appennines, Sardinia, Sicily (Figure 4.8).

The division of Italy into 8 river basin districts: Eastern Alps, Po River Basin, Northern Appennines, Serchio River, Central Appennines, Southern Appennines, Sardinia, Sicily.

Figure 4.8: The Italian river basin districts[16]

In this new context, the role of the PTAs has been gradually redefined, to the point that, in the present regulatory framework, they are no longer part of the broader river basin plans, but ‘sectoral regional plans’, through which the regions – based on the objectives established for the river basin districts by the district Authorities, define the actions and projects that need to be put into place to ensure the achievement, or conservation, of the quality objectives of the water bodies, and the necessary measures for the qualitative and quantitative protection of the regional water system. The Protection Plan, in fact, has changed its nature from higher-ranking government plan to district planning implementation plan (Figure 4.9).

[16] Source: ISPRA



The River Basin District Plan is a higher planning-level plan, which can be implemented at the different spatial scales.

Figure 4.9: Diagram of district planning in Italy[17]

The transitional provisions introduced to govern the delicate transition between Legislative Decree 152/1999 and Legislative Decree 152/2006, are of great importance, because they establish that, until the promulgation of the corresponding measures adopted in connection with part three of the decree (relating to water), the measures implementing the repealed provisions, including the protection plans, would remain fully valid and effective.

The process for implementing the Management Plans took place *ex lege*[18], under the the coordination of the national Basin Authorities, for the peninsular river basin districts, and of the regional authorities of Sicily and Sardinia for the insular river districts.

Taking into account the importance – recognized at Community level – of public participation, information and consultation, the Management Plans have been developed involving the local stakeholders in the formation process. In particular, to promote the knowledge of the plan documents at grassroots level, an integrated consultation and communication process has been launched, based on both the Web and public meetings, for collecting the proposals of the stakeholders and of

[17] Source: http://www.direttivaacque.minambiente.it/

[18] Decree Law 208/2008, amended and converted into Law 13/2009

businesses.
Several Management Plans (Po River Valley and Northern Appennine districts) provide for the promotion and launching of pact-based implementation instruments, such as the so-called "river contracts" (see the Special Focus Box below), among the supplementary measures, with a view to fostering grassroots participation in the decision-making process (especially in view of the first update in 2015).

In 2010, all the District Management Plans have been adopted. 14 PTAs have been approved, 4 adopted, 1 partially adopted, and 1 is being developed.

The basis for the District Management Plans are the regional PTAs, the so-called *Piani d'ambito territoriale ottimali* (Translator's note: practically untranslatable, like many aspects of Italian bureaucracy; they are essentially plans regarding sub-regional districts set up for the purpose of providing, in this case, water supply services), along with river basin planning in accordance with Law 183/89. To date, all the District Management plans have been adopted, while, as regards PTAs, the overall situation is the following: 14 have been approved at national level (Veneto, Autonomous Province of Trent, Piedmont, Lombardy, Liguria, Emilia-Romagna, Tuscany, Aosta Valley , Marche, Lazio, Umbria, Apulia, Sicily, Sardinia); 4 adopted (Basilicata, Calabria, Campania and Molise), one partially adopted (Autonomous Province of Bolzano), and one is being developed (Friuli-Venezia Giulia).
The reform of the institutional and organizational structure of the so-called Integrated Water Service (IWS), incepted by the framework Law 36/1994 (the so-called "Galli Law"), and currently set out in Legislative Decree 152/06, provides for a series of bureaucratic formalities by the regional authorities, including: (i) the demarcation of each so-called *Ambito Territoriale Ottimale* (ATO) (see above), (ii) the definition of the institutional forms of collaboration between the different entities within each ATO (contracts or consortiums, Legislative Decree 267/2000), and, last but not least (iii) the definition of the relations between the ATOs and the IWS operators. To date, all the regions have passed regulations in this respect, except for Trentino-Alto Adige, due to the special autonomy enjoyed by the provinces of Bolzano and Trento. With regard to the demarcation of the ATOs, generally speaking they coincide with the provinces. In fact, Valle d'Aosta, Puglia, Basilicata, Molise and Sardinia have set up a single region-wide ATO; Liguria, Lombardy, Friuli-Venezia Giulia, Emilia-Romagna, Calabria, Sicily have established ATOs coinciding with the provincial boundaries, while in Piemonte, Veneto, Umbria, Marche, Lazio, Abruzzo the boundaries of the ATOs almost coincide with the provincial boundaries, and Tuscany and Campania, entirely different demarcation criteria have been used.
Article 149 of Legislative Decree 152/06 provides for the development, by each ATO Board, of a so-called "ATO Plan" (abbreviated, in Italian, as PdA), setting out a survey of the water supply networks, sewers and wastewater treatment plants (analysis of the condition of the infrastructure), and medium-to-long term planning activities, with respect to the IWS, based on a detailed schedule of actions and an economic and financial plan, according to a specific management and organizational blueprint. The applicable regulations (Legislative Decree 152/06 and DMLLPP 01/08/1996, the latter being commonly known as the "Normalized method"), provide for the routine review of rates every 3 years, and therefore of the PdA (art. 8 DMLLPP 01.08.1996)[19]. At July 2009, a total of 84 Plans had been approved and 1 drafted[20]. The regions that have not yet completed

[19] With regard to the reviews, 30 ATOs, out of 84 approved Plans, have carried out one or more updates of the PdA
[20] COVIRI, Report on the state of water services, 2009

the procedure are Aosta Valley, Lombardy and Friuli-Venezia Giulia. In percentage terms, the approved plans cover 95% of the population (with a population of 55.2 million), while the completed ones concern 1.5% of the population. In short, the completed planning concerns about 96.5% of the population.

GLOSSARY

Reference conditions:
Conditions that reflect a non-existent or neglectable human impact, with respect to the natural physico-chemical and hydromorphological characteristics, for each typology and each biological quality element (BQE).

River contracts:
Voluntary agreements concluded between the institutional, social and economic stakeholders of an area crossed by a river or a river basin.

BQE-Biological Quality Elements:
BQEs (phytoplankton, benthic macroinvertebrates, macroalgae, angiospermae) play a key role in assessing the ecological status.

EQR - Ecological Quality Ratio:
Biological assessment results (BQEs) need to be expressed using a numerical scale between zero and one, the Ecological Quality Ratio (EQR). The EQR value one represents (type-specific) reference conditions, while the values close to zero identify a bad ecological status.

Eutrophication:
A degenerative process of the aquatic ecosystem due to an overabundance of nutrients (phosphorus and nitrogen), such as to modify its balance.

District management plan:
A technical tool for managing river basin districts introduced by the Water Framework Directive.

Acid rain:
Contamination of rainwater by the gases present in the atmosphere.

Discharge:
Volume of water (in cubic metres) passing through any given section of a waterway in the time unit (second).

Typification:
The identification of distinctive and significant sections of a water body based on its hydrological and geomorphological characteristics.

SPECIAL FOCUS BOX

River contracts

River (or lake) contracts are a relatively new and gradually spreading instrument, in Europe and Italy, for tackling the multiple problems of rivers in an integrated agreement-based manner. River contracts are essentially based on the voluntary conclusion of agreements between the institutional, social and economic stakeholders of a river area or basin. The agreements are aimed at tackling the environmental problems of the area, according to an integrated and multidisciplinary approach.

In a multilevel governance framework, the aim of river contracts is to involve all the partners in building a participated mechanism, in which the strategic and operational decisions are taken together and lead to specific commitments and undertakings, by the partners in the process, as a result of which the measures and actions are no longer seen as mandatory obligations imposed from the top down, and therefore scarcely effective[21].

River contracts can be perfectly integrated within the (domestic and European) regulatory framework, which assigns an increasingly central role to access to information and participation in defining environmental policies[22]. Therefore, river contracts can become a strategic intermediate level, between the district and local levels, for the achievement of the protection objectives set out in the WFD.

At European level, the first contracts were concluded in France, at the beginning of the 1980s, and soon spread in many other countries, such as Belgium, Luxembourg, the Netherlands, Spain and Italy. The most advanced experiences have been made in France[23] and Belgium (in Wallonia)[24], where river contracts are legitimized by specific ministry circular letters.

In Italy too river contracts are spreading at a significant rate. At present, 39 such contracts have been launched, or are already in the preliminary phase, plus a lake contract. The two most virtuous regions in this respect are Lombardy and Piemonte, which are also the only two regions that have also set up a solid regulatory base, Lombardy with Regional Law 26/03, title V, chapter II of which identifies river contracts as partnership development processes, functional to the launching of river rehabilitation schemes. Instead, in

[21] For further information, see Massimo Bastiani, *Contratti di fiume – Pianificazione strategica e partecipata dei river basins*, 2011, Dario Flaccovio Editore

[22] For reference: Water Framework Directive 2000/60/EC; European Landscape Convention (2000); Directive 2003/4/EC; Directive 2005/35/EC; Directive 2001/42/EC

[23] The *Contract de Rivière* (CR) is a voluntary non-binding agreement based on strong concertation between entities and between planning/programming levels, and on the involvement of the local communities, primarily with respect to information and consultation. To date, about 232 such *Contract de Riviere* have been launched, completed or are under way (www.gesteau.fr)

[24] The involvement of non-institutional players has been addressed through the substantial balancing of the institutional and the socio-economic players taking part in the participatory process. The Region of Wallonia has proved to be particularly sensitive to agreement-based mechanisms at local level, and has decided – since 1993 – to support them by issuing a circular letter setting out the acceptability criteria and the manner of implementation of the river contracts. A river contract is introduced as a "memorandum of understanding between all the public and private partners, aimed at reconciling the multiple functions and use of rivers and their basins", highlighting the concertation role

Piemonte, river/lake contracts are specifically mentioned in the technical regulations implementing the Regional Protection Plan (art. 10), and in the regulations implementing the Regional Land Management Plan (adopted in December 2008).
An important step forward towards the full recognition of river contracts, as instruments for implementing regional management policies at the scale of water bodies, concerns the District Management Plans relating to the Po River Basin and the Northern Appennines. River contracts, in fact, are included among the supplementary measures for achieving the objectives set out in the plans and, ultimately, in the WFD.

Table 1: River contracts in Italy[25]

Region/Autonomous Province	**Contracts started or in a preliminary phase or in the design phase**
	no.
Piedmont	8
Aosta Valley	-
Lombardy	6
Bolzano	-
Trent	*1*
Veneto	3
Friuli-Venezia Giulia	-
Liguria	-
Emilia-Romagna	4
Tuscany	2
Umbria	3
Marche	-
Lazio*	1+1
Abruzzo	1
Molise	-
Campania	2
Apulia	1
Basilicata	1
Calabria	-
Sicily	1
Sardinia	2
TOTAL	**36 + 1**

Note:
* 1 river and 1 lake contract

[25] Source: Coordination of the national committee on river contracts (2011)

CHAPTER 5

THE SEA AND COASTAL ENVIRONMENT

Introduction

The position of the Italian peninsula divides the Mediterranean into two main basins, which are to all intents and purposes semi-enclosed seas: the Western Mediterranean, which is bounded by the Strait of Sicily and features broad abyssal plains, and the Eastern Mediterranean, much more irregular and dominated by the Mediterranean Ridge. The Italian coastline is approx. 8,000 km long, also considering the straight stretches of shore running inland at the mouths of rivers, the port and maritime structures (so-called "spurious" coastline), and the stretches of man-made coastline consisting of permanent offshore structures built alongside the coast. Over 9% of the coastline is man-made, comprising works close to the shore (3.7%), port structures (3%) and other structures superjacent to the coastline (2.4%).

The Italian coastline is approx. 8.300 km long.

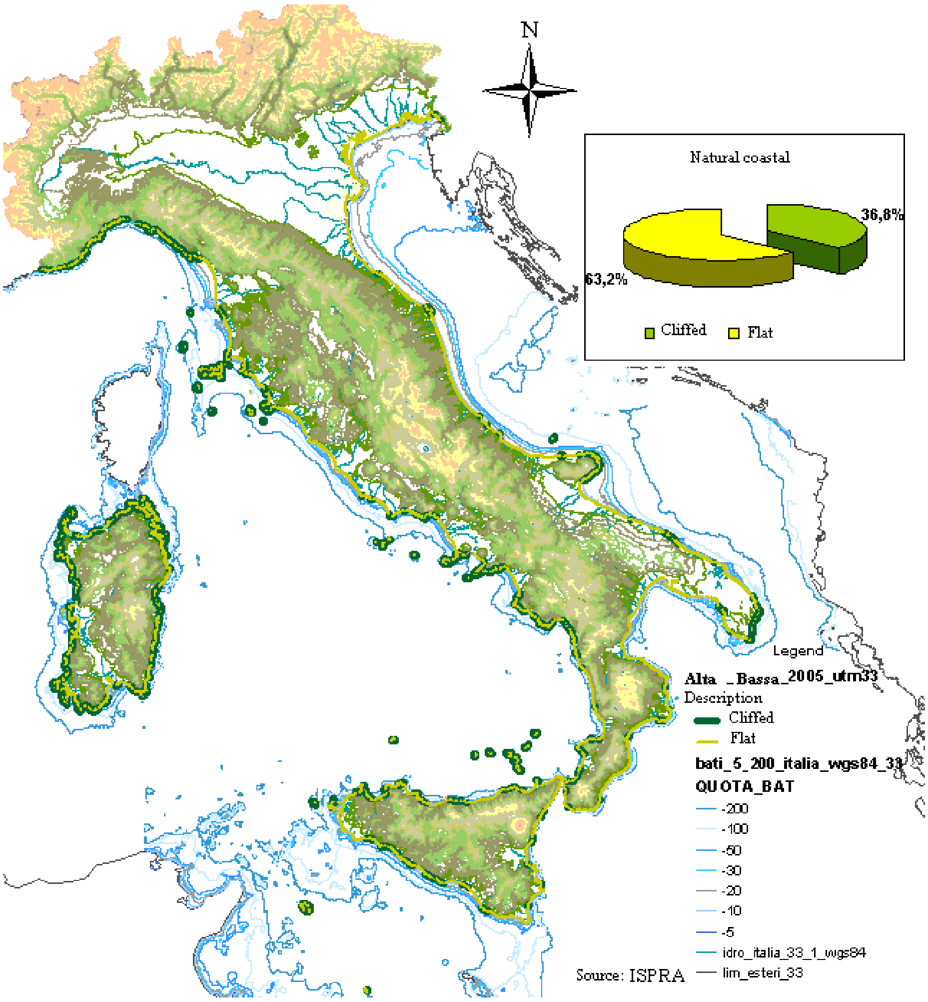


Figure 5.1: Map of the Italian coastline, showing the cliffed and flat coasts[1]

[1] Source: ISPRA, Map built using the ortophotos of the IT2006 flight

The natural coastline (Figure 5.1) is approx. 7,500 km long. Over a third consists of cliffed coasts, more or less tall and craggy, with rocky outcrops, which can be found predominantly along the shores of the two main islands, Sardinia and Sicily, and along the Tyrrhenian seaboard, in the regions of Liguria, Toscana and Campania.

The natural coastline is 7,500 km long.

Flat - sandy and rocky – shores are present on all seaboards, often alternating with rocky cliffs, or in between two promontories, except for the Adriatic seaboard, which consists almost exclusively of long straight sandy beaches or river deltas, as well as the most extensive lagoon areas in the country (see the special-topic box on the Venice Lagoon).

About 70% of the flat coast consists of sand or shingle beaches, for a total length of 3,270 km and a land area of over 120 km^2.

70% of the flat shores consist of sand or shingle beaches, for a total length of 3,270 km and an area of 120 km^2.

Italian beaches are generally broad (several tens of metres), and are present primarily on the Adriatic seaboard.

The broadest beaches are located on the coastline of Emilia-Romagna and Veneto; Sicily is the region with the most kilometres of sandy beaches, while Calabria features the largest area (km^2) of beaches, which account for no less than 20% of the entire area of the country.

The coastal – or "littoral" – environment is a dynamic ecosystem, where the natural and anthropic processes merge and interact, altering its geomorphological, physical and biological characteristics.

Coastal dynamics.

The sandy shores are the most vulnerable areas where these changes can be most clearly observed.

The continuous movement of the sediments by the sea (currents, tides, waves, storms) subjects the coastal areas to ceaseless change, with moving shorelines and land areas that are alternately submerged by the sea and then re-emerge, even in the space of a season.

This "destructive" action by the sea is opposed primarily by the "constructive" actions of the rivers, which carry large amounts of sediments from the interior, which serve the purpose of "nourishing" – i.e. restoring – the shingle and sand shores, and by the many maritime works, which are built to prevent the gradual accumulation of sediments at the mouths of the rivers and hinder their movement along the coastline.

Over the last few decades, the Italian coastline has undergone significant geomorphological changes, determining a predominance of – primarily anthropic – coastal erosion.

Table 5.1: Changes to the flat shoreline, in the periods 1950/1999 and 2000/2007[2]

Shoreline	1950/1999 (changes >+/-25m)		2000/2007 (changes >+/-10m)	
	km	**%**	**km**	**%**
Stable	2,387	49%	2,832	60%
Changed	2,227	46%	1,747	37%
Erosion (erosion)	*1,170*	*24%*	*897*	*19%*
Accretion	*1,058*	*22%*	*851*	*18%*
Undefined	248	5%	143	3%
TOTAL	**4,862**	**100%**	**4,722**	**100%**

Between 1950 and 1999, 46% of flat shores underwent changes in excess of 25 metres. Between 2000 and 2007, 37% of the shores underwent changes in excess of 10 metres, and the stretches of receding shores (897 km) exceed the total length of the advancing shores (851 km).

Between 1950 and 1999, 46% of flat shores underwent changes in excess of 25 metres and, despite the beach nourishment, which have nevertheless reclaimed large sections of coastline from the sea, the overall length of the receding shoreline (1,170 km) exceeds that of the advancing shoreline.
The analysis of the changes to the shoreline in the period between 2000 and 2007 has confirmed this trend: 37% of the shoreline has changed in excess of 10 metres, and the amount of retreat shoreline (897 km) still exceed the advancing shoreline (851 km). Figure 5.2 shows a significant example of the changes in the periods in question relating to a stretch of shore undergoing an obvious and progressive process of erosion.

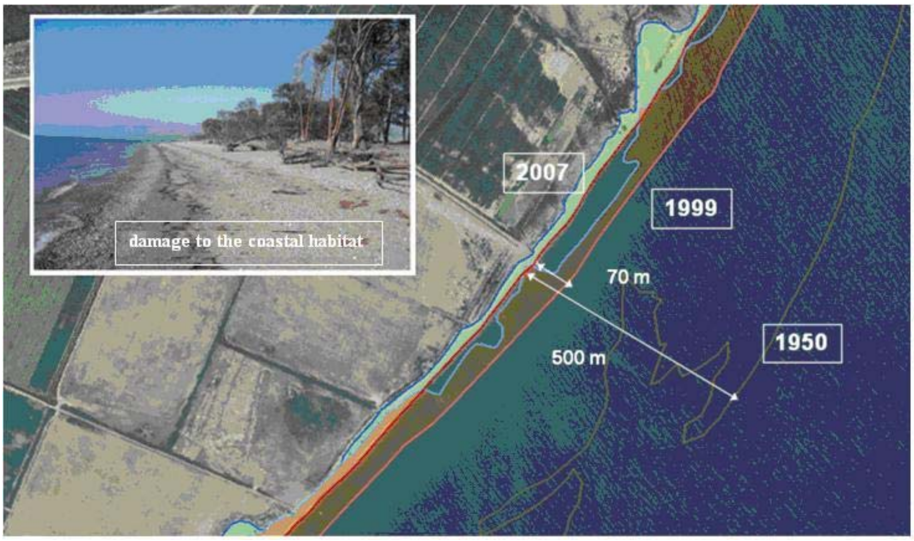


Figure 5.2: Historical overview of a beachline subject to erosion (Sinni – Basilicata)[3]

The changes to the shoreline are the result of an obvious and progressive process of erosion, especially in the proximity of river mouths.

[2] Source: ISPRA. The difference in the total length of flat coastline is due to changing shoreline, the exclusion of the stretches of artificially filled-in (albeit partially natural) shores, considered at 1999, the further maritime defence works built between 2000 and 2007 and the exclusion of the further “masked” areas emerging from the ortophotos of the IT2006 flight.

[3] Source: Data processed by ISPRA. Aerial surveys by the IT2006 flight and superimposition of the shoreline based on the mosaics of the 1:25.000 IGM maps and of the beaches surveyed by the ortophotos of the IT2000 and IT2006 flights

In terms of land area, between 1950 and 1999, no less than 54 km^2 of shoreline underwent significant erosion (over 25 m), and the balance between the receding and advancing shorelines is negative, with a final loss of approx. 5 km^2 of shoreline.
The retreat shoreline and loss of coastal areas is particularly obvious in the proximity of the river mouths. Entire beaches have receded considerably, with a loss of land and its value, in both environmental and economic terms; moreover, many instances of coastal erosion have seriously jeopardised the safety of buildings, roads and railways, especially during sea storms.

Despite the many coastal management and defense works carried out to date, the total area of beaches is diminishing. Between 1999 and 2007, a total of 16 km^2 of beaches was lost, compared to 15.2 km^2 of advancing shoreline. Ultimately, the balance between receding and advancing beachlines, and the stability of the coastline, is still negative (Table 5.2); moreover, the difference between the total beach area in Italy in 1999 (122.2 km^2) and in 2007 (121.6 km^2) highlights the loss of a further 600,000 m^2 of beaches. Some beaches have narrowed further or, as shown in Figure 5.2, have retreated towards the interior.

Despite the many coastal management and defense works carried out to date, the total beach area diminished, between 1999 and 2007, by 16 km2, compared to 15.2 km2 of advancing shoreline.

Table 5.2: Changes to shoreline in the period between 1999 and 2007[4]

The balance between receding and advancing beachlines, and the stability of the coastline, is still negative.

	Km	%	km^2
Beaches	3,271	100%	121.6
Stability	1,499	46%	
Retreat	882	27%	16.0
Advance	851	26%	15.2
Undefined	39	1%	

The coastal areas are the most built-up areas, with the highest concentration of production facilities; in recent years, the increased population density and activities has heightened the focus on the coastal evolution processes, erosion in particular.

The population density in coastal areas is approximately double the national average, regardless of the seasonal flows due to tourism. Based on the ISTAT data, it emerges that 30% of the Italian population lives permanently in the 646 coastal municipalities, on an area of 43,000 km^2, equal to approx. 13% of the total area of the country.
This high population density inevitably features a large concentration of urban and built-up areas and production facilities, which have considerably altered the natural and environmental characteristics of the areas, to a greater or lesser degree.
Furthermore, also due to the predominantly mountainous nature of the country, the main land transport corridors run at a short distance from

About 30% of the Italian population lives in the 646 coastal municipalities.

[4] Source: ISPRA

the coastline, and Italy's strategic position in the Mediterranean has historically favoured maritime transport and trade.

In Italy, land use is higher in the coastal areas, compared to the rest of the country; based on the analysis of the data set out in the *Corine Land Cover*, updated to 2006, it emerges that 9.2% of the 10 km wide belt of land from the shoreline is urbanized, compared to 5.8% of the rest of the country. Use of the coastal areas for residential and transport purposes has gradually increased over the years, and between 2000 and 2006, throughout Europe, there has been a 5% growth in the area running at 10 km from the shoreline[5]. Moreover, the nearer we get to the coastline, the greater the degree of urbanization, with land use increasing exponentially. No less than 34% of the land area of the country within 300 metres from the shoreline, which has been declared a 'landscape conservation area' (under Legislative Decree 42/2004, as amended), has been urbanized, for a total area of 696 km^2.

In Italy, in 2006, 9.2% of land within 10 km from the sea was urbanized, compared to 5.8% in the rest of the country.

In the Central Adriatic regions – following a process of urbanization developed over the last 50 years – over half the land within 300 metres from the shoreline has been occupied (Abruzzo: 62%, Marche: 59%, Emilia-Romagna: 55%). Other areas of Italy feature different situations, with various large maritime cities (Trieste, Napoli, Catanzaro, Catania), surrounded by an unbuilt coastline, culminating in the island of Sardinia, which is the region with the lowest concentration of built-up coastal areas.

Figure 5.3: Beach with inner boundary partially occupied by buildings (Molise)[6]

Figure 1 shows how anthropic actions have increasingly interfered in the natural coastline processes. The strengthening of the inner boundary of the beach with permanent man-made (urbanistic and maritime) structures, has influenced the environmental dynamics and characteristics of many coastal areas.

Figure 5.3 clearly shows how anthropic activities have increasingly interfered with natural coastal processes, either for exploitation or

[5] EEA, 2010, *The European Environment – State and outlook 2010*, Report 1/2010

[6] Source: ISPRA

defense. The strengthening of the inner boundary of the beach with permanent man-made (urban planning and maritime) structural works, has influenced the environmental dynamics and the characteristics of many coastal areas.

53% of the inner boundary of beaches is now man-made, with 87% consisting of more or less densely built-up areas, mostly holiday homes or beach tourism facilities.

53% of the inner boundary of beaches is man made.

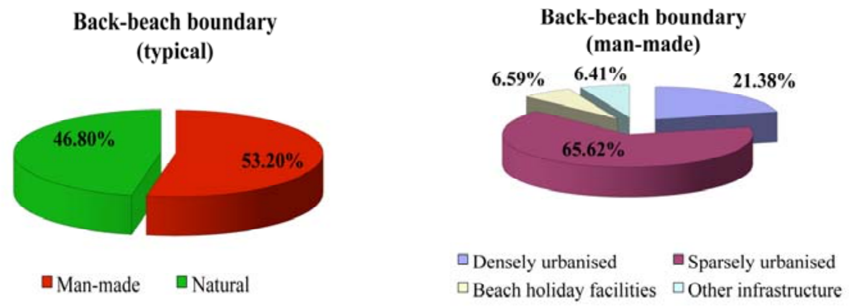


Figure 5.4: Distribution by type of back beach (a) and of man-made back beach (b)[7]

Moreover, in Italy, over 300 km of coastline are occupied by about 700 ports, and other smaller maritime works and facilities, such as, for example, the simple jetties or pontoons found in marinas.

In Italy, over 300 km of coastline are occupied by about 700 ports, and other smaller maritime works.

The maritime works in port areas are about 2,250 km long; of which 615 km (27%) relating to commercial/industrial facilities (e.g. shipbuilding), and approx. 1,415 km (63%) consist of ports, marinas, etc..

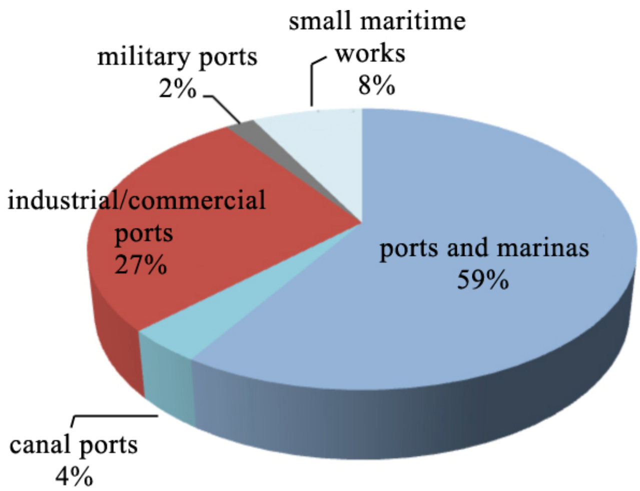


Figure 5.5: Percentage length of maritime works by type[8]

The maritime works in port areas (comprising wharves, quays, jetties, breakwaters, etc.) are about 2,250 km long; of which 615 km (27%) relating to commercial/industrial facilities (primarily freight handling and shipbuilding), and approx. 1,415 km (63%) consist of ports and canal ports, serving as terminals for ferries and cruise ships, fishing ports and marinas, or a combination of either (Figure 5.5).

27% of maritime works consist of industrial and commercial ports, while 63% consists of ports, marinas and canal ports.

Between 2000 and 2007, a total of 34 new ports were built, occupying a further 13 km of coastline, for a total length of 70 km, and a further 7,500 moorings[9].

34 new ports were built between 2000 and

[7] Source ISPRA
[8] Source: ISPRA

2007.

The new ports are primarily used for recreational boating purposes; 21 of the new ports, in fact, are marinas (Figure 5.6 shows an example of marina), while 9 are used for fishing and recreational boating, and the remainder for fishing, commercial shipping or passenger transport.

Figure 5.6: New marina in Rimini[10]

In the same period, however, 181 of the existing port areas, including the large port systems of Genoa, Naples, Civitavecchia, Ancona (Figure 5.7), were extended or refurbished, and in some cases the works are still in progress.

Figure 5.7: Port of Ancona, example of a port extension project, including the relocation of the marina and the construction of new commercial shipping facilities[11]

The projects involving port areas have required different works,

[9] http://www.pagineazzurre.com/italian/porti

[10] Source: ISPRA. Aerial surveys by flights IT2000 and IT2006 and superimposition of the shoreline at 2006

[11] Source: ISPRA

ranging from the extension of small marinas to the complete overhauling of large facilities, such as the former NATO base at la Maddalena, which is in the process of being converted into an enormous tourism facility. In recent years, maritime works comprised the necessary refurbishment works primarily for new marinas (at Genoa, Cagliari, Ravenna, etc..), to improve the mooring of passenger ferries and cruise ships (at Palermo, Civitavecchia, etc..) and to increase commercial shipping.
The typical natural phenomena occurring in coastal areas, and consisting of beach erosion, flooding and other extraordinary events, obviously represent a danger for the houses, infrastructure and economic activities located close to the shores.
In Italy, in fact, coastal risks are essentially related to erosion and to storms and flooding, especially in the case of the flat sandy shores and alluvial coastal plains.

In Italy, in fact, coastal risks are essentially related to erosion and to storms and flooding.

To tackle these problems a large number of projects have been implemented, over the years, with a view to mitigating beach erosion and protecting houses and transport infrastructure.
In the more serious cases, structural works have been carried out along the shoreline, while in other cases alternative solutions have been adopted and experimented, such as groynes, breakwaters, or combined solutions, primarily with a view to interfering in the coastal dynamics under way, to foster sedimentation and limit the impact of storm surges. The geomorphological characteristics of the shoreline, its exposure to meteo-marine events and the intensity of storm surges are the parameters on which the choice of the best coastal management and defense measures and resources is based.
Long stretches of coastline are protected by hard engineering works and the shores of the Central Adriatic regions are almost entirely protected by means of structures either alongside the shoreline itself, or built at a distance of only several hundred metres away.

A large number of projects have been implemented, over the years, to mitigate beach erosion and protecting houses and transport infrastructure.

Artificially stabilized shorelines have gradually increased over the years and, despite the large-scale use of artificial beach nourishment methods, using either river sand or sea deposits, between 2000 and 2007 further coastal management interventions were carried out (with the construction of 250 groynes, reinforced river mouths and combined works), defense works closer to the shore (over one kilometre) and offshore breakwaters (16 km).
The coastal defense works, aimed primarily at preventing erosion and stabilizing beaches, have not always produced the desired effects, often simply transferring the erosion further along the shoreline, and have also often contributed to the process of artificialization and deterioration of the coastal marine habitats.

There has been a gradual increase in the artificial stabilization of the shoreline: between 2000 and 2007 further coastal defense works and new breakwaters have been built.

An alternative method capable of ensuring a good degree of defense against coastal erosion, both environmentally and economically, is beach nourishment or replenishment. This consists in the reconstruction of an eroded beach by importing a suitable replenishment material (with regard to grain size, sorting and composition). In the past, this used to come from quarries on land and, only in several cases, from river or marine quarries. In recent years, however, the search for new sources of beach replenishment materials

Beach nourishment continues to be an alternative coastal defense method.

has privileged the use of sand from the seabed. On the continental platform, in fact, there are relict sand deposits (from ancient shorelines) which are ideal for this purpose. The use of relict sands for this type of intervention entails certain advantages, such as the availability of large amounts of sediments (millions of m^3), a grain size and composition similar to that of the beach sands, a low environmental impact and relatively low costs. These materials, located on the continental platform at depths of between 30 and 130 metres, are generally sourced by dredging.

The first beach nourishment project in Italy was carried out in 1994, on the beaches of Cavallino and Pellestrina (Venice), and, on the Tyrrhenian seaboard, at Ostia (Rome), in 1999.

In Italy, the first sand dredging operations were carried out in 1994 to replenish the Cavallino and Pellestrina beaches (Venice). Since 1994, approx. 6,000,000 m^3 of sand have been used sourced from an offshore deposit located between the mouths of the Tagliamento and Adige rivers, at a depth of 20 m.
Instead, on the Tyrrhenian seaboard, the first beach nourishment operations by sand dredging were carried out in 1999, at Ostia, using a relict sand deposit offshore from Anzio (Rome). Relict sand dredging for beach replenishment purposes has also been carried out offshore from Ravenna (2002 and 2007) and Civitanova Marche (AP) (2006).

Besides the coastal management and defense projects, the growing need for energy supplies, and the necessity to connect the land and the offshore environment has led to the design and construction of underwater pipelines and cables, which allow the effective, continuous and reliable transportation of resources. The progress made in underwater cable technology, the quick rate of return on the investments made and the capacity to source energy from hydroelectric or wind facilities have made these underwater pipeline/cable connections very attractive, proving that this is by far the most cost-effective way for transporting crude oil, natural gas and their by-products over very large distances.
In order to reduce the risk factors, the seabed trenching and burial of underwater pipelines and cables has become a widespread practise, for security and legal reasons as well. In any case, the construction of underwater pipelines/cables must necessarily take into account the environmental impact produced by the trenching and backfilling activities. The removal and temporary alteration of the biotic communities in the trenching areas, the resuspension of the sediments and the possible release of pollutants, the environmental stress to which the marine organisms are subjected, the reduced photosynthesis activities and the impairment of the phanerogam prairies or of the sensitivie ecosystems located close to the trenches are among the major environmental impacts related to the construction of this type of infrastructure.
Hence, it becomes clear that any type of underwater or coastal project requires an in-depth and solid knowledge of the physical and biological processes taking place in these environments.

The state of the sea is characterized by physical

The sea level, height and period of the waves, currents, atmospheric pressure, wind, temperature are basic parameters for the characterization of the tide and wave regimes of the Italian seas and of the marine dynamics along the shores. The data surveyed and collected by ISPRA's sea level (RMN) and wave measuring (RON) networks, suitably processed and statistically analysed, provide a large amount of local and regional information on the state of the sea, for example tide changes, the characterization of the prevalent directions of storm surge waves, the distribution of maximum heights, the statistical processing of the past storm surges, the probability estimates associated with wave heights expected for each single location and, therefore, the assessment of the related risks.

parameters: sea level, wave height and period, currents, atmospheric pressure, wind and temperature.

In the Mediterranean, the tidal range is no more than 45 cm, on average, unlike in the North of Europe, where it can exceed 10 metres, and the tide cycles are of the mixed semi-diurnal type, with two high tides and two low tides a day, which change height during the course of the month.

The tidal range in the Mediterranean is 45 cm, on average.

Regarding the Italian seas, the period between high and low tides is 6 hours, on average, with a limited tidal range, generally between 30 and 70 cm. Figure 5.8 shows an example of tide cycles recorded at the Ancona station.

Tide cycles recorded by the Ancona station.

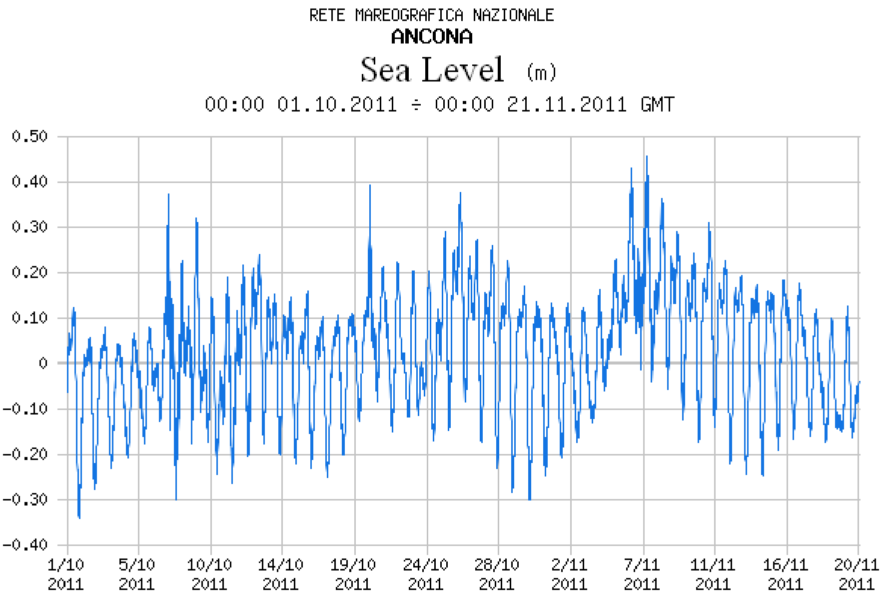


Figure 5.8: Tide levels recorded by the tide gauge at Ancona[12]

In the Adriatic, which is a semi-enclosed sea, there are higher tide ranges than in the Mediterranean. In the Upper Adriatic, the tide range, in fact, can exceed 1 metre and, in special astronomical and weather conditions, such as a strong Sirocco wind, can cause exceptional tides with flooding in the Venice Lagoon (also due to the problems of land subsidence, for several hours, producing the phenomenon known as "acqua alta" (high water) in Venice).

The Adriatic has the highest tides.

The special-topic box on the Venice Lagoon contains a description of the phenomenon, the concomitant causes and the recordings made over the last 140 years.

The marine dynamics and processes in shallow waters are influenced not only by the tidal currents, but also by wave motion, generated

[12] Source: ISPRA

primarily by the wind.

The statistical study of the characteristic directions of the waves takes the name of wave climate. The most useful analysis for studying the wave climate in a certain site are the statistical distribution of the significant wave height, with respect to the period and direction of the waves. These distributions may be graphically represented in the form of “wind roses”.

The wave climate is the statistical study of the direction of the waves.

For example, we may easily infer the number of episodes – in 20 years of surveys – in which the waves were between 2 and 2.5 m tall, due to storm surges from the North-West.

In fact, the graph makes it possible to view the distribution of all the possible situations of height and direction in a single figure.

As shown in Figure 5.9, at each measurement point we can see the wind rose providing two different figures: the angular distribution of the significant wave height and the frequency of the waves grouped in wave height classes.

The Italian wave climate has two principal behaviours: unidirectional (as in the case of La Spezia) or distributed over two or more directional sectors (as in the case of Ancona or Civitavecchia).

The Italian wave climate has two principal behaviours: unidirectional (as in the case of La Spezia) or distributed over two or more directional sectors (as in the case of Ancona or Civitavecchia).

The Tyrrhenian Sea features predominantly unidirectional events, while bimodal climates, at least, are typical of the Ionian and Adriatic Seas.

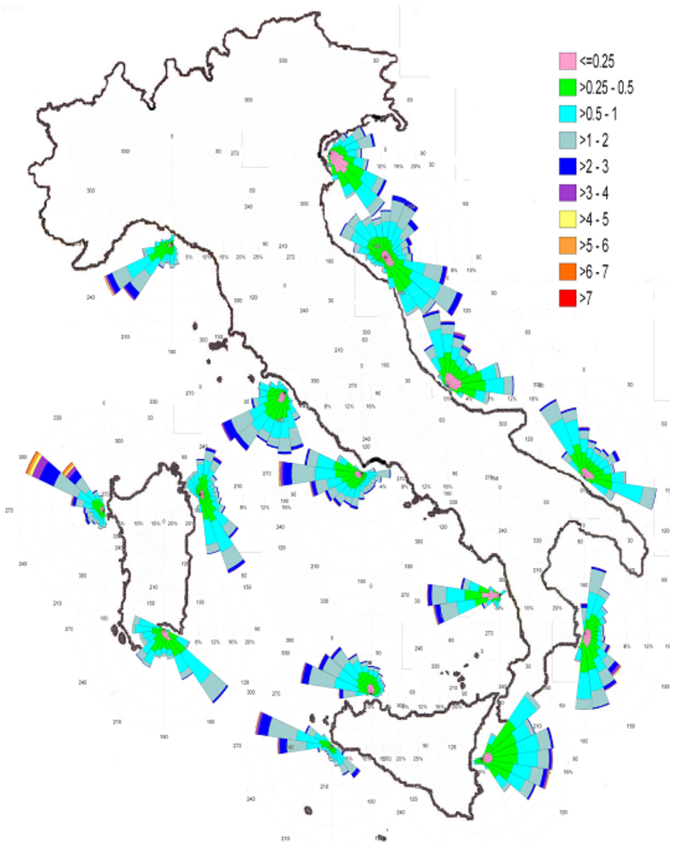
The Tyrrhenian also features taller waves than the Adriatic, due not only to the stronger winds, but also to the much larger area in which the wind can transfer energy to the waves.

The tallest waves have been recorded by the Alghero buoy; moreover, we can see that Alghero also features the highest number of episodes with waves higher than 3 m (Figure 5.9).

The wind generating almost all the storm surges in Western Sardinia is the Mistral, and its effects can also be found in the Central and Southern Tyrrhenian.

For example, the absolute maximum of 9.8 m recorded at the Alghero buoy refers to the same event recorded by the buoys at Cetraro (8.9 m) and Ponza (7.9 m); this was the storm surge that occurred on 28 December 1999, which has been named the “Storm Surge of the Century” or the “Christmas Storm Surge”.

In the Adriatic Sea, storm surges are predominantly northerly or north-east-easterly and less intense (the maximum reported height is 6.2 m), although wave heights of about 3 m are not uncommon.



The Tyrrhenian Sea features predominantly unidirectional events, while the Ionian and Adriatic Seas always feature bimodal climates, at least. The Tyrrhenian also features taller waves than the Adriatic.

Figure 5.9: The wave climate along the Italian coastline – The radial distance indicates the likelihood of an event occurring in the corresponding directional sector, the colour indicates the significant wave height[13]

The wave climate of the seas, with the support of wave parameters surveyed by the observation networks, summarizes the number and strength of the storm surges affecting the various coastal sectors, but the destructive effects of several storm events and the risks faced by many coastal areas increases the need for analyses of the extreme events, in order to calculate the likelihood of certain storm events over the long term.

The study of extreme events consists in identifying a series of maximum events, regardless of the recorded wave heights and applying the Peak Over Thereshold (POT) method; the result of this analysis can be used to establish the average time between two intense events (return time). This method is also useful to establish the likelihood of occurrence, over a certain period (for example, 25 years), of 6 m plus waves or, alternatively, once a 95% likelihood has been established, the tallest waves occurring in the space of 25 years (return height).

The study of extreme waves (using the Peak Over Threshold method) is useful to establish the return time of a certain event and the likelihood of its occurrence.

[13] Source: RON data processed by ISPRA

The result of the analysis of extreme wave events analysis can be used to establish both the average time between two intense events (return time), and the likelihood of occurrence, over a certain period of time, of a wave of above a certain height or, on the contrary, once a certain likelihood has been established, the tallest wave occurring in the defined space of time (return height).

Note:
The return period corresponds to the highest value observed in the 20 year (T_m) period; the return level for 35, 40, or 50 years (H_{s35}, H_{s40}, H_{s50}), based on the extension of the available time series.

Figure 5.10: Distribution of the extreme events along the Italian coastline[14]

Generally speaking, in the Western Italian seas (Tyrrhenian, Ligurian, Straits of Sicily, Central Mediterranean) storm surges are intenser and more frequents that along the Eastern seaboard (Adriatic and Ionian Seas).

Storm surges are more frequent in the Western Italian seas.

Based on the average number of storm surges per year, and the maximum heights recorded, we can distinguish three zones:

- the Adriatic, featuring 12-15 episodes per year and return heights of 5-6 m;
- the Ionian, featuring 8-15 events per year, with return heights of approx. 6 m;
- the Sea of Sardinia, Sea of Sicily, Tyrrhenian and Ligurian Seas, featuring 12-20 episodes per year and return heights in excess of 6.8 m.

The sea water temperature is a key factor in ocean movements and for evaluating climate change.

Besides the wave and tide regimes, another basic parameter for analysing the physical phenomena in the seas is the sea water temperature: an essential factor for the movement of the ocean waters, exactly like the temperature and humidity of the air in the case of atmospheric movements, and of fundamental importance for assessing climate change events. The sea's surface absorbs most of the energy radiated by the sun. This energy then propagates by conduction through the upper layers down to the lower colder layers, or by convection, due to the turbulent movement of the fluid mass. The process of heat transfer by conduction can be practically neglected,

[14] Source: RON data processed by ISPRA

with regard to the diurnal and annual phenomena, while it remains significant only in the case of slow balances (such as those established in the course of the geological periods); on the contrary, convection is much faster and a lot more effective, causing significant rises in temperature up to hundreds of metres below the sea surface. The series of air and sea temperature values feature very similar characteristics, such as a strong temporal autocorrelation and the presence of seasonal and daily components, due to the changes in solar radiation. A direct comparison of these measurements, recorded in the open sea by the RON buoys, provides a considerable amount of information on the sea surface temperatures and heat exchanges with the overlying atmosphere, even without observations on the driver of the process, solar radiation.

By way of example, below is a comparison between the temperatures of the sea and the air collected over the annual cycle by the Ponza buoy (Figure 5.11). We can see, in fact, that the surface layer of the sea undergoes limited temperature oscillations during annual heating, despite the enormous amounts of heat absorbed. Most of the absorbed heat is lost in exchanges with the air, by evaporation, and convective transfer to the underlying water; however, the balance between the absorbed and lost heat is positive, and the average surface temperature of the sea is higher than that of the overlying air. Based on the RON measurements, the difference in temperature between the water and the air is, on average, approx. 1.7 °C.

The sea surface features limited temperature oscillations during annual heating, despite the enormous amount of hea absorbed.

The difference in temperature between the water and the air in Italian seas is, on average, approx. 1.7 °C.

Note:
Temperatures recorded by the Ponza buoy sensors, moored in the open sea at latitude 40°52’00’N and longitude 12°57’00’E, 115 m above the seabed

Figure 5.11: Water and air temperatures recorded by the Ponza buoy[15]

To evaluate the air-water interactions on the free surface of the sea, determining heat exchange, we need to identify and remove all the typically seasonal components. The cross-correlogram of the historical series of the average daily air and water temperatures recorded by the Ponza buoy (Figure 5.12a) highlights a strong correlation between the temperature of the air and the water, as well as an annual seasonal component. This component is not removed if we consider only the residues obtained from the difference between the air and water temperatures (Figure 5.12b), and still features dependence even between values distant in time.

To evaluate the air-water interactions on the free surface of the sea, determining the heat exchange, we need to identify and remove all the typically seasonal components.

[15] Source: ISPRA

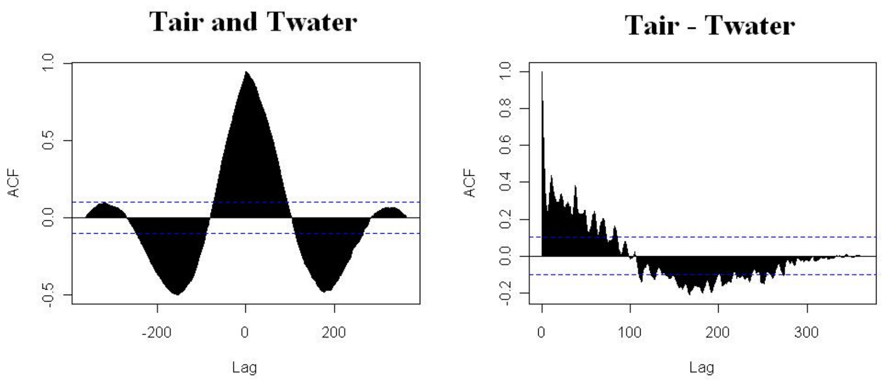


Figure 5.12: Cross-correlogram of the temperature variables (a) and the residues (b) (Ponza buoy)[16]

Instead, by removing from the historical series the respective average monthly values, we can observe a weak correlation of the residues (Figure 5.13a). These residues represent the difference between the water and air temperatures minus the seasonal effects, which depend on a series of meteo-marine factors mentioned above, evaporation above all, as highlighted in Figure 5.13b, which relates the relative humidity values and the "deseasonalized" temperatures.

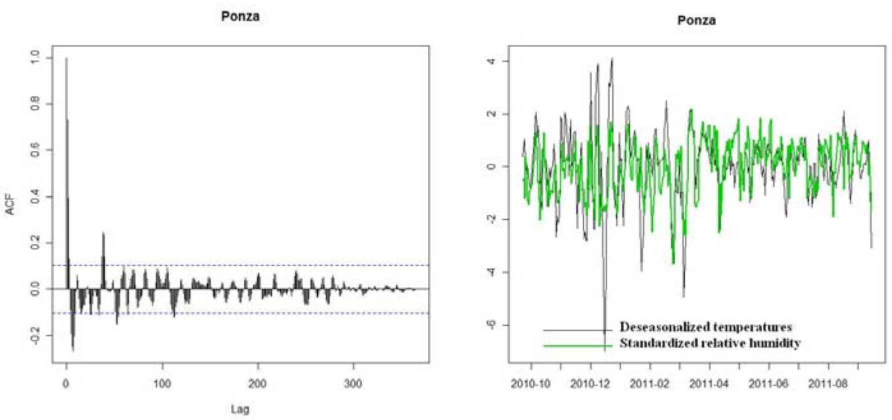


Figure 5.13: Correlogram of the deseasonalized temperature residues (a) and comparison of the residues with the relative humidity (b) (Ponza buoy)[17]

On a diurnal scale, unlike in the case of the ground, which warms up and cools down intensely during the diurnal cycle, the surface waters warm up and then cool down slowly. The breadth of the daily temperature range varies according to factors that depend on the geografical conditions of the site and the stability of the water stratification, but also local factors as well, such as cloud cover, humidity and wind.

In particular, the analysis of the daily temperature excursion of the sea surface and the overlying air highlights how the maximum recorded variation in the Tyrrhenian is 0.3 °C, for the water, and approx. 1.8 °C for the air. Generally speaking, the temperature of the sea water,

The maximum daily variation in the Tyrrhenian is in the order of 0.3 °C, for the water,

[16] Source: RON data processed by ISPRA
[17] Source: *Ibid.*

during the day, undergoes changes in the order of several tenths of a degree; the maximum temperature is reached at about 3 pm. We can also see that, in the open sea, the daily temperature range does not exceed several tenths of a degree, while near the shore the temperatures increase and may even double.

and approx. 1.8 °C for the air. The maximum water temperatures are recorded between July and October.

In any case, the maximum water temperature values are reached when the sky is cloudless, the air is calm and the sun at its highest; the minimum is reached when the sky is cloudy, the sea is rough, the sun is at its lowest and the daily oscillation in the air temperature considerably exceeds that of the surface water.

During the year, the temperatures follow the changes in solar declination, increasing when the sun is high in the sky and dropping when the sun is low on the horizon. The maximum water temperatures, however, are delayed compared to the atmosphere; based on the RON data, the water temperatures are highest between July and October, with maximum frequencies in September.

In the Italian seas, subject to continental influences, the annual oscillation in the temperature is approx. 16 °C in the Tyrrhenian and 22 °C in the Adriatic, compared to an average temperature of 19.5 °C and 18.2 °C, respectively. In any case, at the same latitude, the sea temperature oscillation is much lower than those of the continental areas.

The annual oscillations of the temperature are 16 °C in the Tyrrhenian and 22 °C in the Adriatic.

ECOLOGICAL STATUS OF THE SEA

The concept of ecological quality of the coastal marine environment has been introduced at a regulatory level by the Water Framework Directive (Directive 2000/60/EC), implemented in our Country by Legislative Decree 152/2006. To put it briefly, the ecological quality is determined by measuring the deviation of the Biological Quality Elements (BQEs) - namely, phytoplankton, benthic macroinvertebrates, macroalgae and angiosperms that characterize that environment - from the naturalness or reference values. The deviation from the reference values is the reaction of the BQEs to specific pressures that affect the environment and compromise their status.

Ecological quality is determined by measuring the deviation of the Biological Quality Elements (BQEs) from the naturalness values.

Hence, the procedure set out in the Directive requires Member States to determine the conditions of naturalness peculiar to each biological community and to establish variations or deviations, if any, with respect to its "reference conditions". The definition of ecological quality implies the classification of the status of complex and extremely dynamic biological communities - meaning that they are characterized by a high "natural" variability - through a single numerical score, an index, on which the entire classification system is built.

The environmental goal is represented by the attainment of a "good" ecological status by 2015 for all surface water bodies. Such a goal determines whether or not the conditions of the system are acceptable for a sustainable development of the anthropic activities over the territory (Figure 5.14).

The environmental goal is the attainment of a "good" ecological status by 2015.

The impact of human activities on the ecological status of water bodies represents a crucial aspect that needs to be considered in the design of the ecosystem protection measures.

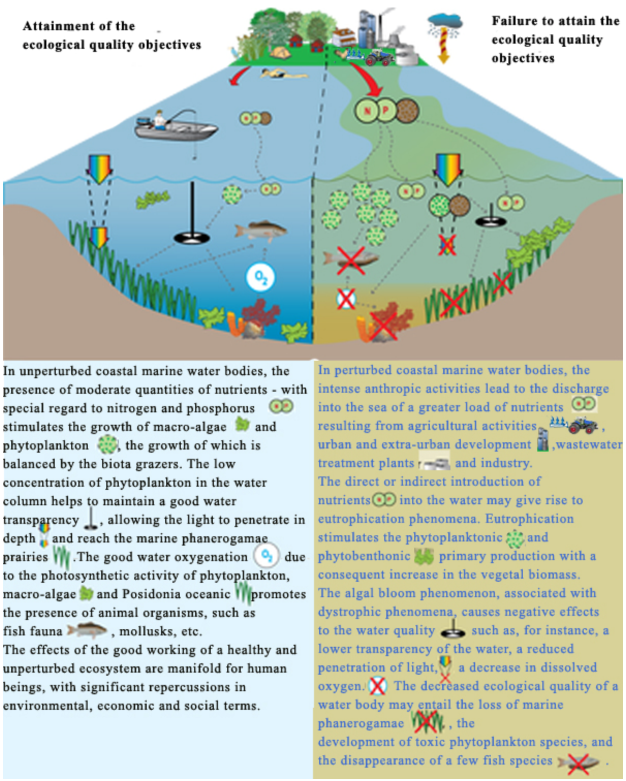


Figure 5.14: Conceptual model representing the interaction between anthropic activities and ecological quality of the coastal marine environment[18]

[18] Source: IAN.UMCES.EDU, 2012, *Integration and Application network*, University of Maryland USA.

The approach referred to above adopts, for classification purposes, suitably defined and validated synthetic indices that are intercalibrated in the Mediterranean eco-region.

The classification indices adopted by Italy through the recent Ministerial Decree 260/2010 include: phytoplanktonic biomass, expressed as concentration of chlorophyll "*a*", for the BQEs 'phytoplankton'; CARLIT (Coastal Cartography) index for the BQEs 'macroalgae'; PREI (Posidonia oceanica Rapid Easy Index) for the BQEs 'angiosperms' and, finally, M-AMBI (Multivariate AZTI Marine Biotic Index) for the BQEs 'benthic macroinvertebrates'.For classification purposes, the BQEs have to be monitored in homogeneous water bodies that are identified based on the typization process and through the analysis of the pressures affecting each coastal stretch section associated with that water body (Ministerial Decree 131/2008 and Ministerial Decree 56/2009).

The classification indices are: phytoplanktonic biomass as chlorophyll, CARLIT, PREI and M-AMBI

Hence, the Water Framework Directive outlines a European course for the protection of the marine ecosystem through the adoption of an "ecosystem-based" approach that is to assess the attainment of previously established ecological quality goals to be achieved and/or maintained, the adoption of adequate environment control regulations and the development of suitable protection and recovery policies.

Figure 5.15 shows an example of classification relative to the water bodies in Friuli-Venezia Giulia, for the BQEs 'phytoplankton'.

The BQEs 'phytoplankton' allows the classification of the FVG water bodies, that is to say, to make a quality judgment with respect to anthropic impacts that affect to a considerable extent the phytoplanktonic marine communities.

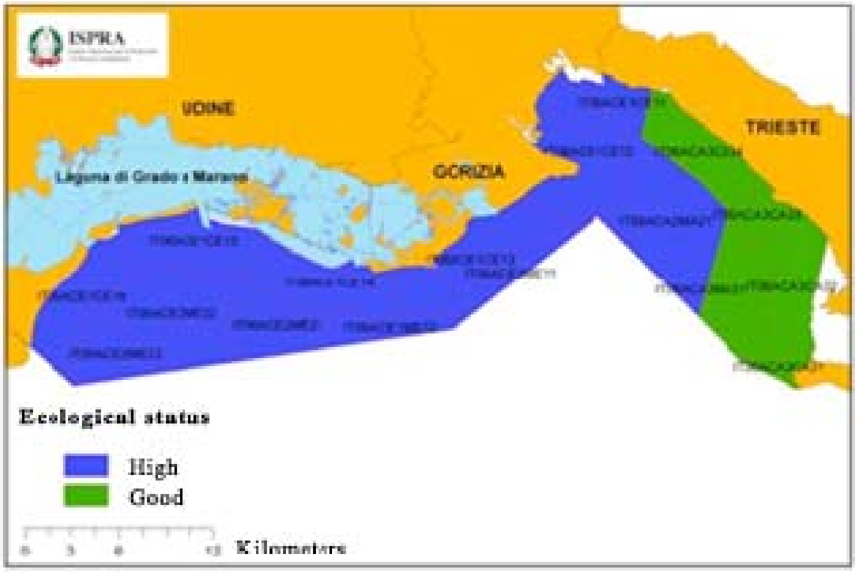


Figure 5.15: Ecological classification of Friuli-Venezia Giulia through the BQEs phytoplankton[19]

The quality of coastal marine waters for bathing purposes meets the requirements of the Decree of the Minister of Health of 30 March 2010, which has finalized the process for the implementation of Directive 2006/07/EC, concerning the management of bathing water quality, which had started with Legislative Decree, no. 116 of 30 May 2008. Therefore, starting from the 2010 bathing season, the bathing waters are monitored and assessed according to the new criteria as

[19] Source: ISPRA processing of Friuli-Venezia Giulia data (National WISE-SINTAI Center).

outlined below.

The new monitoring system provides for the sampling of merely two indicators of fecal contamination (Enterococci and *Escherichia coli*) with sampling intervals that, from fortnightly, become monthly.

The new bathing water monitoring program provides for the sampling of the indicators of fecal contamination (Enterococci and Escherichia coli).

Furthermore, the qualitative assessment is no longer carried out in terms of compliance with bathing suitability values, as it is based on four quality classifications (excellent, good, sufficient and poor). As regards this subject, it should be borne in mind that Directive 76/160/EEC differentiates the compliance values into mandatory values that should be compulsorily observed and more stringent guideline values that should be attained.

Waiting to have access to a series of data collected with the new system, the European Commission has provided for a transitional water classification system that has also recourse to the data collected in the years before 2010 with the old monitoring system. To that end, the intestinal Enterococci and *Escherichia coli* are deemed equivalent to the fecal Streptococci and fecal Coliforms, respectively, which had been provided for by the previous Directive. It ensues that, being there no real quality classes, the results are still expressed in terms of compliance as in the preceding system. Furthermore, keeping into account the difficulties entailed by the changeover to the new monitoring system, the European Commission has admitted - with respect to the assessment of the 2010 bathing season - a tolerance margin for the sampling frequency, considering valid the samples collected with an interval of up to 41 days. Since the Directive lays down that the first sample should be collected just before the start of the bathing season, the less stringent provision allows considering that sample valid if collected up to 10 days from the start of the bathing season. In this case, the sampling interval should be considered from the start of the bathing season rather that from the date the first sample is collected.

The EC has provided for a transitional classification system that has also recourse to the data collected in the years before 2010 with the old monitoring system.

From a quantitative point of view, Italy accounts for 4,896 bathing waters, equal to 33.7% of all the coastal bathing waters in Europe. In 2010, 85.3% of all waters have proved to comply. Out of this total, 77.2% complied with the guideline values and 8.1% complied with the mandatory values (Figure 5.16). A 6.9% decrease may be observed with respect to 2009, when 92.2% of all waters proved to comply. On the other hand, considering just the compliance with the stricter guideline values, the decrease in 2010 amounted to 13.6%. There is a 0.2% increase in the number of waters classified as not in compliance with the mandatory values, while there is a marked reduction - from 310 in 2009 to 33 in 2010 - in the number of waters where bathing is prohibited (Table 5.3). Furthermore, it should be noted that the introduction of the less restrictive sampling frequency provision has allowed Italy to “save” 2.583 bathing waters that, otherwise, would have been considered as being insufficiently sampled.

Italy accounts for 4,896 bathing waters, that is to say, for 33.7% of the European bathing waters. In 2010, 85.3% of Italy’s bathing waters have complied with the requirements.

Table 5.3: Assessment of bathing waters[20]						
Year	TOTAL	B	CG	CI	NC	NF/NS
	no.					
2009	4,921	310	4,467	69	51	24
2010*	4,896	33	3,779	395	57	632
2010	4,896	33	1,433	175	40	3,215

In 2010, 85.3% of Italy's waters have complied with the requirements. Yet, a 6.9% decrease with respect to 2009 has been reported. Furthermore, the waters not suitable for bathing report a marked decrease, as they drop from 310 in the 2009 season to 33 in 2010.

Notes:
*: Less restrictive assessment system
CI : conforming to mandatory values; **CG**: conforming to guideline values;
NC: non-conforming to mandatory values; **NF**: insufficiently sampled;
NS: not sampled; **B:** bathing prohibition.

In 2010, 85.3% of the waters have complied with the requirements. Out of this total, 77.2% have complied with the guideline values and 8.1% have complied with the mandatory values.

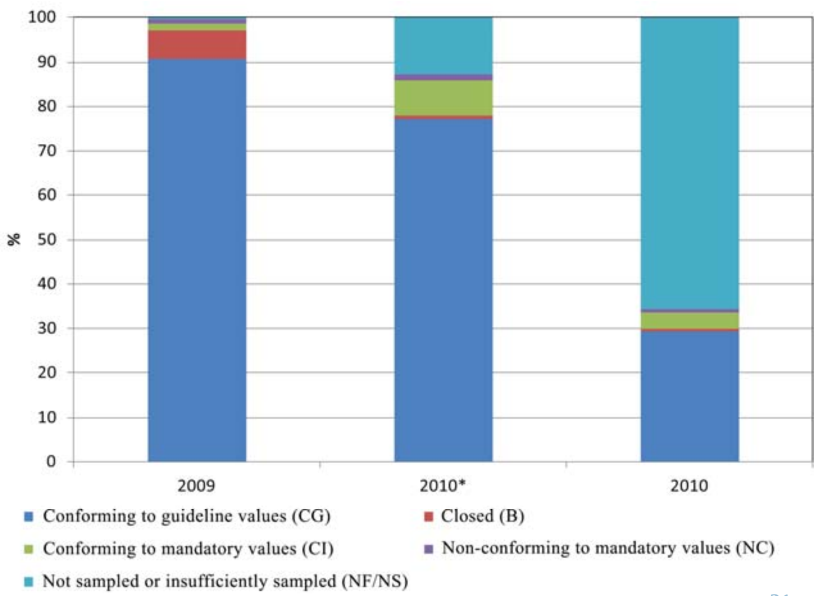


Figure 5.16: Assessment of conformity of bathing waters[21]

Table 5.4 shows how the picture relative to most regions is substantially different when viewed with the two different assessment systems. This clearly indicates that problems linked to the monitoring frequency have characterized the bathing season. In any event, it should be pointed out that the insufficiently sampled waters are not necessarily poor quality waters. It just means that they are waters where the sampling system dictated by the provisions of the Directive has not been complied with. However, the insufficiently sampled waters affect the calculation of the conforming waters.

[20] Source: ISPRA processing of EEA data.
[21] Source: *Ibidem.*

Table 5.4: Comparison of the bathing water assessment of conformity with the 2010 method[22]

In Emilia-Romagna, Friuli-Venezia Giulia, Molise and Veneto, all the bathing waters prove to comply with both assessment systems, while in Basilicata all the waters comply if just the less restrictive assessment standard is taken into consideration.

Region	TOTAL	2010*						2010					
		CG	CI	NC	NF	B	NS	CG	CI	NC	NF	B	NS
	n.												
Abruzzo	118	90	16	12				43	9	11	55		
Basilicata	60	57	3					19			41		
Calabria	650	449	118	15	68			166	39	14	431		
Campania	348	268	69	11				239	60	9	40		
Emilia-Romagna	96	96						96					
Friuli-Venezia Giulia	57	53	4					53	4				
Lazio	274	231	24					157	20		97		
Liguria	410	341	36	8	23	2		57	8	1	342	2	
Marche	240	203	13	1		23		39		1	177	23	
Molise	33	29	4					29	4				
Apulia	674	363	12	1	298			109	7	1	557		
Sardinia	660	632	21	5	2			135	4	3	518		
Sicily	819	587	45	2	176	8	1	127	1		682	8	1
Tuscany	363	289	27	2	45			73	16		274		
Veneto	94	91	3					91	3				
TOTAL	**4,896**	**3,779**	**395**	**57**	**631**	**33**	**1**	**1,433**	**175**	**40**	**3,214**	**33**	**1**

Notes:
*: Less restrictive assessment system
CI: conforming to mandatory values; **CG**: conforming to guideline values; **NC**: non-conforming to mandatory values; **NF**: insufficiently sampled; **NS**: not sampled; **B:** bathing prohibition.

In four regions (Emilia-Romagna, Friuli-Venezia Giulia, Molise and Veneto) all the bathing waters prove to comply with both assessment systems, while in Basilicata all the waters comply if just the less restrictive assessment standard is taken into consideration. Furthermore, it should be observed that most of the conforming waters comply with the guideline values that are stricter than the mandatory values.

In the 2010 season, 36 coastal waters experienced 41 events of short-term pollution.

The data published by the European Environment Agency show that, during the 2010 season, 41 events of "short-term pollution"[23] have occurred in 36 coastal bathing waters, of which 14 in Marche, 16 in Calabria, 4 in Lazio, 5 in Veneto and 2 in Sardinia.

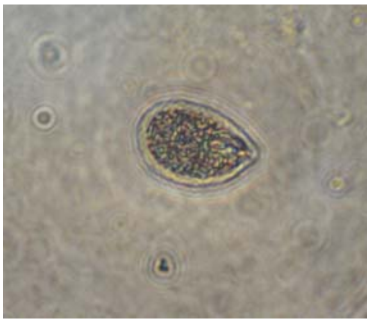
Compared with previous years, the 2010 bathing season has also been characterized by the fact that the new Directive provides for the possibility of diversifying the actual duration of the bathing season in relation to specific conditions and/or needs. Having recourse to this possibility, Italy's bathing season has begun for most waters on 1 May and has ended on 30 September; for 96 waters it has begun on 15 May and has ended on 19 September, while for 16 waters the opening date has been advanced to 14 April.

[22] Source: ISPRA processing of EEA data.

[23] The concept of "short-term pollution", introduced by Directive 2006/7/EC, means a microbiological contamination that has clearly identifiable causes and that is not normally expected to affect bathing water quality for more than approximately 72 hours after the bathing water quality is first affected. These events have to be anticipated and preventive measures have to be implemented to protect bathers.

Lately, the benthonic microalga *Ostreopsis ovata*, present by now since a number of years in the Mediterranean Sea, has been associated with phenomena of toxicity for both human beings and the marine environment.

Ostreopsis ovata.



O. ovata under an optical microscope

O. ovata biofilm on the seabed

Figure 5.17: *Ostreopsis ovata* and biofilm[24]

Ostreopsis ovate, a benthonic microalga present since a few years in the Mediterranean Sea, may give rise to phenomena of toxicity for both human beings and the marine environment.

Ostreopsis ovata Fukuyo (Figure 5.17) is a potentially toxic dinoflagellate found for the first time in Italian waters (Lazio) in 1994 (Tognetto et al., 1995). Since then, the presence of this microalga has been detected Italy with more and more frequency in an increasing number of regions, with an extremely high abundance particularly in the benthonic compartment. In recent years, blooming events have resulted in a few cases of human intoxication and in the suffering or mortality of benthonic marine organisms[25]. The first reported observation of *O. ovata* occurred in Villefranche-sur-Mer towards the end of the 1970s (Taylor, 1979). Occurrences have been reported in a number of areas of the Mediterranean Sea, including along the coasts of Lebanon, France and Spain and in the Balearic Islands, where it has led to cases of human intoxication. Furthermore, this microalga has also been found in the Northern Aegean Sea where the contamination of shellfish by *Ostreopsis* sp. toxins has been reported (Aligizaky and Nikolaidis, 2006).

In quite a number of cases, the benthonic blooms appear macroscopically as reddish brown mucilaginous layers or biofilms that cover to a considerable extent the bottom and hard substrata. The development of beige-brown-reddish foams may also be observed, more frequently on the sea surface, as well as a widespread opalescence with a consequent reduction of transparency and suspended flakes in the water column.

The bloom of these algae appears on a yearly basis in different places and times and may cause serious damages to existing

In Italy, summertime and recurrent benthonic blooms of *Ostreopsis ovata*, often in association with other potentially toxic dinoflagellates, such as *Amphidinium carterae*, *Coolia monotis* and *Prorocentrum lima,* have occurred in systems with either a high or a low hydrodynamism on different substrata in various locations in the Ligurian Sea, Tyrrhenian Sea, Ionian Sea and Adriatic Sea, with toxic effects on human beings and benthonic organisms (shellfish and echinoderms), associated with the production of toxins belonging to

[24] Source: ARPA Calabria.

[25] ISPRA, Report 127/2010, 148/2011.

the palytoxin group (palytoxin and ovatoxin-a)[26].

Available genetic studies have allowed ascertaining the existence of an Italian and Mediterranean genotype of *O. ovata* with a low genetic variability, which is quite different from the Asian genotype but uniform with respect to the genotype present in the Atlantic Ocean. Furthermore, the presence of *Ostreopsis* cfr. *siamensis*[27] has been reported in the Mediterranean Sea and in Italy.

To-date, *Ostreopsis ovata* has been detected in all the Italian coastal regions with the exception of Emilia-Romagna, Molise and Veneto[28]. This datum has been confirmed by the outcome of the 2010 monitoring program that, besides, has pointed to the absence of this macroalga even in Abruzzo (Figure 5.18).

benthonic communities.

The presence of this toxic microalga has been detected in all the coastal regions, except for Abruzzo, Emilia-Romagna, Molise and Veneto.

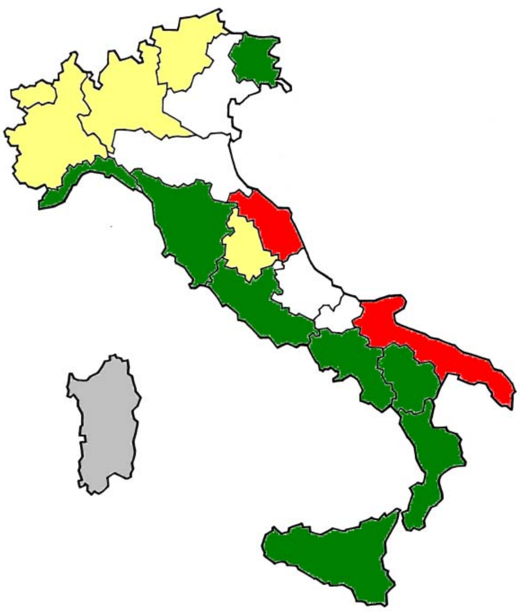


Figure 5.18: *Ostreopsis ovata* along the Italian coasts (2010)[29]

With reference to the algal bloom, the eutrophication phenomenon is known to represent a significant dystrophy of the coastal marine environment.

According to the current Community stance, eutrophication is a process by which a body of water acquires a high concentration of nutrients, especially nitrogen and/or phosphorus compounds, which determines an increase in primary production and algal biomass, alterations of the benthonic community and a decrease in water

Eutrophication amounts to a significant dystrophy of the coastal marine environment, with consequences that are deemed negative when

[26] ISPRA, Report 127/2010, 148/2011.

[27] Penna A., Fraga S., Masò M., Giacobbe M.G., Bravo I., Bertozzini E., Andreoni F. Vila M., Garces E., Lugliè A., Vernesi C., 2008, *Analisi della biodiversità genetica di alcune specie microalgali responsabili di fioriture tossiche nel Mar Mediterraneo*, Biol. Mar. Medit., 15(1): 46-49. Accoroni S., Romagnoli T., Colombo F., Pennesi C., Di Camillo C.G., Marini M., Battocchi C., Ciminiello P., Dell'Aversano C., Dello Iacovo E., Fattorusso E., Tartaglione L., Penna A., Totti C., 2011, *Ostreopsis cf. ovata bloom in the northern Adriatic Sea during summer 2009: Ecology, molecular characterization and toxin profile*, Mar. Pollut. Bull. 62 (2011) 2512-2519.

[28] ISPRA, Report 127/2010.

[29] Source: ISPRA, Report 127/2010.

quality.
The consequences of eutrophication are deemed negative if they give rise to a deterioration of the state of health of the ecosystems and/or a reduction in the sustainable use of goods and services.

they determine a deterioration of the state of health of the ecosystems.

The northwestern Adriatic Sea is a unique case in the entire Mediterranean Sea basin owing to the impressive algal blooms that may occur in this area.
The intensity of these blooms and the chlorophyll and phytoplanktonic biomass concentration values reported in certain periods and in a few environmental situations have no equal in any other part of the Mediterranean Sea[30].

The northwestern Adriatic Sea features impressive algal blooms.

The reasons for this phenomenon, studied and monitored for over thirty years, should be referred for the most part to the input of nutrients discharged into the sea by the Po River.
On the average, the estimated loads of nutrients entering the Adriatic coastal system are in excess of 110,000 t/year of nitrogen and 7,000 t/year of phosphorus[31].
The Po River valley is a basin having national relevance since it covers nearly one fourth of the entire Italian territory with a population close to 16 million inhabitants.
The basin witnesses the concentration of over one fourth of the Italian industries, one fourth of the entire national agricultural production and over half of Italy's livestock farms.
This turns the Po River valley into a strategic area for Italy's economy, causing it to be one of the European territories with the highest absolute concentration of inhabitants, industries and commercial activities.
In addition to the contribution of nutrients coming from the Po River, there are those coming from the other tributary basins of the north Adriatic Sea: the Adige, Piave, Brenta and Tagliamento Rivers, as well as the lagoons of Venice and Grado-Marano, etc.
The shallow and sandy coast and the current characteristics determine the best possible conditions for the occurrence of the eutrophication penomenon.
The general current that flows up the Adriatic Sea in a counter-clockwise direction tends to "push" the fresh water inputs coming from the Po River against the coasts of Emilia-Romagna.
The coastal system proves extremely efficient in using the available nutrients and, therefore, produces a great amount of phytoplanktonic biomass.
Figure 5.19 shows the mean yearly trends of the parameters that characterize the coastal strip: salinity, chlorophyll, dissolved inorganic nitrogen (DIN) and total phosphorus.

The estimated loads of nutrients entering the Adriatic coastal system are in excess of 110,000 t/year of nitrogen and 7,000 t/year of phosphorus.

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[30] UNEP, *Assessment of the state of eutrophication in the Mediterranean Sea*, R.A. Vollenweider, A. Rinaldi, R. Viviani and E. Todini eds, MAP Thecnical Reports no. 106, Athens 1996.
[31] Po River Basin Authority, Parma.

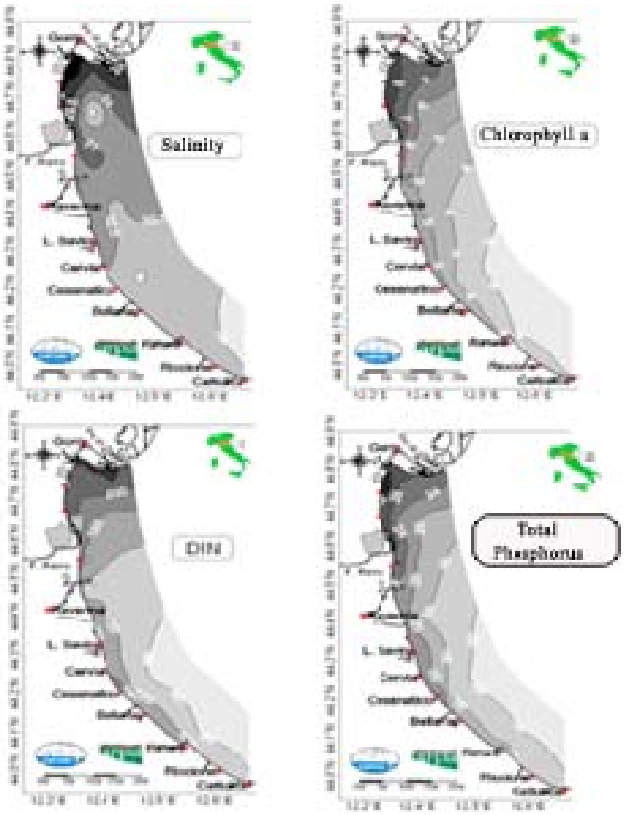


Figure 5.19: Coastal waters of Emilia-Romagna. Variation of the main trophic status parameters: mean values for the period from 1992 to 2002[32]

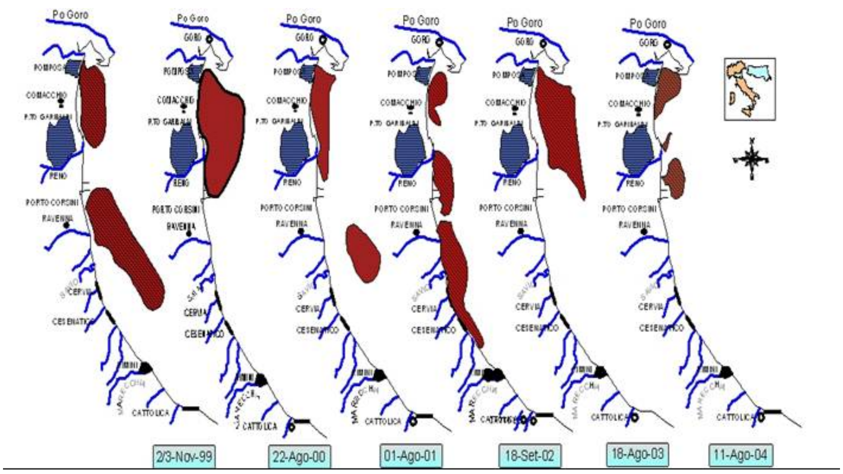
The shallow and sandy coast and the current characteristics determine the best possible conditions for the occurrence of the eutrophication penomenon. The general current that flows up the Adriatic Sea in a counter-clockwise direction tends to "push" the fresh water inputs coming from the Po River against the coasts of Emilia-Romagna.

Insofar as the temporal evolution of the phenomena is concerned, as a rule the algal cycle start since January-February, with extended diatom blooms in consequence of the high wintertime flow of the Po River.
The subsequent months witness a progressive decrease in the algal production, with less intensive summertime blooms involving for the most part the dinoflagellates.
The eutrophication consequences should be referred for the most part to the damage caused to the coastal marine environment by the conditions of anoxia and/or hypoxia that may affect coastal seabeds. It should be stressed that this phenomenon occurs nearly every year: areas of varying extent of the Emilia-Romagna coastal system end up suffering from anoxia/hypoxia of the subsurface layers, with greater frequency and intensity in the areas neignboring the Po River delta but affecting also the areas to the south for a range of at least three chilometers from the shore (Figure 5.20).
The demand for oxygen that results from the processes of oxidation of the great amount of organic substance accumulated in the seabed water may become so high as to cause anoxic crises, with the result of determining the death by asphixiation of all the benthonic organisms.

The eutrophication consequences should be referred for the most part to the damage caused to the coastal marine environment by the conditions of anoxia and/or hypoxia that may affect coastal seabeds.

In any event, the persistence of the phenomenon along the coastal strip is furthered by a marked thermohaline stratification with weak coastal currents and smooth sea. These conditions are typical of the late summer and fall season, when the Po river flow is low and the coastal system features minimum chlorophyll values in surface waters.

[32] Source: ARPA Emilia-Romagna. Yearly reports of the Daphe Oceanographic Structure.



The anoxia phenomenon occurs nearly every year in more or less extensive areas of the Emilia-Romagna coastal system, and is more frequent and intense close to the Po delta.

Figure 5.20: Northwestern Adriatic Sea: evolution of the phenomenon and extension of the area hit by seabed anoxia[33]

Besides, it should be pointed out that, as a rule, the interannual variability proves very high, with a succession of years characterized by considerable rainfall and Po River flows that are on average high, and vice versa.

[33] Source: ARPA Emilia-Romagna. Rapporti annuali della Struttura Oceanografica Daphne.

The causes

In the Mediterranean Sea and in Italy, the coastal and marine zones are among the most vulnerable and seriously threatened natural ecosystems, even though they are for the most part covered by specific protection tools at both a national and a Community level. This has been acknowledged by EEA[34] that has once again stressed that the European coastal area is affected by a widespread and progressive deterioration in terms of habitat destruction, eutrophication, contamination, invasion of alien species and erosion.

The coastal marine zones of the Mediterranean Sea and Italy are among the most vulnerable and threatened natural ecosystems.

The action of the sea, with its crashing force during surges (huge breakers), manifests itself on steep coasts with a slow erosive process that undermines the base of the ridges and, under certain conditions, leads to the collapse of parts of the rock system, as well as on low-lying coasts – more vulnerable territories – with constant movements of the sediments that give rise to a continuous and more evident reshaping of the territories. The considerable width of the Italian shorelines is ascribable to the deforestation connected with the intensification of the commercial and agricultural activities through the ages. These activities have accelerated the soil erosion processes in the countryside and on hilly grounds, favoring the river transport of huge amounts of sediments towards the sea. This has caused many river mouths to benefit from a great supply of sediments and the development of wide and branched deltas, which have allowed the structuring of the coastal plains as well as the shoreline progradation. The subsequent optimization of the regime of water courses, the urbanization of shorelines with the destruction and stiffening of dune systems, a use of the soil designed to reduce the loss of fertile land and the stabilization of slopes have caused this huge input of sediments to run out, favoring the regression of the shoreline and, therefore, triggering erosion phenomena throughout the Peninsula. The subsidence of the littoral sediments, connected with the draft of water for irrigation purposes and reclamation works that turned many coastal strips into healthy areas, has contributed to the creation of low-lying and floodable areas that are now below the level of the sea.

The evolution of the Italian shoreline is affected for the most part by the contribution of river sediments.

In short, our Country is witnessing a constant upward trend in the erosion phenomena affecting its shorelines owing to:

- reduced supply of river sediments in consequence of river-bed digging and the entrapment of sediments by slope stabilization, river management and damming works (with an anthropic rather than natural dominance);
- surges and concomitant flooding events that give rise to paroxysmal erosion phenomena at the mouth of rivers;
- relative sea level increase and concomitant effects of decrease in soil levels owing to natural and anthropic subsidence phenomena;
- indiscriminate coastal urbanization, with rows of vacation homes, promenades, little squares jutting out on the beach, port facilities at times out of context, breakwaters and groins potentially built to protect earlier works.

Surges, relative increase in the sea level, subsidence and indiscriminate urbanization contribute to the erosion of the shorelines.

Italy's port system is changing owing to two main factors: the demand

[34] EEA, 2010, *The European Environment – State and Outlook 2010*, Report 1/2010.

for mooring places for pleasure boats and the development of the transport system for freight traffic and for handling containers (transshipment) that require large transport hubs. Container ships (which may be even longer than 300 m) that get to a transport hub require deep water (15-18 m), large maneuvering and docking spaces and a depth of at least 400 m in the port storage yards. With a view to obtaining the spaces required for this type of works, new port facilities are typically built away from highly urbanized areas, as it has happened at Gioia Tauro, Cagliari or Savona-Vado and in Europe at Marseille, La Rochelle and Algeciras.

Considering the new works finalized between 2000 and 2007, a container terminal outside the urban areas has only been built at Olbia. Elsewhere, due to the difficulty in locating large free spaces to be devoted to the construction of these works and in order to benefit from existing port infrastructures, rather than building new container terminals it was deemed preferable to see to the reorganization or to the conversion of existing ports. The required space has been recovered by taking it directly from the sea with huge filling works, as exemplified by Leghorn, Chioggia, Civitavecchia and Ancona, and the maritime facilities have been built and extended around these spaces.

The rigid structures built to protect the shorelines subject to erosion have not solved the problem.

The rigid structures (groins, barriers, etc.) built to protect the shorelines subject to erosion have not solved the problem and, in quite a number of cases, have contributed to the process of artificialization and deterioration of the coastal marine habitat.

The practice of dredging relict sands stems from the need to have access to huge amounts of material to be used for the nourishment of beaches. After all, the recourse to sand deposits located off the coasts has been a widespread practice both in Europe and in the rest of the world since a number of years.

In addition to allowing an improved knowledge of the meteo-marine characteristics of the basins, the study of the hydrodynamic sea processes represents also a preliminary step for coastal area planning, for the design of strategic works and works for the protection of the habitat.

The study of the hydrodynamic sea processes (tide regime, wave climate, surges, etc.) allows getting to know the meteo-marine characteristics of the basins, but it represents also a preliminary step for coastal area planning, for the design of strategic works (ports, railways, roads, offshore facilities), and for the design of works for the protection of habitats and activities in the most vulnerable areas.

As far as the coastal areas are concerned, the risk associated with storms is expressed in terms of likelihood of the events and vulnerability of the areas taken into consideration.

Since the postwar period, the most accessible coastal areas have undergone an intense and unrestrained anthropization process with the construction of urban, economic and productive settlements and, unfortunately, the vulnerability of the coastal areas is increasingly higher. Even though the study of extreme events allows estimating in a reliable manner the likelihood of the events that may occur in the various areas, it should be considered that the impact of climate changes in the distribution of meteo-marine events could lead to consequences, even in the medium-term, that are by no means negligible.

As previously specified, the population density and the exploitation of both the soil and the coastal landscape for town-planning purposes provide an indication of the strong interaction between man and the coastal marine environment and point to the impact they have on the

coastal habitats, including the urban and industrial wastes that are the main source of pollution and eutrophication of marine waters.
While there are numerous sources of pollution that entail the unsuitability of water for bathing purposes, the main sources result from microbiological pollution.
The land-based sources responsible for the pollution of bathing waters are sewage and effluents that have been inadequately treated or not treated at all, as well as the washout of farmland. Therefore, urban wastewater treatment plants, industrial activities, agricultural activities (fertilizers, pesticides, etc.), livestock farms and solid waste treatment plants are all potential pollution sources.

The major sources of pollution of bathing waters are sewage and effluents that failed to be adequately treated and the washout of farmland.

The risk for the bathers caused by a source of contamination face may vary in relation to the hydrogeologic characteristics of the drainage basin. As a rule, the presence of the mouth of a major river close to a bathing area may represent a potential risk for bathers in relation to the load of pollutants transferred in that water course through drainage water and wastes. Therefore, the atmospheric conditions become extremely important. In fact, it is a known fact that heavy rains may deteriorate the quality of bathing water owing to the pollutants washed out from the soil and carried through rivers to the bathing area. The latter situation may give rise to events of short-term pollution.
As for the phenomenon of toxic blooms and, specifically, insofar as O. *ovata* is concerned, it seems that – just like other dinoflagellates – in the periods when it is not detected in the water (winter-early spring) it may survive in the sediments in the form of cysts (resting stage).

The Ostreopsis ovata *benthonic blooms appear almost exclusively during the summer and fall (beginning of October) seasons; in particular, the maximum bloom is reported in the height of the summer along the Tyrrhenian shoreline and in the months of September and October along the central Adriatic coasts.*

The field surveys have allowed assessing that the *Ostreopsis ovata* benthonic blooms appear almost exclusively during the summer and fall (beginning of October) seasons. In particular, the maximum bloom is reported in the height of the summer along the Tyrrhenian shoreline and in the months of September and October along the central Adriatic coasts. This would suggest a different eco-physiological reaction of the populations involved[35]. The conditions that seem to promote the occurrence and maintenance of blooms are shallow waters, presence of rocky and/or macroalgal substrata, poor hydrodynamism due to the natural morphology of the coast or presence of groins and artificial barriers for checking the coastal erosion, extremely stable meteo-marine conditions, water temperature in excess of 25°C in the Ligurian and the Tyrrhenian Sea and between 20 and 23°C in the Adriatic sea, and lack of a thermocline[36].

The main factors of anthropic pressure leading to eutrophication phenomena are the urbanization of coastal areas,

In the Mediterranean Sea, the main sources of nitrogen are washout of farmland and atmospheric deposition, while most phosphorus results from point sources, untreated or insufficiently treated urban and industrial wastes. Hence, the main factors of anthropic pressure leading to the eutrophication of the coastal marine environment are urbanization of coastal areas, tourism, agriculture, industry and

[35] Accoroni S., Cerino F., Cucchiari E., Romagnoli T. *Ostreopsis ovata bloom along the Conero Riviera (northern Adriatic Sea): Relationships with environmental conditions and substrata*, 2010, Harmful Algae 9, 233-239.
Accoroni S., Romagnoli T., Colombo F., Pennesi C., Di Camillo C.G., Marini M., Battocchi C., Ciminiello P., Dell'Aversano C., Dello Iacovo E., Fattorusso E., Tartaglione L., Penna A.. Totti C., *Ostreopsis cf. ovata bloom in the northern Adriatic Sea during summer 2009: Ecology, molecular characterization and toxin profile, 2011.*
[36] ISPRA, Report 127/2010, 148/2011.

aquaculture. The effect of anthropic pressures on the values of chlorophyll, the main phytoplanktonic biomass indicator, has been tested within the MED-GIG context using the common database of the Euromediterranean Countries. The pressure indicators taken into account included the concentrations of nutrients in their forms and other support parameters detected in concomitance with the chlorophyll 'a' measurements. An example of the results is represented by the cases relative to both the Adriatic coastal waters, where total phosphorus (TP) proved to be the main factor capable of conditioning the chlorophyll variability, while the weight of other factors did not prove significant when compared with the weight of phosphorus, and those of the Thyrrenian Sea (Figure 5.21). In the case of the Adriatic Sea, the very high correlation ($R^2 = 0.88$) shows that the chlorophyll 'a' variability is controlled for the most part by phosphorus. In the Thyrrenian Sea, although the correlation is still significant ($p > 0.01$, con $R^2 = 0.25$), phosphorus has just slight control over the variability of chlorophyll 'a', as the latter is affected by other factors that are not represented in the linear model. Besides, the different slope of the two lines points to two rather different trophodynamic regimes. In fact, the Adriatic coastal system has a more efficient reaction to the availability of phosphorus, producing more phytoplanktonic biomass than that produced in the Thyrrenian Sea, being the TP concentration equal.

tourism, agriculture, industry and aquaculture.

The chlorophyll 'a' to total phosphorus ratio allows making out two different trophic regimes: the trophic regime of the Adriatic Sea and the trophic regime of the Tyrrhenian Sea.

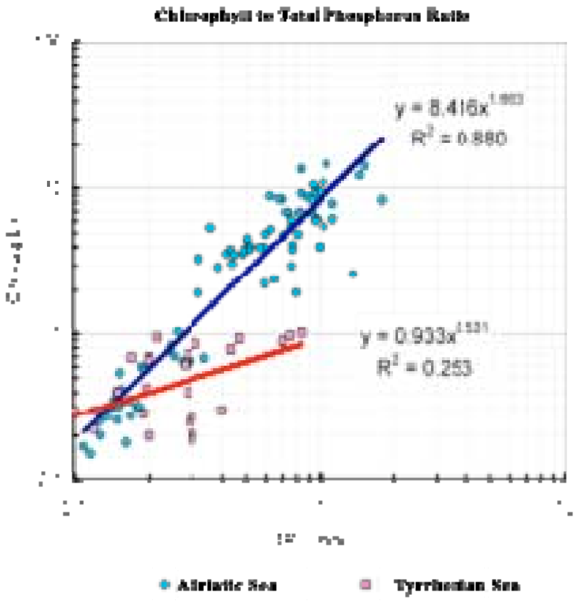


Figure 5.21: Relationship between the yearly geometric means of chlorophyll 'a' (Chl) and the corresponding total phosphorus (TP) values in the coastal monitoring sites in the Adriatic and Tyrrhenian Seas[37]

The alterations affecting the elements that, as a whole, contribute to making up the "marine biodiversity" are highly complex processes, dictated by a number of aspects that, therefore, make it hard to determine precisely which changes are a direct result of specific anthropic activities. Notwithstanding the above, it is by now clear that the damages caused to the marine biodiversity have negatively affected

[37] Source: Precali R., Giovanardi F., France J. and Mazziotti C., 2011, Technical Annex to *Milestone* V of the MED-GIG Intercalibration Exercise, 2nd phase.

the ability of the marine environment to provide adequate quantities of organisms that humans eat, to maintain a good water quality status and to make up in a suitable manner for perturbation phenomena caused by human activities[38].

Threat sources that have a negative effect on the state of preservation of the species: anthropic presence, withdrawal activities, environmental deterioration.

A recent assessments of the sources of threat that are likely to have a negative effect of the status of preservation of the protected sea species in the Italian seas[39] has led to the detection of three main threats based on the type of damage, the human activities that have caused them and the measures required to reduce them:

- threats that are likely to determine a physical or mechanical disturbance and that result, either directly or indirectly, from the anthropic presence (AP);
- threats linked, either indirectly or directly, to withdrawal activities (WA);
- threats linked to the environmental deterioration, meant as physical, chemical and ecological loss of environmental quality (ED).

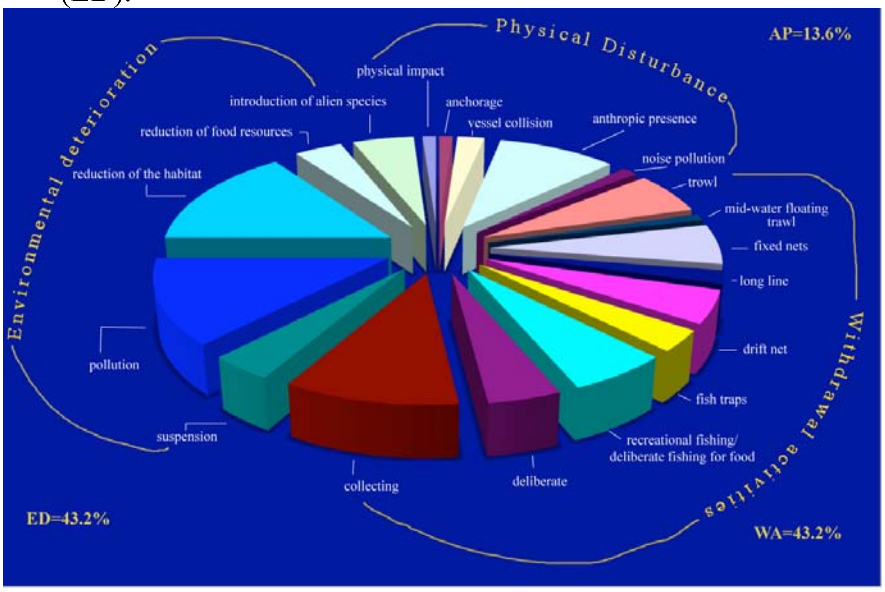


Figure 5.22: Percentage incidence of the categories of threat detected during the assessment of the vulnerability of protected marine species[40]

The threats resulting from withdrawal activities (WA) prove just as important as the threats attributable to environmental deterioration (ED). On the other hand, a lower percentage is reported for the threats determined by anthropic activities that give rise to physical disturbance (AP).

As it may be inferred from Figure 5.22, the threats resulting either directly or indirectly from withdrawal activities (WA) prove just as relevant (in terms of number of times when they have been ascertained by the bibliography and subsequently converted into overall percentage) as the threats ascribable to environmental deterioration (ED). On the other hand, a lower percentage is reported for the threats determined by anthropic activities that give rise to physical or chemical disturbances or that are brought about by the closeness of the anthropic presence (AP).

[38] EEA, 2010, *The European Environment – State and Outlook 2010*, Report 1/2010.

[39] Tunesi L. Agnesi S. Clò S. Di Nora T. Mo G., 2006, *La vulnerabilità delle specie protette ai fini della conservazione*. Biol. Mar. Mediterr., 13(1): 446-455.

[40] Source: Tunesi L. Agnesi S. Clò S. Di Nora T. Mo G., 2006, *La vulnerabilità delle specie protette ai fini della conservazione*. Biol. Mar. Mediterr., 13(1): 446-455.

The alien or allochtonous species, that is to say, the animals and plants that penetrate or are deliberately or accidentally introduced by human activity into areas that are outside their native distributional range, represent at present one of the major threats to marine biodiversity. The Mediterranean Sea is the most invaded sea in the world with an average, from 2000 to date, of one new species reported each month, even though there is disagreement in the scientific world with respect to the actual number of alien species currently present.

The sea that is invaded the most by alien species is the Mediterranean Sea.

The risk resulting from the introduction of a new species is correlated to the ecological role, the latter plays and increases whenever the invasive species interacts, either directly or indirectly, with the key species of the native community.

While the presence of allochtonous species in the Mediterranean Sea is nothing new, the event that has unquestionably amplified the introduction of new species is represented by the opining of the Suez canal back in 1869. The phenomenon has subsequently augmented with new introduction channels, such as the ballast water of vessels, the keel of vessels fouled with sessile organisms, aquaculture, aquariology, and imports of live baits.

The introduction of new species in the Mediterranean Sea has amplified further to the opening of the Suez Canal (1869) and has been increasing owing to new introduction channels (ballast water, aquaculture, imports, etc.).

It is unquestionable that the accommodating capacity shown by the communities of Mediterranean organisms with respect to the new species has contributed to the assertion of the allochtonous species in the Mediterranean Sea. In fact, the relatively young age of the Mediterranean basin (nearly 5 million years) has not allowed the establishment of stable and well-structured sea populations capable of countering the arrival of highly competitive species, such as the Indo-Pacific and Atlantic species.

Furthermore, the settling of new species has been furthered by environmental conditions that have been weakened by strong anthropic pressures (pollution or overexploitation for fishing activities) that have made the autochthonous populations even weaker.

Finally, it is most likely that climatic changes have promoted the successful introduction of alien species thanks to an increase in the temperature of surface water and changes in the main currents that conditioned their diffusion in the Mediterranean Sea.

At present, 48 alien fish species have been reported in the Italian seas, many of which have been found only once or just a few times. Out of these 48 species, it is quite likely that 28 species have come through the Gibraltar Strait, 9 species through lesseptian migration, 8 through sea freight or release from aquaria, and 3 have an uncertain origin.

48 alien fish species have been reported in the Italian seas. It is most likely that 28 species have come through the Gibraltar Strait, 9 species through lesseptian migration, 8 through sea freight or release from aquaria, and 3 have an uncertain origin.

The best-known cases of colonization by Atlantic species concern the blunthead puffer *Sphoeroides pachygaster* and the lesser amberjack *Seriola fasciata*. The last three decades have witnessed an explosion of the blunthead puffer population and, nowadays, the species is caught for the most part in the southern seas by trawling. The blunthead puffer flesh contains minimum quantities of tetrodotoxin and could prove toxic but not lethal for human consumption.

The Atlantic amberjack entered the Italian seas in the early 1990s and, since then, it is easily caught at a young age as a *by-catch* of the lampuga fishing activities carried out from September to January. Its

current distribution is limited to the Sicilian and Sardinian seas.
The most significant cases of colonization by Indo-Pacific species relate to the bluespotted cornetfish *Fistularia commersonii* and the rabbitfish *Siganus luridus*. The former, reported in the Strait of Sicily, all along the western Italian coast and in parts of the eastern coast, has currently successfully settled in the Sicilian seas where it is frequently caught. The latter has settled in the Pelagie islands and is occasionally reported even in other areas.
While alien fish have not yet brought about important impacts in the Italian seas, the phenomenon should not be underestimated. In fact, in the eastern basin, the alien species are responsible for deep changes reported in the yield composition, with a reduction of a few valuable autochthonous species.

The answers

All the regulatory instruments addressing the marine and coastal environment have a common denominator: they promote and require the planning and development of a "mechanism" for the coordination of the economic, administrative and cultural sectors in order to ensure the protection of the marine environment and the sustainable development of the coastal areas. This implies the integration of all the related policies, of the different sectors and of the administration at all levels, as well as the integration of the terrestrial and marine components of the territory concerned, starting from an initial assessment of the status and use of the marine and coastal environment.
Another leading component is represented by the measures to monitor the environmental and ecological parameters, as they ensure an ongoing assessment of both the national strategies and the effectiveness of the plans and programs that have been planned and implemented.
The preceding editions have debated at length – at both European and regional level – the numerous legislative measures and instruments the application of which contributes to the protection of the coastal environment. This edition is going to show the latest developments of the Integrated Coastal Zone Management (ICZM), the Water Framework Directive (WFD Directive 2000/60/EC) and the Marine Strategy Framework Directive (MSFD - Directive 2008/56/EC) of 17/06/2008, which is going to be dealt with at length in a special focus box at the end of the chapter.

Integrated Coastal Zone Management (ICZM) and protection plans.

The Integrated Coastal Zone Management (ICZM) implementation process continues on a number of fronts. At a national level, inter-institutional consultation processes are currently under way for the ratification of the ICZM Protocol to the Barcelona Convention that, signed in Madrid in 2008, has entered into force on 24 March 2011 further to the ratification of at least six Countries. As generally recognized, its guidelines and approaches converge with those set out in the Recommendation 2002/413/EC of the European Parliament and of the Council concerning the implementation of the Integrated Coastal Zone Management in Europe and, in December 2008, even the European Council has adopted the decision to sign the ICZM Protocol

(2009/89/EC).
Furthermore, in 2010, Italy has drawn up its Report relative to the progress made in the ICZM implementation, as laid down in Recommendation 2002/413/EC.
The Report describes the measures involving all the parties concerned that have been implemented with a view to drawing up a "National Integrated Coastal Zone Management Strategy". In the meantime, Italy is carrying on with the initiatives relative to the other Community instruments for which the ICZM is likely to turn into a reference point for harmonizing the protection and management of the coastal marine environment.
Besides, the Report points to quite a number of Regions that, thanks to competences acquired after their administrative decentralization, have developed instruments that may be likened to the ICZM.

An increasingly more extensive recourse to an integrated approach is being reported in the development of measures for managing coastal areas.

In fact, the Regions are adopting more and more an integrated approach to the development of measures falling within their competence and the competence of Basin Authorities. Quite recently, an increasing number of Basin Authorities has adopted master plans dealing with the most urgent aspects of coastal erosion. This pressing need is perceived in particular in those zones of the Peninsula characterized by steep coasts where the erosion phenomena may give rise to landslides and collapses.
The soil protection issues in coastal environments have always fallen within the jurisdiction of those Basin Authorities competent for that part of the basin facing the sea, and even Basin Authorities are adopting more and more the ICZM approach for their sectoral planning along the coast. Hence, for instance, we are witnessing the involvement in the planning process of a variety of stakeholders. To be precise and for delimitation assessment purposes, this entails the inclusion among risk factors not only of aspects strictly connected with the protection of human life, but also of aspects connected with the landscape and the environmental heritage.
In the meantime, the Regions that have not yet implemented a coast management plan are currently adopting legislative and organizational measures to get to their development (as in the case of Basilicata and Sicily), while other Regions are finalizing through the definition of new instruments their pathway to the integrated management of the coastal area, such as Liguria with its Plan for the Protection of the Coastal and Marine Environment.
The classification of the marine water bodies relative to the different water basins is the instrument to assess the ecological status of the basin, that is, its deviation with respect to the attainment of the good quality status, to be attained by 2015, as set out by the Water Framework Directive, implemented by Legislative Decree 152/2006.

Development of Management Plans and Programs of Measures for each water district.

The attainment of the environmental quality objectives presupposes the development of adequate Management Plans and Programs of Measures for each water district identified starting from the boundaries of the water basins. The Basin Authorities are entrusted with the draft of Management Plans that need to be developed based on the data resulting from the monitoring programs carried out by the Regions responsible for the classification of the water bodies.

The Management Plans are submitted to the European Commission through the National Information System for the Protection of Italian Waters (NISPIW), the national WISE center.
The EC carries out preliminary investigations of the Management Plans contents in order to assess their regulatory consistency and the attainment of the environmental goals on the part of Member States.
Just as the WFD and the ICZM, the Marine Strategy Framework Directive (MSFD), which is dealt with in a special focus box, proposes the adoption of an ecosystem-based approach to the management of human activities, while enabling a sustainable use of marine goods and services that does not entail a further environmental deterioration or a violation of the precautionary principle.

Marine Strategy Framework Directive (MSFD).

The handling of marine sediments (even when they are good quality sediments) may have significant impacts on the marine environment, connected with the seabed characteristics and their variation, with possible and localized repercussions on fishing activities (for instance, breaking of fishing nets) and the entry of fine sediments into the water column, which mainly occurs during the dredge loading phase as a result of the discharge of the excess water taken up with the sediment (overflow). The dispersion of the resulting cloud of suspended sediments may damage any sensitive habitat close to the areas involved, such as the *Posidonia oceanic* prairies, the biocenosis of the coralligenous, etc.
In view of the above, the utmost relevance should be attached to the access to detailed and updated information about the environment where the deposits are located in order to anticipate and assess both the handling effects and the choice of measures that are likely to mitigate the resulting impacts.

The handling of marine sediments may significantly affect the marine environment. Therefore, a thorough knowledge of the environment where the deposits are located is required.

Since 1999, ISPRA has carried out environmental studies – originally in cooperation with Lazio and Emilia-Romagna (ARPA Emilia-Romagna) – that have recently led to the finalization of a dredging-specific environmental monitoring protocol that could be applied to other geographical areas. In fact, the protocol experimentation has been subsequently exported to other Italian Regions (Marche) and the resulting protocol has also been presented at a European level[41].

Dredging-specific environmental monitoring protocol developed by ISPRA.

When laying cables and pipes, the characterization of the relative site plays a leading role owing to the possible risk factors connected with the installation of this type of infrastructures. Preliminary seabed explorations, studies of wave motion and marine currents, as well as historical studies of shipwrecks or underwater wrecks of war craft have to be carried out in order to ascertain the technical feasibility and the constraints of the selected connection course. Likewise, one has to know whether other cables or pipes are already present on the seabed. Hence, it is important to provide since the design phase for a minimization of damages and a mitigation of the effects having recourse to devices and operational arrangements that are likely to allow both a reduction of the area directly affected and a limitation of the impacts on nearby areas.

Preliminary seabed explorations, as well as studies of the wave motion and marine currents, etc., are required before laying/installing cables and pipelines.

[41] www.beachmed.eu.

At a European-wide level, the dredging of relict sands and/or offshore sand for nourishment purposes has been dealt with by taking into consideration a variety of (engineering-design, environmental and economic) aspects in the following projects:

European initiatives concerning the dredging of relict sands.

- BEACHMED Project – INTERREG IIIB - MEDOOC Operational Program "Environmental recovery and maintenance of eroding shorelines through the use of marine sand deposits".
- BEACHMED-e Project - INTERREG IIIC Regional Framework Operation, "The strategic management of beach protection for a sustainable development of the coastal zone of the Mediterranean".

The regulatory reference framework currently in force in Italy, which applies specifically to the dredging of relict sand for nourishment purposes, is still partially pending. To-date, the matter is governed by the Ministerial Decree of 24 January 1996 (preliminary inquiries for issuing the authorization) and Law no. 179 of 31 July 2002, which determined the shift of the authorization competence from the State to the Regions.

Although the physical conditions of the sea or the distribution of surge events may not be modified, it is nonetheless possible to have recourse to monitoring and planning tools in order to adjust to natural events, even intense ones, limiting the vulnerability of marine and coastal environments and, consequently, the risk. This objective may be attained through the ongoing monitoring of marine events and an in-depth analysis of the phenomena and their geographical and temporal variability. The prevention-based mitigation of likely damages becomes particularly important in the light of climatic changes that could reveal new vulnerabilities and new risks.

The monitoring of marine events and the analysis of the phenomena permit to adjust and to lessen the effects.

Since a number of years, Italy relies on two nation-wide monitoring networks to check the status of the sea: the National Sea level Network (RMN) and the National Wavemeter Network (RON), both run by ISPRA. The parameters surveyed by the RMN and RON, which are used to get to know the status of the sea and the coastal marine environment, are shared and included in such international sea monitoring projects and networks as the Sea Level Observing System of the Intergovernmental Oceanographic Commission (IOC) and the Global Telecommunication System (GTS) of the World Meteorological Organization (WMO). Besides, they have always been the reference parameters for planning, designing and implementing maritime and coastal protection works, as well as for port and open-sea navigation.

ISPRA's National Sea Level Network (RMN) and National Wavemeter Network (RON), survey the parameters to get to know the status of the sea and of the coastal marine environment.

With its 33 monitoring sites evenly distributed throughout the Italian territory, the National Sea level Network (RMN) is now the most important sea level measuring network in the Mediterranean Sea (Figure 5.23).

Figure 5.23: National Sea level (RMN) Network: measurement sites[42]

The National Marigraphic Network (NMN) has 33 measurement sites evenly distributed throughout the territory.

The morphology of our Peninsula is particularly suited to the collection of sea level data that are not only useful and significant for determining the trend of tides along the coasts but also for studying and interpreting a number of other phenomena that occur in the Mediterranean basin. Among the most relevant of these phenomena, mention should be made to the *seiches*[43] (the best known of which is unquestionably the seiche of the Adriatic Sea) and the anomalous waves caused by seismic events, given that the three main tsunamigenic areas in the Mediterranean Sea involve directly the Italian coasts: the first one is located between the Gibraltar Strait and the Sicilian Channel, the second one in the southern Tyrrhenian Sea and the third one all along the Hellenic submarine arc.

Furthermore, Italy's position and coastal development represent ideal conditions for the collection of several other data having considerable meteo-climatic and environmental interest. The National Sea level Network (RMN)collects information and data coming from four technologically integrated sub-networks:

- Network for the measurement of the sea level and the determination of tides and seiches;
- Meteo-marine network of the Italian coasts;
- Network for the timely detection and characterization of anomalous waves (tsunami) (Figure 5.24);
- Network for the qualitative characterization of environmentally sensitive marine areas.

[42] Source: ISPRA.

[43] Free oscillations of the entire basin, the effect of which may be added to that of the tides.

Figure 5.24: Anomalous waves network[44]

Anomalous waves network.

The extension of the service, operational since 2010, allowed the implementation of an extremely advanced network that integrates the four application contexts: marigraphy, meteorology, analysis of anomalous waves and water quality. All the monitoring sites of RMN are equipped with radar (sea level), Tidron shaft-encoders (sea level), air temperature/humidity, water temperature, wind speed and atmospheric pressure sensors. Furthermore, 10 monitoring sites are equipped with a multiparametric probe with the following parameters: water temperature, pH, Redox, and conductivity. The parameters surveyed by the monitoring sites are published in the ISPRA site (www.mareografico.it), which also gives access to the tide range values anticipated for major as well as secondary ports, which are shown in the section devoted to the tide tables.

National Wavemeter Network (RON).

Since time immemorial, the collection of long time series of meteo-oceanographic data in the open sea has been a requirement for meteorologists and oceanographers interested in clarifying the mechanisms of exchange between sea and atmosphere and their influence on the behavior of both of them. The only system capable of providing direct elements for understanding the meteo-oceanographic processes in the open sea is represented by in-situ measurements through meteo-oceanographic buoys that turn into a fundamental reference for climatic as well as forecasting studies connected with both the atmospheric and the marine environment.
ISPRA's National Wavemeter Network (RON), operational since 1989, currently comprises (Figure 5.25) fifteen offshore stationary measurements sites evenly located along the Italian coasts within 15 nautical miles from the coastline at a depth of about 100 meters. Furthermore, the network is undergoing continuous developments and, in view of the optimum overall yield in terms of data being stored, it allows the real time access to a wealth of data for scientific and technical processing purposes.

[44] Source: ISPRA.

61207	CATANIA
61208	MAZARA
61209	PALERMO
61210	CROTONE
61211	CETRARO
61212	SINISCOLA
61213	ALGHERO
61214	PONZA
61215	MONOPOLI
61216	CIVITAVECCHIA
61217	ORTONA
61218	ANCONA
61219	LA SPEZIA
61220	VENEZIA
61221	CAGLIARI

The National Wavemeter Network (NWN), operational since 1989, comprises 15 stationary measurement sites evenly located along the Italian coasts within 15 nautical miles from the coastline at a depth of about 100 meters.

Figure 5.25: Location of the RON buoys with WMO coding[45]

The RON is based on measurements sites made up by directional wave measuring buoys with solid state accelerometers, equipped with a full meteorological station, which transmit the surveyed data at 30-minute intervals through a VHF radio system (if need be, through the Inmarsat D+ bidirectional satellite channel) to the corresponding land-based reception centers and delivered by the latter in real time to the control center at the ISPRA headquarters.
The dissemination of data occurs in real time, mainly through the Internet address www.telemisura.it, and the RAI teletext service (page 719). Furthermore, since 2009, the said data are disseminated through the Global Telecommunication System (GTS) to national and international organizations for their integration in large-scale forecasting models.
Considering the beginning of the observation period (1989), historical data series covering a period of nearly twenty years are now available for eight monitoring sites, while the data series cover approximately ten years with respect to the other sites. Besides, the network offers a nearly total coverage of the Italian seas.

Sea status forecasting systems.

If the networks monitoring the status of the sea survey current conditions, the systems forecasting the status of the sea through numerical simulation models prove to be an important tool for mitigating the risk associated with the occurrence of adverse meteo-marine conditions and storms at sea.
It is well known that the physical processes that determine the evolution of the status of the sea (wave motion, currents, tidal height) are closely connected with the atmospheric dynamics that, in its turn, interacts in a crucial manner with the sea surface (through the exchange of heat, humidity and momentum). This is the reason why, for instance, the global models used for climatic simulations are coupled atmosphere-ocean climate models.

[45] Source: ISPRA.

Sticking to the scope of short-term forecasts (a few days), the retroaction of the evolution of the status of the sea (i.e., heat transport by currents) on the dynamic and thermodynamic processes of the atmosphere may be disregarded, as the latter occur on a much faster time scale. Hence, a one-way coupling between meteorological models and sea forecasting models becomes feasible.
To put it simply, the models forecasting the status of the sea (wave measurement models, models forecasting the sea surface elevation, oceanographic models) may be developed in tandem with a meteorological model that provides them with the atmospheric forcing values (typically, surface pressure and wind) for the entire duration of the forecast.
In the Mediterranean Sea environment, special difficulties have to be taken into account when forecasting atmospheric and marine surface phenomena.
The Mediterranean Sea weather is characterized by the two-way interaction between large-scale phenomena (i.e., extratropical cyclones having an Atlantic origin) and the effects of "complex" local factors (orography, distribution of lands and seas, etc.) that give rise to small and medium-scale phenomena (from 10 to 1,000 km).
In its turn, the quality of the wave measurement forecast depends critically on the quality of the sea wind forecast (the same applies to the tidal height forecast with respect to the surface atmospheric pressure forecast).
To sum up, a good forecasting system is required to solve simultaneously all the scales affected by the atmospheric phenomena, or rather, it requires a resolution of a few hundred meters on a wide integration domain.

The SIMM-POSEIDON system enables the forecasting of "high-impact" marine events (storm surges, 'high water' in Venice, etc.).

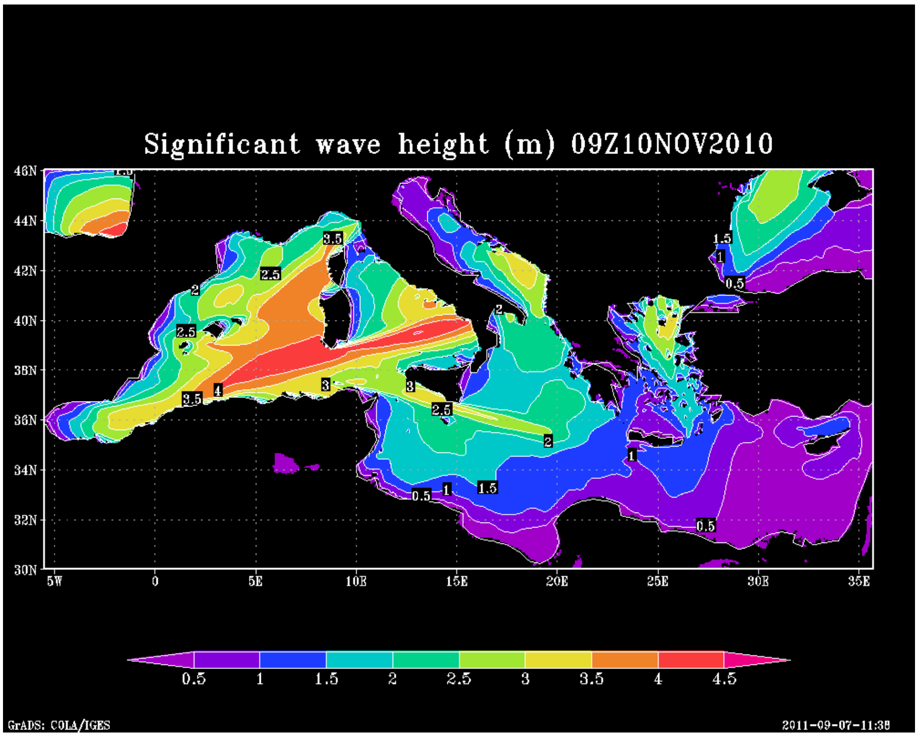


Figure 5.26: The SIMM–POSEIDON forecast of the storm surge of 10 November 2010, at 9:00[46]

[46] Source: ISPRA

The Hydro-Meteo-Marine Forecasting System SIMM, developed by ISPRA, consists of a “cascade” of four models: a Limited Area Meteorological model BOLAM (Bologna Limited Area Model), which provides forecasts for the Mediterranean Basin according to a horizontal resolution of 10 km; a Wave Model (WAM), which provides the intensity, direction and spectrum of wave movements in the Mediterranean, at the same resolution; a high-resolution shallow-water model POM (Princeton Ocean Model) (in a bidimensional version); and a Finite Element Model to predict sea levels in the Adriatic and the Venice Lagoon, respectively (VL-FEM).
The marine part of the system is called SIMM-POSEIDON (Previsional Operational System for the mEditerranean basIn and the Defence of the lagOon of VeNice).

Risk mitigation based on the SIMM system can be achieved either directly or indirectly.
The ability to predict “high impact” events (Figure 5.26), either at sea (storm surges, ‘high water’ in Venice, etc.), or on land (heavy rainfall, floods, etc.), is of the essence because it enables the effective planning of human activities while minimizing the impact of these events on human communities (direct approach).
The climatological study of the events enables the statistical characterization of the phenomena, in relation to the water cycle or the state of the sea (indirect approach), and to extend the wave climates to areas without measuring instruments, or near the shore, where the open sea statistics are inapplicable.
Besides publishing sea state predictions, other applications of the SIMM-POSEIDON system are, for example, weather routing (to optimize shipping routes based on meteo-marine conditions), or to track the movement of pollutants in the sea (as in the case of oil spills).

The ability to predict “high impact” events, either at sea, or on land, enables the planning of human activities while minimizing the impact of these events on human communities. The climatological study of the events enables the statistical characterization of the phenomena, in relation to the water cycle or the state of the sea. Coastal Prediction System (SPC).

Due to the many activities located along the coastline, there is a great need for a specific forecasting system for coastal areas, for long-term planning purposes and in connection with the plan of protection works, such as the Coastal Prediction System – SPC.

Coastal Prediction System (SPC), for the long-term planning and design of rehabilitation works and actions.

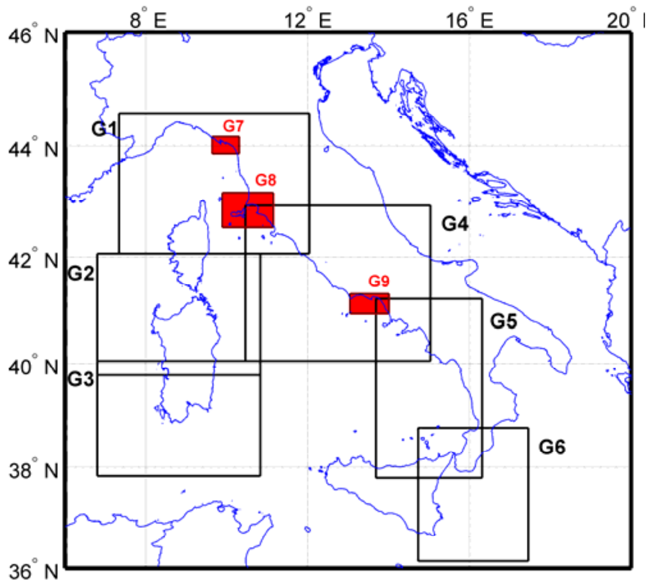


Figure 5.27: Structure of the regional areas (in black) and of the coastal areas (in red) in the Coastal Prediction System[47]

The key feature of the SPC is the ability to take into account the effects produced by even the smallest changes in the depth of the sea floor on wave propagation towards the shore.

These effects are primarily refraction (i.e. the waves change direction and the crest lines tend to rearrange themselves parallel to the depth contours), shoaling (i.e. the gradual increase in the height of the wave as it approaches land), friction with the seafloor, and wave breaking. The Coastal Prediction System developed by ISPRA, operational since 2011, features six regional areas, inside which very-high-resolution coastal areas have been identified, with respect to which numerical simulations are carried out (Figure 5.27).

The following coastal areas are currently operational: Marina di Carrara, Isle of Elba, and Terracina. Figure 5.28 shows the specificities of the coast simulation, whila a large-scale prediction is reporte in (Figure 5.26).

The effects of refraction due to seafloor depth can clearly be observed, as well as the areas where the waves break in the proximity of the shore (the strip in which the colour changes from yellow to blue).

The Coastal Prediction System will soon be finally integrated with the SIMM-POSEIDON system.

[47] Source: ISPRA

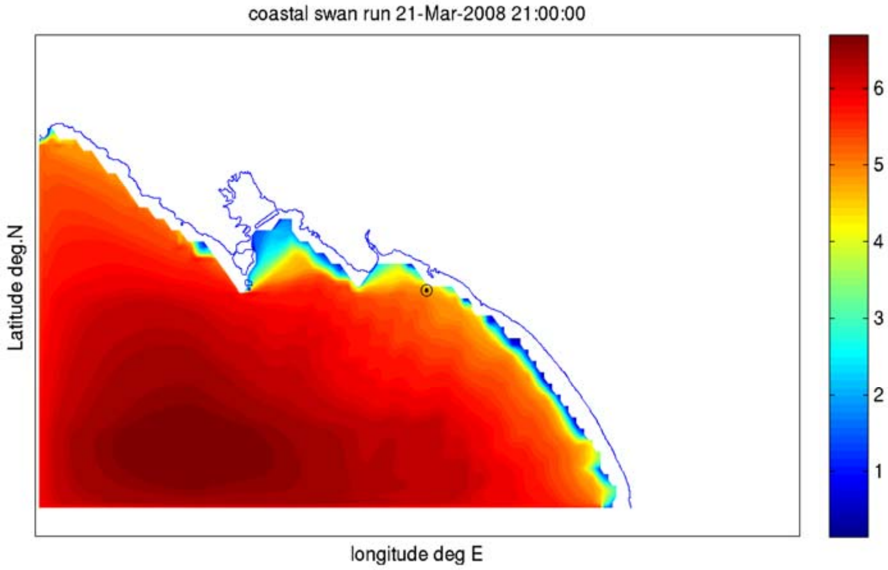


Figure 5.28: Coastal sea state forecast for 21 March 2010 at 21:00 in the coastal area of Marina di Carrara. The color represents the significant wave height in metres[48]

To effectively study the morphodynamics of beaches and the vulnerability of the coastal areas, we need to integrate the systems for collecting information about the sea with programs for the periodical monitoring of the geomorphological changes to the coastline, in order to collect measurements and information on the extent of the changes, and to identify the most vulnerable areas, according to the urban and environmental context.

The remote sensing of geographical data, coupled with the potential of GIS systems, now offer a well-tested technology for the periodical coast monitoring programs, aimed at collecting information about and monitoring the coastal marine environment, preparing reports on the condition of the coastal areas, and updating the physical environmental indicators for supporting the definition of coastal protection and management strategies.

Most regional coastal administrations have introduced this technology to support their planning activities, with respect to the use and protection of coasts at local level.

The Coastal Geographical Information System (SIGC) developed by ISPRA, features a uniform nationwide representation of the coastline, with geomorphological and anthropic information.

The Coastal Geographical Information System (SIGC) developed by ISPRA, features a uniform nationwide representation of the coastline, with information on the characteristic geographical parameters of the coastline, analysis data of the evolutionary dynamics of the littoral areas, port infrastructures, shore erosion protection works, land use data, and defense instruments related to coastal management. The system integrates geographical surveys and conventional environmental reconnaissance and diagnostic techniques (historical maps and orthorectified vertical aerial photographs) and experiments carried out using high-resolution satellite images and aerial perspective photographs.

Rules governing bathing waters.

Legislative Decree 116/2008, and the related implementation Decree 97/2010, issued by the Ministry of Health, lay down new regulations

[48] Source: ISPRA

for managing bathing water quality. In particular, the latter implementation decree contains the criteria for determining advice against bathing and bathing prohibitions, as well as the technical procedures and specifications for preventing health hazards to bathers. The key aim of Directive 2006/7/EC, in fact, is to protect human health from the risks arising from the poor quality of bathing waters, through environmental prevention and improvement.

The procedure for classifying the quality of bathing waters is based on a dataset of values collected over a 3 or 4-year period, instead of on the results of a single year, which makes it more realistic than the previous one.

To ensure a further level of control, the implementation decree, compared to Directive 2006/07/EC, also establishes the limit values for the single samples, exceeding which a bathing ban is applied until safe bathing conditions are re-established. These values are 200 ufc/100 ml in the case of intestinal enterococci, and 500 ufc/100 ml in the case of *Escherichia coli*.

Moreover, since the new rules take into account the environmental assessments of an area, with respect to the bathing waters, the classification is less susceptible to adverse weather conditions. In fact, the samples collected after short-term polluting events, due primarily to heavy rainfall or extraordinary situations, if unfavourable and if provided for in the bathing water profile, may be excluded for classification purposes (no more than one per bathing season).

According to the new bathing water management rules, besides the sampling of the microbiological parameters, a series of environmental assessments also need to be made, with a special focus on any potential sources of pollution.

According to the new bathing water management rules, besides the sampling of the microbiological parameters, a series of environmental evaluations also need to be made, with a special focus on any potential sources of pollution. In particular, account should be taken of a number of factors, such as the morphology and hydro-geological characteristics of the area, as well as its specific meteo-marine conditions. Therefore, each section of bathing water must have its own profile setting out, besides the necessary identification data, a description of the surrounding geographical area and, above all, information about the impacts that can affect the quality of the bathing water, including the forecasts of any short-term pollution and the suitable management measures put into place. The first profiles were prepared on 24 March 2011.

Preparing a profile entails carrying out an accurate analysis of the geographical area in which the bathing water is located, which represents a useful instrument for operators, enabling them to identify the possible sources of pollution that might affect the quality of the water. As the public must be informed about the quality of bathing water, a summary of each profile must be prepared, setting out practical information on the presence of any services in the area.

Actions and monitoring for Ostreopsis ovata.

Algal blooms are an entirely different matter. For a number of years now, certain stretches of coastline are affected by algal blooms by a potentially toxic species, such as *Ostreopsis ovata*. In the worst cases, the local authorities have imposed precautionary measures, such as temporary bans on bathing, along the stretches of coastline concerned. Since these are purely extraordinary events, which cannot easily be foreseen, these measures do not affect the determination of the sea quality judgement.

However, every year ARPA monitors the blooms of *Ostreopsis ovata* and of other toxic benthic dinoflagellates. In some cases, the monitoring activities are conducted within the framework of regional or ARPA-sponsored projects, in others as part of the ordinary bathing water monitoring activities (Legislative Decree 116/2008), or within the framework of the activities for monitoring the mollusc farming areas (Gulf of Trieste) (Legislative Decree 152/2006).

The nationwide monitoring of Ostreopsis ovata *continues every year.*

ISPRA coordinates the collection and processing of the monitoring data, the updating of the sampling and analysis methods, and the surveillance, information, communication and management activities, in the case of toxic algal blooms.

Information is exchanged by means of seminars and annual reports, as well as the toxic algae portal on the ISPRA website, which can be accessed by all experts. With regard to 2010, the choice of the sampling stations was based on the experience built up on the ground by the operators, especially with regard to the hydromorphological characteristics most frequently associated with the development of benthic algal blooms. Moreover, the level of use of the stretches of coastline for tourism is also taken into account, selecting stations located in areas featuring large-scale bathing tourism[49].

As a rule, the monitoring and research activities were carried out between June and the end of September 2010 and, in a few cases, the end of October (Campania, Sicily) or even December (Basilicata), with a fortnightly or monthly frequency. Samples of the water and/or of macroalgae were removed to search for the toxic microalgae causing the blooms and, in several cases, edible marine organisms as well, on which the characterization and quantification of the toxins was carried out, if found to be positive to the mouse test[50]. Awaiting the definition of the critical threshold concentrations for human consumption, when the mussels were found to be positive to the mouse test, harvesting from the natural banks was prohibited (Campania). The physico-chemical parameters of the water were recorded in specific field survey data sheets, along with information on the sampling sites, any visible signs of algal blooms, or of distressed marine organisms (sea urchins, mussels, sea stars, fish). Where a significant blooming of *O. ovata* was detected, bans on bathing were temporarily put into place, with suitable signage.

Sampling methods.

The sampling methods adopted in the majority of cases are those described in the APAT/ARPA operating protocols (2007), while several regional ARPAs (Puglia, Molise, Calabria, Friuli-Venezia Giulia) preferably used, also in addition to the common protocols, a faster sampling method called the “syringe” method[51]. A significant time/space variability was found, with respect to the algal blooming dynamics, in the study year, which makes it even more difficult to compare the data with that collected previously, also preventing the clarification of certain aspects related to the triggering of the blooming events, the achievement of maximum development, and then the decline phase, besides the role played by nutrients.

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[49] ISPRA, Report no. 148/2011

[50] Toxicity tests carried out on mice

[51] Abbate M., Bordone A., Cerrati G., Peirano A., 2010, *Nuova metodica per il campionamento della microalga ticoplanctonica Ostreopsis ovata Fukuyo* 1981, ENEA RT/2010/7/ENEA ISSN/0393-3016

Although the problem of eutrophication is very complex, the basic principles and factors determining the increased amount of trophic levels are now extensively understood and it has become possible to define several benchmarks for the purpose of controlling the eutrophic risk (Ministry of the Environment – ICRAM, 2000). The priority action to be undertaken consists in keeping under control the nutrient loads produced and released by the basins, to enable the substantial reduction of the concentrations of both nitrates and phosphates in the water column: there is little sense in tackling the issue of algal growth without first dealing with the excess of nutrients in the coastal waters. The analysis of the data contained in the Si.Di.Mar. database built by the MATTM, on the marine and coastal monitoring by the regions (pursuant to Law 979/82), and the results of the surveys conducted by ISPRA, have confirmed – for the Adriatic Sea – the trend towards phosphorus limitation, a trend that seems to be consolidating itself compared to the situation in the 1980s-early 1990s, in terms of the increased cases of phosphorus-limitation, compared to total observations[52]. The prevalence of cases of phosphorus-limitation can also be found in the coastal areas of the Ligurian and Tyrrhenian seas, however, situations of this type can always be found in localized areas, especially in the proximity of urban areas and the mouths of rivers, which pour large quantities of nitrogen into the sea. The punctual analysis of the data for almost all the Tyrrhenian regions shows that, in the majority of the cases observed, nitrogen-limitation prevails. Phosphorus remains, therefore, the element on which efforts must be focused to counteract coastal eutrophication (where present or where the eutrophic risk cannot be neglected), and with respect to which the national hypertrophication control policies can be most effective.

In eutrophic risk control strategies, the priority action always consists in controlling the loads of nutrients generated and released by the basins, to enable the substantial reduction of the concentrations of both nitrogen and phosphorus in the water column.

Eutrophication is one of the 11 quality descriptors referred to in the EU Marine Strategy Framework Directive (MSFD) and, therefore, should be used for the initial evaluation of the marine environment and the determination of the requirements to achieve a good environmental status by 2012. In order to achieve (or maintain) a “good environmental status”, it is necessary to minimize human-caused eutrophication, in particular its principal negative effects, such as the loss of biodiversity, the deterioration of the ecosystem, harmful algal blooms, and low levels of oxygen in bottom waters. Before the transposition of the reference directives on the quality of the marine environment, the prevalent attitude with regard to environmental planning and control was aimed at identifying and removing the causes of eutrophication, primarily from a management perspective: the problem of trophic levels should be addressed according to an integrated approach, according to which the scientific and socio-economic aspects are closely correlated. Coastal waters, coastal land, the large basins directly affected by anthropic activities, nutrient loads, etc., represent the whole system, the natural and socio-economic components of which are the respective sub-systems. This type of approach, of course, is still valid and is at the core of the so-called Integrated Coastal Zone Management (ICZM) process.

In order to achieve a “good environmental status”, it is necessary to minimize human-caused eutrophication.

[52] Giovanardi F. and R.A. Vollenweider, 2004, *Trophic conditions of marine coastal waters: experience in applying the Trophic Index TRIX to two areas of the Adriatic and Tyrrhenian seas*, J. Limnol., 63(2): 199-218

With regard to eutrophication, DM 260/2010 requires the evaluation of the phytoplankton EQB, through the measurement of the quantity of biomass, expressed as the concentration of chlorophyll "a", supported by other environmental variables, of a water-related (temperature, salinity, transparency), physico-chemical (dissolved oxygen, pH), and chemical (nutrients in their various forms) nature. The monitoring programs set out in the applicable regulations (DM 56/2009) have been planned and are carried out in line with requirements set out in Directive 2000/60/EC.

Domestic measures for environmental and marine species conservation.

The marine conservation policy should be capable of mitigating the (direct or indirect) effects of the widespread environmental deterioration and depletion activities, tackling aspects such as the fight against pollution and the prohibition of activities leading to the physical destruction of the habitats that the marine species need in order to survive.

In Italy, the conservation of the environment and of the marine species is regulated by a series of domestic regulations (for example, Law 503/1981, Law 979/1982, Law 394/1991, Law 157/1992, Law 59/1993, Law 175/1999, DL 275/2001, DPR 357/1997, DM 3/05/1989, DM 16/10/1998, Regulation 1626/1994) based on international conventions and ad hoc Community regulations and directives. Over the last decade, several international conventions and European directives – in particular, the Convention on Biological Diversity, Barcelona Convention, Directive 92/43/EEC, Directive 79/409/EEC – transposed into Italian law, define a regulatory framework that confers the status of "protected/threatened species" or "species deserving of protection" to a much larger number of Mediterranean marine species than contemplated in the previous legislative instruments (Relini, 1999).

In the Italian seas, 86 threatened/endangered species and deserving of maximum protection have been listed, based on the international and Community instruments.

Generally speaking, the above regulations provide for the implementation of measures suited to countering the rapid decline in numbers of the species deserving of protection, by means of the introduction of prohibitions relating to: the possession, intentional taking in any way, trade and exhibition, disturbance during particular phases of the biological cycle (for example, during reproduction, migration, wintering, molting, in the case of animal species), uprooting and removal (in the case of plant species).

In several cases, the regulations also provide for spatial protection guarantees, through the creation of special conservation areas, in order to mitigate certain human-caused impacts by conducting specific activities in selected areas (Habitat Directive).

The protection of certain threatened species and of specific benthic habitats, however, cannot be achieved only by prohibiting intentional taking, or by protecting certain important areas for specific phases of the biological life cycle of a particular species. The vulnerability of certain species and habitats, in fact, is also the result, in some cases, of the interactions (protracted in time and space)[53] with fishing

[53] Tunesi L., Agnesi S., Clò S., Di Nora T., Mo G., 2006, *La vulnerabilità delle specie protette ai fini della conservazione*. Biol. Mar. Mediterr., 13(1): 446-455

equipment. Consequently, the mitigation of this impact may require specific fishing management activities, which can be defined only after an exhaustive evaluation process. For example, Regulation 1967/2006 prohibits trawl fishing in areas featuring certain particularly vulnerable marine habitats, such as seagrass fields, coral reefs, and Maerl beds.

The invasion by alien species has led to the introduction of domestic and international regulations aimed at protecting marine biodiversity.

Today, "alien species" is one of the descriptors of the environmental status of marine waters (see the MSFD). In particular, it identifies in the introduction of alloctonous species one of the major threats to biodiversity in Europe, and specifically requires the Member States to take into account the invasive species in their definition of "good ecological status".

Research project relating to the "Implementation of a knowledge base concerning the identification and distribution, in Italian seas, of non-indigenous species".

In Italy, since 2002, following the conclusion of a Convention between the Ministry of the Environment and the then Central Institute for Scientific and Technical Research applied to the Sea ICRAM (*Istituto Centrale per la Ricerca Scientifica e Tecnologica applicata al Mare*), now called ISPRA, a large-scale research project was launched for the "Implementation of a knowledge base concerning the identification and distribution, in Italian seas, of non-indigenous species". This has resulted in the creation of a database of the alien species present in the Mediterranean and belonging to eight taxa (cnidarians, tunicates, decapods, fish, molluscs, marine plants, bryozoans and polychaetes). A taxonomic atlas has also been created for the identification and distribution of the above mentioned species. The results of this project represent an excellent springboard for tackling the phenomenon of alien species, which requires constant monitoring because it is an ongoing process.

Pollutants such as heavy metals, persistent organic compounds, petroleum products, radioactive elements, are factors of contamination that need to be taken into account when determining the quality of a coastal marine environment, supplementing the ecological status.

The study and evaluation of the concentration of heavy metals, persistent organic compounds, petroleum products, and radioactive elements, are the subject of numerous national and international monitoring programs.

The study and evaluation of the concentration of these contaminants in the marine environment are the subject of numerous national and international monitoring programs, set up in accordance with the supranational conventions, which bind the signatory States to implementing suitable marine protection measures. In particular, the evaluation of the environmental fate of these contaminants, and their concentration trends in the various environmental spheres, is an integral part of the aims of the Barcelona Convention, which, through the implementation of specific protocols, such as the LBS (Land-Based Sources) Protocol, tend to limit the introduction and use of many polluting substances, with a special focus on persistent bioaccumulative toxic substances (PBTs). PBTs, in fact, are particularly interesting because, in low concentrations, they tend to accumulate in the fatty tissues of the marine organisms and can reach concentrations such as to represent a human health hazard.

In order to minimize this risk, the Stockholm Convention (2001) has identified a list of synthetic substances, not naturally present but introduced by man into the environment (so-called 'xenobiotic' substances), which need to be reduced and gradually eliminated from the production processes, such as: PCBs (polychlorinated biphenyls), chlorinated pesticides, polychlorinated dibenzodioxins and PCDFs (polychlorinated dibenzo-furans). Last but not least, Directives 2000/60/EC and 2008/56/EC include specific recommendations aimed at improving the quality status of Mediterranean marine waters through the analysis, management and monitoring of the components related to the chemical contamination of the sea.

Research programmes.

A survey carried out since 2004, through the development of international projects within the European Union, has produced a first definition of the degree of chemical contamination of marine-coastal waters, at the scale of the entire Mediterranean basin, using mussels as bio-indicators.

The results achieved with the so-called "Active Mussel Watch" method have led to the identification of hot spots, i.e. sites featuring high levels of accumulation of certain classes of contaminants, assigned priority status by the Water Framework Directive (WFD). In the case of Italy, the following hot spots have been identified: La Maddalena and the Gulfs of Naples and Taranto. The following results refer to a 6-year survey period comprising 3 distinct research projects financed by: Community cross-border cooperation programmes (Interreg III B); European neighbourhood and partnership instruments (MEDA programme); the United Nations Environment Programme (UNEP). These projects involve 16 countries on both the northern and southern shores of the Mediterranean, 21 partners, including marine research centres and international organizations such as UNEP MAP and the CIESM (The Mediterranean Science Commission). ISPRA has participated in these projects, conducting 10 oceanographic research campaigns, which have helped form a surveillance network against the chemical contamination of the Mediterranean marine environment (Figure 5.29).

Surveillance network against the chemical contamination of the Mediterranean environment.

Figure 5.29: Artificial sampling stations: Mytilos, MytiMed and MytiAd Projects (2004-2009)[54]

[54] Source: B. Andral, F. Galgani, C. Tomasino, M. Bouchoucha, C. Blottiere, A. Scarpato, J. Benedicto, S. Deudero, M. Calvo, A. Cento, S. Benbrahim, M. Boulahdidi and C. Sammari, 2011, *Chemical contamination baseline in the Western basin of Mediterranean Sea based on transplanted mussels*. Arch. Env. Tox. Cont. 61(2): 261-71

The highest concentrations of PCBs, referred to the hot spots (Figure 5.30), reflect the trend found for other classes of inorganic and organic contaminants, such as heavy metals and dioxins.
This evidence shows how the heaviest impact on the Mediterranean environment originates from the most highly urbanized and/or industrialized areas.
This result is further confirmed by the analyses of the data at the scale of the entire Mediterranean, where, for example, the coastline of the metropolitan areas of Barcelona, Marseille and Algiers must also be classified as hot spots.

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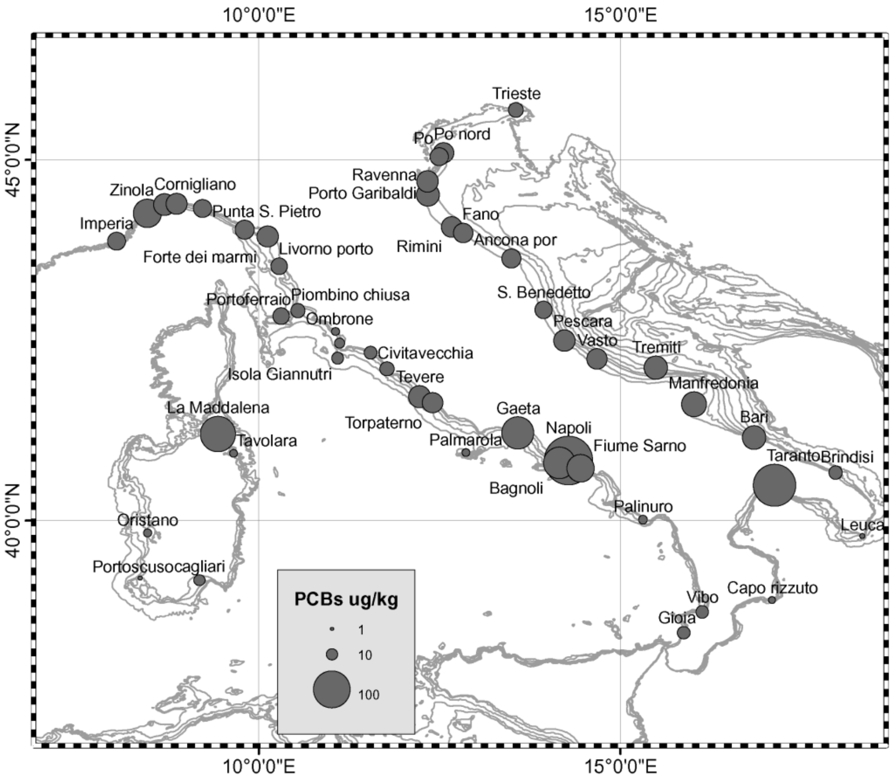

Figure 5.30: GIS processing of the concentrations of PCBs found in mussel tissues, within the framework of the Mytilos, MytiMed and MytiAd Projects (2004-2009)[55]

Based on the statistical analysis of the results collected during the monitoring campaigns, it has been possible to build the distribution and probability curves for each class of contaminants, following the definition of the preliminary classification criteria relating to the rates of accumulation: high/medium/low, compared to the overall spread of values found in the Mediterranean area.
For example, Figure 5.31 shows the distribution and probability curves for PCBs and the breakdown products (DDs) of the pesticide DDT, with the relative position, based on the total measurements made, of several interesting locations on the Italian coastline.
We would like to highlight the position occupied by the three stations

[55] Source: Scarpato A., Romanelli G., Galgani F., Giovanardi F., Giordano P., Calvo M., Caixap J., BenBrahim S., Sammari C., Deudero S., Boulahdid M. & Andral B., 2010, *Western Mediterranean coastal waters-Monitoring PCBs and Pesticides accumulation in Mytilus galloprovincialis by active mussel watching: the Mytilos project*. J. Environ. Monit.. 12: 924-935

in the Gulf of Naples, which feature contentration values comparable with the maximum values recorded in the Mediterranean. Moreover, observe the basic effect the Po river has in maintaining the accumulation values of these contaminants consistently high, on average, at the stations located in the northern and central Adriatic.

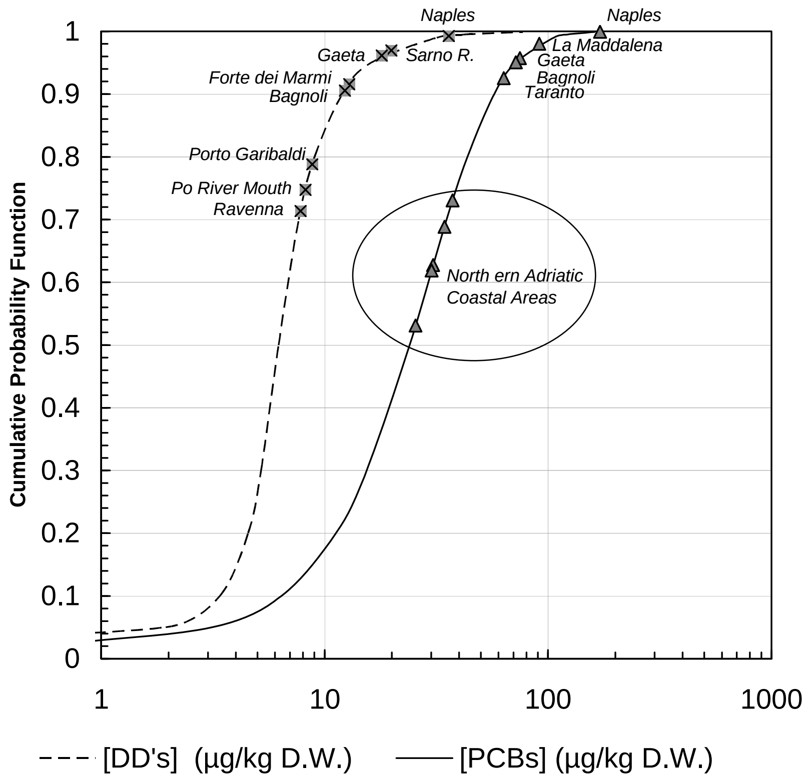

Figure 5.31: Cumulative probability distribution and location of several monitoring stations in the North Adriatic and in other critical areas (2004-2009)[56]

The Mussel Watch project cannot be considered completed. The surveillance network is expected to be extended further, to include hitherto unsurveyed areas, such as the Turkish coastline.
In this context, ISPRA will continue to collaborate with the network of international partners built up over the years, participating in the presentation of a new project proposal called "Chemical Active Reduction in Mediterranean Sea".

[56] Source: ISPRA data, publication in progress. Romanelli G., Amici M., Perini V., Parravano R., Ronci A., Scarpato A. *Valutazione della qualità dell'ambiente marino-costiero mediante mussel watch attivo: bioaccumulo di PCB in campioni di Mytilus galloprovincialis*. Convegno CoNISMA per le scienze del mare "Quali mari italiani?", Lecce, 5-7 novembre 2008

GLOSSARY

WAVE CLIMATE:
Statistical characterization of the behavior of waves.

COASTAL DYNAMICS:
Morphodynamic evolution of the coastlines. Essentially, it depends on the action of the sea (wave motion, tides, currents, storms), but it is influenced also by all those direct and indirect, natural and anthropic actions that affect the equilibrium of the coastal territory modifying its geomorphologic features.

EUTROPHICATION:
Degenerative process of the water ecosystem due to an excessive enrichment in nutrients (nitrogen and phosphorus) that may cause an alteration of its equilibrium.

EUSTATISM:
Rising or falling in the sea level.

OSTREOPSIS OVATA:
Potentially toxic dinoflagellate species.

ECOLOGICAL QUALITY:
Obtained by measuring the deviation of the Biological Quality Elements (BQEs) - phytoplankton, benthonic macroinvertebrates, and macroalgae, angiosperms – from the naturalness or reference values.

BEACH NOURISHMENT:
A technique by which an eroded beach is replenished through the supply of material that is suitable from the point of view of both grain size and composition.

SEICHES:
Free oscillations of the entire basin, the effect of which may be added to that of the tides.

ALLOCHTONOUS OR ALIEN SPECIES:
Animals or plants that penetrate or are either deliberately or accidentally introduced by human activity into areas that are outside their native distributional range.

SPECIAL FOCUS BOX

Box 1: The Venice Lagoon

The Venice Lagoon, with an area extending over 50,000 ha, is the largest and most important lagoon in our Country. Its dynamics is the fruit of a variety of natural and anthropic factors: the natural and induced subsidence of the soil, the long- and medium-term oscillations of the sea level, the deposition of river sediments, and the dynamics of the marine waters along the coastline.

The impact of human intervention has always been relevant in an environment subject to such an extent to the intersection of extremely delicate equilibriums that allow its existence. By definition, a lagoon is an ever-changing environment that is naturally bound to turn into an inlet or to silt up. Since the times of the "Serenissima Repubblica" of Venice, all human interventions were designed to preserve conditions fostering not only the human settlement but also such activities as fishing, navigation, military defense, trading of goods, transport and, over the last century, even industrial production.

The engineering measures involved the diversion of a few rivers and minor watercourses that originally flowed into the lagoon or in its close proximity. The deposition of river sediments had given rise to a considerable silting of extensive areas of the lagoon. Even the mouths of the harbor, which were not mechanically stabilized, were affected by underwater sand bars that represented a serious obstacle to cargo boats entering the lagoon. With a view to averting this risk, huge hydraulic works were carried out on the final sections of the Brenta, Piave, Sile and Po Rivers.

Vice versa, the need to protect the lagoon from the aggressiveness of the sea warranted the construction of huge sea protection walls, the "Murazzi" in particular, that were to reinforce the coastal defense of the lagoon. At the same time, the need to allow the propagation of the tide to work off and to limit the effects of the high water inside the lagoon basin, particularly in the inhabited areas, led to the definition of a perimeter (the so-called "*contermine lagunare*") extending over 157 km, that kept the lagoon basin definitely apart from the adjoining territories and the sea. No sandbank reclamation or any building work that was likely to modify the resulting water balance was allowed inside this perimeter.

The Venice Lagoon, located in the northern end of the half-closed basin of the Adriatic Sea, reports - together with the Gabés Gulf (Tunisia) - the most important tidal oscillations in the entire Mediterranean Sea. The Adriatic Sea extends over 800 km with an average width of 100 km. Thanks to the mountain ranges that flank its coasts and the shallow water in its northern part, the Adriatic Sea lends itself to the genesis of storm surges (rises in the sea level associated with atmospheric disturbances) induced in particular by south-east winds (sirocco). Besides, one should bear in mind the "memory" effect of this basin that manifests itself with the "seiches", that is to say, free oscillations of the entire basin, the effect of which may combine with that of the tides, since they have a comparable recurrence.

The high water phenomenon, typically caused by a difference in pressure between the upper and the lower Adriatic Sea, is heightened in particular by the sirocco wind that causes the sea water to swell all along the northern coast. The said phenomenon, spectacularly perceived in the historic center of Venice, actually affects the entire coastal area of the northern Adriatic, from the mouth of the Isonzo River down to Rimini. In fact, the high water event is not only a problem for town centers, as it exposes the sandy coastlines of this area to the risk of erosion. Finally, it should not be underestimated that a strip of the coastal plain a few kilometers wide is below the mean sea level and that, in the area of the Po River delta, it extends over a few dozen kilometers. All these areas have now been reclaimed for farming purposes. The presence of a number of rivers that are superelevated in their final sections completes the overall picture of this area.

The coexistence of these potential risk factors called for the adoption of suitable measures to protect these territories. In particular, it has been clear since the establishment of the *Magistrato alle Acque* - the Venice Water Authority (1501) - that the surge defense works, the free expansion of the tide and the diversion of the riverbeds were, as they are today, an answer to the pressures exerted by natural phenomena. Systematic observations of the height of the tides within the lagoon started in 1872, even though previous historical high water data series were already on record. Within this context, the Marigraphic Network of the Venice Lagoon, which currently includes about forty marigraphs inside the lagoon and a dozen along the coast, allows monitoring the tidal trends as well as other physical quantities, such as atmospheric pressure and wind regime, in twenty different sites along the coast and in the lagoon.

The MNVL, supplemented by the National Marigraphic Network (NMN), ensures the on-going monitoring of sea and weather conditions over all the Italian coasts. This wealth of detailed and real time observations permits the processing of tide regime forecasts close to the inhabited centers, both inside and outside the Venice Lagoon, which are affected the most by the high water phenomenon. These forecasts, calculated by means of statistical models and brought up to date at least every three hours, are circulated through the web portal www.ispravenezia.it, ensuring constant information throughout the day.

In any event, the forecast of short-term trends should not be separated from the long-term analysis. In fact, if storm surge phenomena vanish within a few days, there are long-term phenomena that require ongoing monitoring and analyses. It is generally known that the soils in the north Adriatic coastal strip tend to consolidate over time due to their composition: this phenomenon is known as subsidence. Starting from the 1920s, this natural phenomenon has been accelerated in the Venice area by massif extractions of groundwater for use in the nearby industrial area of Porto Marghera. In fact, the decreased pressure in the water tables has contributed to a rapid compaction of the soils. The closing of the wells allowed observing a significant slowdown in the rise of the mean sea level in Venice, which indirectly measures the height loss of the city soil.

The loss of the relative soil height is not exclusively ascribable to natural or anthropic subsidence, as it is also due to eustatism, that is to say, a sea level rise due for the most part to global warming phenomena. The measurement of the tide in the Venetian area reflects both effects. Luckily, the existence of another historical marigraph in Trieste, a city that is located in a territory that is not geologically affected by clear subsidence phenomena, allowed calculating it through a comparison of the two series. In fact, while the measurement of the mean sea level in Venice includes the contribution of both subsidence and eustatism, the measurement of the mean sea level in Trieste keeps just the latter into account. Therefore, different trends in the mean sea level are ascribable exclusively to the subsidence effect.

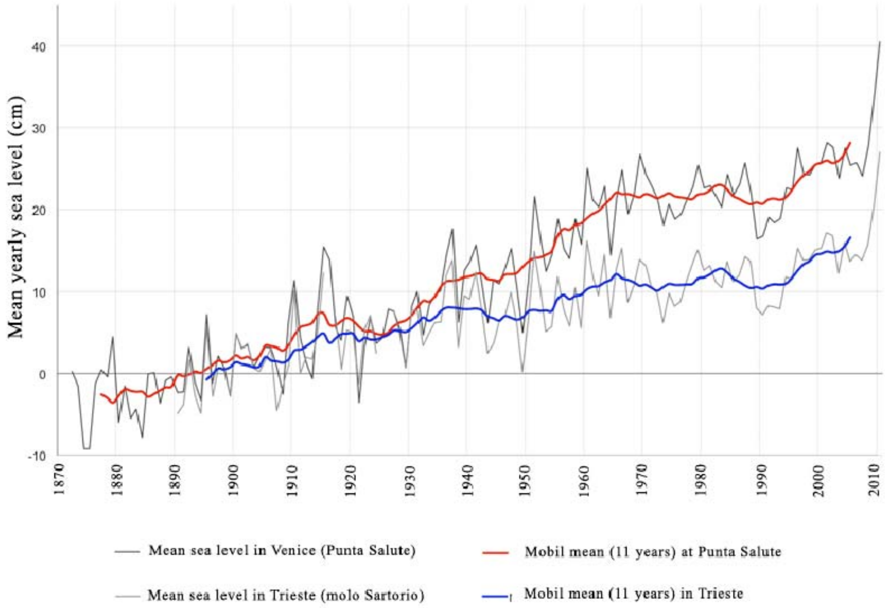

Figure 1: Mean sea level in Venice and Trieste[57]

The mean sea level trend in Venice has witnessed a momentous upsurge, particularly in 2009 and 2010 and, specifically, the values reached in 2010 were the highest ever. From a comparison with other NMN stations, it is clear that this is not a typically Venetian phenomenon as it characterizes the Mediterranean basin. The striking rise in the mean sea level in Venice (Figure 1) has been matched by a good 18 cases of high water with values ≥ 110 cm during the year. Even with respect to lower sea height classes, which give rise to the flooding of limited and circumscribed city areas, 2010 has been an absolute record. In fact, the persistence of low-pressure systems during most of the year caused the mean sea level to remain high even at times that are not traditionally critical for high water. Such a phenomenon has been particularly relevant with respect to medium-high tides (from 80 cm up to 109 cm). As for the tides reported in 2010, a good 101 cases ranged from 80 to 89 cm (64 in 2009), 46 cases ranged from 90 to 99 cm (25 in 2009), and 30 cases ranged from 100 to 109 cm (17 in 2009).
Figure 2 clearly shows that the exceptional increase in the lower classes – a silent and scarcely sensational phenomenon – is actually a sign of an alarming change that is under way since the mid-1990s.

[57] Source: ISPRA.

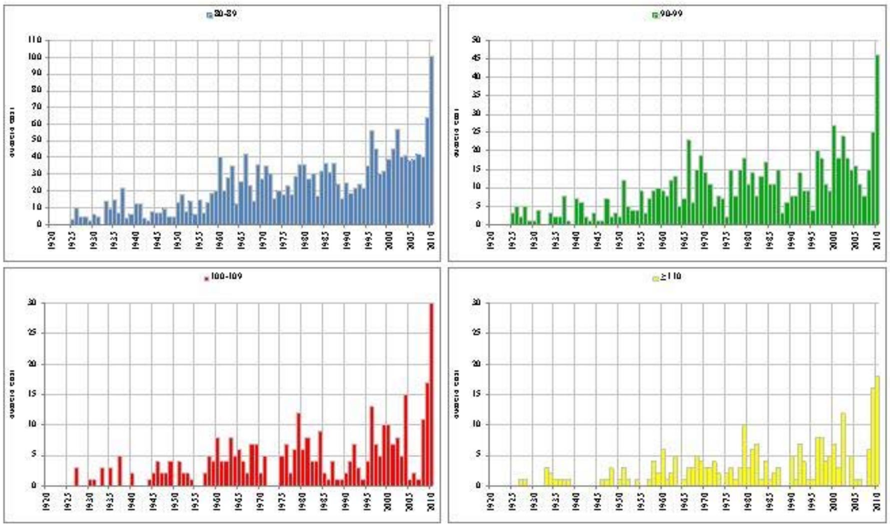

Figure 2: Cases of high water by height classes[58]

The progressive increase in the cases of high water occurrence has engendered since a number of decades a lively debate on the arrangements to be adopted for the protection of the lagoon and its habitat, the livability of city centers, the sustainability of trade, and the tourist and industrial pressure over the entire coastal area. A number of measures have been implemented in the coastal stretch overlooking the Venetian Lagoon and its interior. They have entailed the reinforcement and nourishment of the coastal strip stretching from the mouths of the Piave River to the mouths of the Brenta River, the reinforcement of the dykes protecting the mouths of the harbors at Lido, Malamocco and Chioggia; the protection and consolidation of the sandbanks inside the lagoon, as well as their *ex novo* construction; the renaturation of a few areas of the third industrial zone at Porto Marghera; the construction of the lunate bars protecting the harbor mouths; the creation of a new artificial island inside the harbor mouth at Lido, and works connected with the construction and future implementation of the mobile high-water protection barriers (Mo.S.E.). While the impact of these complex works is definitely relevant in terms of both morphological modifications and changes in the hydraulic setups within the lagoon, their assessment lies outside the purpose of this special focus box.
All the same, a few changes currently under way may be recognized in the altered characteristics of the tide propagation inside the lagoon. In particular, the propagation time has increased slightly in recent years, while the mean tide height has decreased by a few centimeters (Figure 3). As a rule, these characteristics should be considered constant over time, net of relevant morphological modifications. It is clear that the aforementioned measures belong to this category. The results of the initial analyses seem to point to slight changes in the setup of the tides, with a partial recovery of the specific ability of a lagoon to dampen and slow down the tidal wave. Although a few indirect benefits on the setup of the tides inside the lagoon may be recognized, there is no

[58] Source: ISPRA

spatial homogeneity in the data relative to different sectors of the lagoon. Even in this case, the thoroughness of the data collected over time is likely to shed more light on the matter.

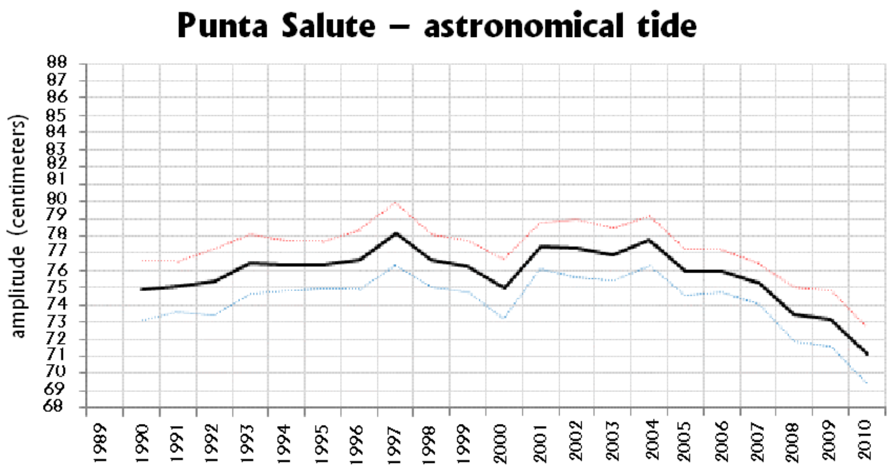

Figure 3: Amplitude of the astronomical tide in Venice[59]

Directive 2000/60/EC, implemented by Legislative Decree 152/2006, makes it mandatory to protect, enhance and restore the status of all bodies of surface water with a view to attaining a "good" ecological and chemical status by 2015, and to maintain a high status where it already exists (art. 4 of Directive 2000/60/EC, art. 76 of Legislative Decree 152/2006).

Even for the Venice Lagoon, as for all the other national transitional bodies of water, the ecological status is defined based on programs monitoring the Biological Quality Elements (BQEs): macroalgae, phanerogamae, benthonic macroinvertebrates, phytoplankton and fish. Even the physicochemical, chemical and hydromorphological parameters in the water matrix and in the sediment matrix contribute to the classification of the ecological status.

The regulations in force consider these parameters as elements supporting the BQEs hat are used to enhance the interpretation of the monitoring data in order to ensure a proper classification of the ecological status of bodies of water and to guide management measures.

The Ministerial Decree 260/2010 has provided for the determination of the BQE quality indices for benthonic macroinvertebrates (M-AMBI and BITS) and macrophytes (MaQI); the definition of type-specific reference values for the application of the said indices; and the definition of class limits for the supporting physicochemical elements. The index for the ecological classification of macrophytes, which integrates the BQEs 'macroalgae' and 'phanerogamae', is the outcome of the cooperation between ISPRA and Ca' Foscari University in Venice, while the ongoing cooperation with CNR-ISMAR and Ca' Foscari University is going to lead to the definition of the phytoplankton and fish fauna indices, which are going to integrate the ecological classification tools for transitional waters. The relative "Protocols for the sampling and determination of the biological and

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[59] Source: ISPRA.

physicochemical quality elements within the context of the monitoring programs of transitional waters under Directive 2000/60/EC", already developed by ISPRA in December 2008 and published in the National Information System for the Protection of Italian Waters (NISPIW), have been brought up to date in July 2011.
The monitoring program for the classification of the ecological status of the Venice Lagoon has been worked out by ISPRA and ARPAV in February 2009 on behalf of MATTM and the Veneto Region, respectively.
In November 2010, further to the issue of the Ministerial Decree 56/2009, the publication by the Eastern Alps Basin Authority of the Management Plan (February 2010) and the Ministerial Decree 260/2010, ISPRA and ARPAV have brought up to date the Program illustrated below.
Pursuant to the regulations in force, the monitoring program purposes to define a consistent and exhaustive general framework of the ecological status of the water bodies inside each water basin district, to classify all the surface water bodies that have been "located" and to provide an accurate description of the status of the surface water bodies as a basis for managing the water environment.
The overall logic process followed for developing the program for monitoring the water bodies in the Venice Lagoon involved first of all the zoning of the area of interest[60]. Subsequently, the risk of not achieving the objectives of Directive 2000/60/EC has been assessed in respect of each body of water. A surveillance monitoring shall be carried out on water bodies identified as being "not at risk" and "probably at risk", while an operational monitoring shall be carried out on water bodies "at risk".
The definition of the Program to sample transitional waters requires an assessment of their inner heterogeneity, identifying the actual habitats and their relative distribution and extension. Hence, the number of sites and the yearly monitoring frequency have been defined in respect of each habitat.
Based on the findings of the Management Plan, all the water bodies in the Venice Lagoon are "at risk" of failing the objectives of Directive 2000/60/EC and, therefore, the operational monitoring program has been implemented.
Such a monitoring program should be carried out for at least a year every three years, the only exception being phytoplankton, the physicochemical and chemical parameters in the waters and the substances that are not specified in the list of priority substances in waters and the sediments that need to be monitored every year.
The operational monitoring investigates the BQEs most sensitive to the specific pressures to which the water body is subject.
The water bodies in the Venice Lagoon are often affected by the presence of multiple pressures, the relative or absolute relevance of which may be hard to define and in respect of which the most sensitive quality elements may be different. Hence, a subset of 30 sites has been selected to monitor all the BQEs (macrophytes, benthic macroinvertebrates, fish fauna, and phytoplankton) and to have access

[60] ISPRA, 2009; Environmental Data Yearbook.

to more comprehensive data without an excessive increase in the monitoring effort.
As for the 30 additional monitoring sites (Figure 4), the sampling frequencies selected over the year refer to the surveillance monitoring frequency. Whether or not all the BQEs should be maintained with a three-year frequency shall be assessed based on the initial findings of the additional monitoring.

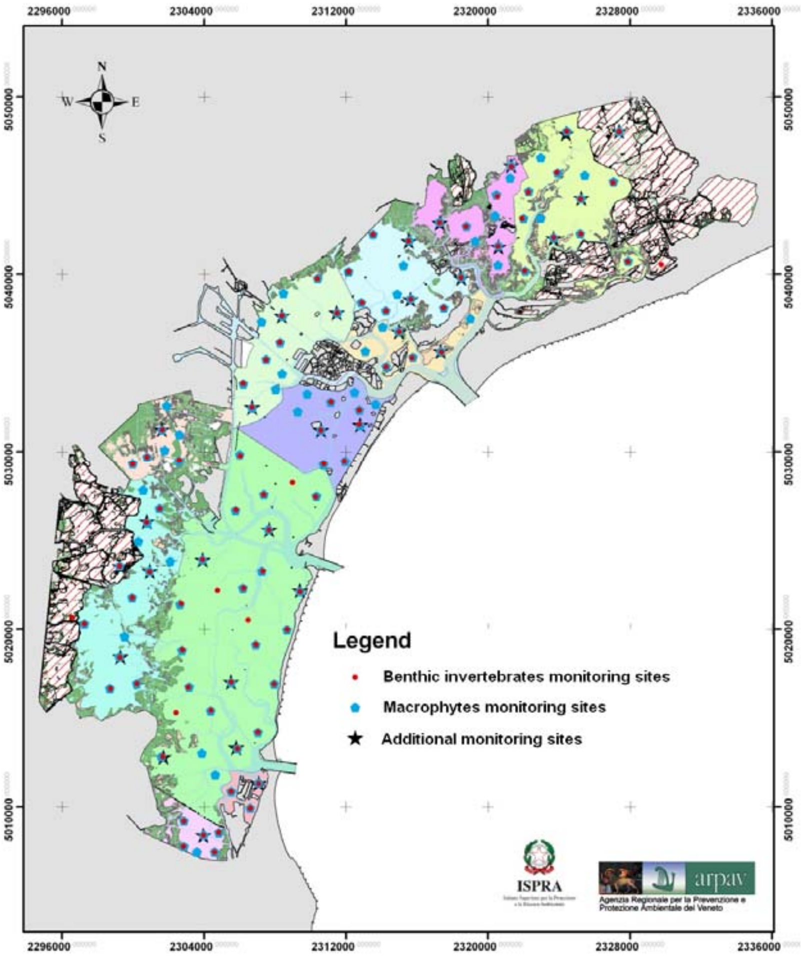

Figure 4: Location of the sites monitoring the biological elements 'benthic invertebrates' and 'macrophytes'[61]

The numerousness (30) and location of the sites (Figure 5) for sampling the supporting physicochemical parameters for the Venice Lagoon have been defined trying to get to the proper compromise between sampling effort and representativeness of the water bodies being monitored by locating distribution areas shared by the different BQEs monitoring points.
The monitoring of the chemical substances that are not deemed a priority and that support the ecological classification is carried out by the Venice Water Authority on 16 out of the 30 monitoring sites.

[61] Source: ISPRA-ARPAV, 2010, Update of the Venice Lagoon Monitoring Program within the meaning of Directive 2000/60/EC aimed at defining its ecological status.

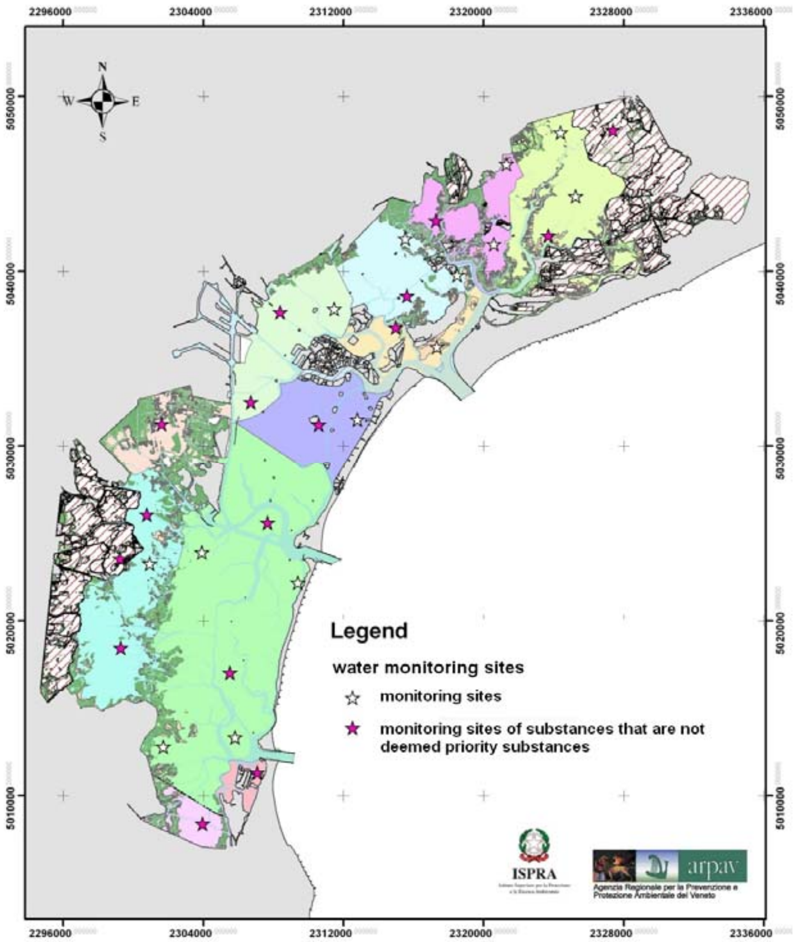

Figure 5: Location of the sites monitoring the chemical and physical elements supporting the ecological classification: water matrix[62]

Insofar as sediments are concerned, the monitoring of the hydromorphological parameters varies depending on the parameter being investigated. The observations on the "nature and composition of the substrate" are carried out when the benthonic macroinvertebrates and phanerogamae BQEs are monitored. The observations on the "depth and morphology of the seabed" are carried out once every 6 years. The observations on the "structure of the intertidal zone" are carried out once every 3 years. The "tide regime" is monitored with a frequency defined based on the characteristics of the water body.

The "Monitoring Protocols" developed by ISPRA for transitional waters specify that the monitoring of sediments needs to be synchronous and referred to the same sites monitoring the reference BQEs. The location of both the 87 sites monitoring the benthonic macroinvertebrates and the distribution areas of the phanerogamae present in the Venice Lagoon coincides with the location of the sites monitoring the hydromorphological parameters supporting the "nature and composition of the substrate" (Figure 6).

[62] Source: ISPRA-ARPAV, 2010, ISPRA-ARPAV, 2010, Update of the Venice Lagoon Monitoring Program within the meaning of Directive 2000/60/EC aimed at defining its ecological status. Revised.

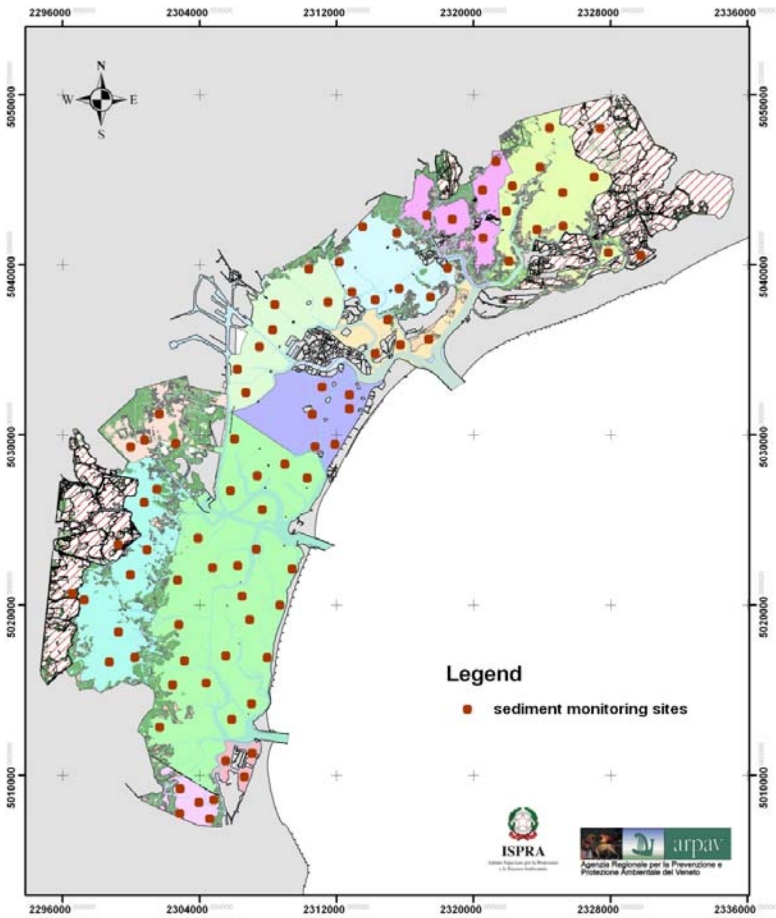

Figure 6: Location of the sites monitoring the chemical and physical elements supporting the ecological classification: sediment matrix [63]

SPECIAL FOCUS BOX

Box 2: Marine Strategy Framework Directive (Directive 2008/56/EC)

The Marine Strategy Framework Directive (MSFD) is one of the fundamental regulatory instruments adopted by the European Union for the protection of marine environments, marine ecosystems and biodiversity[64]. Adopted on 17 June 2008, the Directive became operational on 15 July 2008. It originated from the thematic strategy for the protection and conservation of the marine environment, submitted by the European Commission on 25 October 2005[65]. This thematic strategy purposed "to protect and restore Europe's oceans and seas and ensure that human activities are carried out in a sustainable manner so that current and future generations enjoy and benefit from biologically diverse and dynamic oceans and seas that are safe, clean,

[63] Source: ISPRA-ARPAV, 2010, ISPRA-ARPAV, 2010, Update of the Venice Lagoon Monitoring Program within the meaning of Directive 2000/60/EC aimed at defining its ecological status. Revised.
[64] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (OJ L 164 (2008), p. 19).
[65] COM 2005(504) final.

healthy and productive”.
Hence, the MSFD is the regulatory instrument to attain that objective and, at the same time, represents the environmental pillar of the farthest-reaching integrated marine policy of the EU[66]. Legislative Decree 190/2010 dated 13 October 2010 has transposed the Directive into national law.

Objectives. The main MSFD objective is to achieve or maintain good environmental status (GES) in the marine environment by 2020.
This entails the need to preserve “ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations”.
In different words, this objective requires that marine species and habitats are protected, that human-induced decline of biodiversity is prevented, that diverse biological components function in balance, and that the anthropogenic inputs of substances and energy, including noise, into the marine environment cause no polluting effect.

Criteria of good environmental status. The good environmental status is the key concept of the MSFD.
This environmental status must be attained in each marine region and subregion identified by the Directive that, with reference to the marine region of the Mediterranean Sea, singles out four associated subregions: *i*) Western Mediterranean Sea, *ii*) Adriatic Sea, *iii*) Ionian Sea and Central Mediterranean Sea, and *iv*) Aegean-Levantine Sea.
The GES needs to be determined based on 11 qualitative descriptors of the marine environment that refer to numerous aspects of the marine ecosystems, including biodiversity, pollution, and the impact of productive activities.
These descriptors (Table 1) are listed in Annex I to the Directive. In September 2010, the EC issued a Decision that, based on the scientific and technical assessment of independent experts, has seen to a further development of the descriptors specifying 26 criteria and 56 related indicators that are to be used by Member States to determine the GES for their marine ecosystems and to assess the extent to which it is being achieved[67].
Such criteria and indicators include a combination of elements relative to status, impacts and pressures.
The criteria are accompanied by the methodological standards to make such criteria operational. In any event, while a few criteria are already suitably developed and operational, a number of other criteria still require an improved scientific knowledge and should be addressed in the process for the revision of the EC decision.

[66] COM 2007(575) final.
[67] Commission Decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters.

Table 1: Qualitative descriptors for determining good environmental status (Annex I, Directive 2008/56/EC)

1. Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.
2. Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.
3 Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.
4. All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.
5. Human-induced eutrophication is minimized, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.
6. Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.
7. Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.
8. Concentrations of contaminants are at levels not giving rise to pollution effects.
9. Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.
10. Properties and quantities of marine litter do not cause harm to the coastal and marine environment.
11. Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

Implementation. The cornerstone for the MSFD implementation is the development of marine strategies that represent the action plans for the application of the ecosystem-based approach to the management of human activities. With this view in mind, the MSFD defines a five-step course to be implemented by Member States according to a specific time schedule:

- Initial assessment of the current environmental status of the waters concerned and the environmental impact of human activities thereon (to be completed by 15 July 2012).
- Determination of good environmental status (to be established by 15 July 2012).
- Establishment of a series of environmental targets and associated indicators (by 15 July 2012);
- Establishment and implementation of monitoring programs for ongoing assessment of the environmental status, based on the environmental targets (by 15 July 2014);
- Development of programs of measures designed to achieve or maintain good environmental status (by 2015), keeping into account the socio-economic impact of the proposed measures. The programs have to enter into operation on or before a year (2016).

Each step of the implementation of the MSFD requires regional cooperation.
The general remarks relative to each one of these elements are set out in the text of the Directive together with other prescriptions relative to exceptions, recommendations for Community action, EC

communications and assessments, updates, reporting and proper public information. The EC plays a formal role in the assessment of the measures taken by Member States to implement the MSFD and provides support by promoting a common implementation strategy. Member States are required to ensure a sustainable use of resources and ecosystem services in their marine environment taking into account the general interest.

Regulatory and political reference frameworks. The MSFD has a holistic nature and, therefore, takes into consideration all the thematic and sectoral policies that are susceptible of affecting the marine environment through "pressures" and "impacts" that have repercussions on the "status" of marine waters. Hence, the objective of the Directive must be viewed as the pursuit of an adaptive management, that is to say, a "dynamic balance" between "good environmental status" of marine waters and "sustainable" development, through an appropriate use of both the marine resources and the marine environment (meant also as spatial use and potential sources of pollution).

With a view to attaining this objective, Member States are required to contribute to the consistency of different policies and to promote the integration of the environmental issues in any other policy that is relevant at a Community and international level. Quite a number of Community policies concern the application of principles and standards of the environmental sector that need to be taken into consideration in the development of marine strategies. For instance, the latter include the principle of prevention, the principle of precaution, the "polluter pays" principle, the strategic environmental assessment, the application of the ecosystem-based approach to the management of human activities, the "Waste Water" Directive, the "Nitrates" Directive, the "Bathing Water" Directive, the EU Biodiversity Strategy, the regulations that set limits to atmospheric emissions or that protect special habitats or species. Besides, special relevance has been attached to their relations with the Water Framework Directive (2000/60/EC) and the Directive concerning "Habitats" (92/43/EEC) and "Wild Birds" (79/409/EC). In relation to international agreements, the marine strategies should be developed on a regional basis, for instance, the Mediterranean Sea marine region, promoting the cooperation among neighboring Member States and third countries belonging to the same marine region. From this point of view, special relevance is attached to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona, 1995) that falls under the aegis of the United Nations Environment Program, Mediterranean Action Plan (UNEP-MAP).

CHAPTER 6

EXPOSURE TO PHYSICAL AGENTS

Introduction

"Physical agents" include all the factors that immit energy into the environment and are potentially harmful to human health and the ecosystems, such as noise, electromagnetic fields, vibrations, light pollution, ultraviolet (UV) radiations and ionizing radiations.

The data collected and processed within the EU, as part of policy implementation, with a view to assessing the amount of people exposed to certain levels of noise, identifies noise pollution as one of the major environmental issues, with a large and widespread impact on the population and the environment. Its effects, in terms of disturbance and deterioration of the quality of life, are well documented and such as to convince the European Commission to pursue, as a priority, the reduction in the number of people exposed to noise, by implementing policies based on pooled analyses and common measures.

Despite the attempts at solving the problem through the existing complex legislative framework, at both community and national levels, the in-depth studies conducted on the matter and the implementation of prevention and remediation measures, the issue requires yet further attention and the definition of common and effective responses.

With regard to electromagnetic pollution, the strong perception, among the general public, of the risks entailed by exposure to electromagnetic fields and radio frequencies continues to diminish, also as a result of the widespread monitoring and information activities carried out, in recent years, by the Environmental Agencies Network. The radiocommunications sector, which is currently undergoing a significant technological development, the first effects of which are reflected in the recent upgrading of the relevant national and regional regulations.

Physical agents include all the factors, governed by physical laws, which can transform the environmental conditions in which they appear.
The data collected and processed within the EU, as part of policy implementation, with a view to assessing the amount of people exposed to certain levels of noise, identifies noise pollution as one of the major environmental issues, with a large and widespread impact on the population and the environment.

The strong perception, among the general public, of the risks entailed to human health by exposure to electromagnetic fields and radio frequencies continues to diminish.

NOISE

The issue

The data collected and processed in connection with the first round of the implementation of Directive 2002/49/EC[1] relating to the assessment and management of environmental noise, aimed at defining a common approach for avoiding, preventing or reducing, depending on the respective priorities, the harmful effects of exposure to environmental noise, highlight the presence of a large number of people exposed to levels of noise such as to affect their quality of life.

In the European Community, approx. 60 million people, living in urban agglomerations, are exposed to values of L_{den}[2] in excess of 55 dB, while approx. 40 million people living in urban agglomerations are exposed to values of L_{night}[3] in excess of 50 dB, considering road infrastructures[4] as the sources of the noise.

In the European Community, a significant number of people, living in urban agglomerations, is exposed to noise levels, in particular approx. 60 million people are exposed to values of L_{den} in excess of 55 dB, while approx. 40 million people are exposed to values of L_{night} in excess of 50 dB, considering road infrastructures as the sources of the noise.

In Italy, based on the data published by the European Commission in the NOISE[5] (*Noise Observation and Information Service for Europe)* database, approx. 2 million[6] people living in urban agglomerations are exposed to L_{den} levels in excess of 55 dB, equal to 20% of the total population of the agglomerations taken into account, the strategic noise maps of which have been sent to the Commission[7].

The progressive implementation of Directive 2002/49/EC, and the availability of broader and more accurate information, have outlined a critical situation, to the point of convincing the European Commission to strengthen the actions under the directive, which is currently being revised, by increasing the stringency of the commitments and deadlines introduced.

Directive 2002/49/EC, transposed into national law by Legislative Decree 194/2005[8], aims to determine exposure to environmental noise, requiring the competent authorities in the Member States to provide for noise mapping, in the urban agglomerations and main road vehicle, rail and airport infrastructures, using the L_{den} and L_{night} indicators, introduced for the purpose of establishing the number of people subject to annoyance or sleep disturbances, respectively, induced by noise. The Member States are also required to introduce Action Plans aimed at: preventing and reducing environmental noise

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1 Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise

2 L_{den}: day-evening-night noise indicator, for overall annoyance, introduced by Directive 2002/49/EC

3 L_{night}: night-time noise indicator, relating to sleeping disturbances, introduced by Directive 2002/49/EC;

4 EEA *European Environment Agency*, processed on 30 June 2011

5 Database dedicated to information obtained through the implementation of the actions referred to in Directive 2002/49/EC, http://noise.eionet.europa.eu/index.html

6 NOISE, *Noise Observation and Information Service for Europe*. Data updated to 24/02/2012: 1,957,800

7 NOISE, *Noise Observation and Information Service for Europe Agglomerations: Florence, Milan, Rome*

8 Legislative Decree 194/2005 «Implementing Directive 2002/49/CE relating to the assessment and management of environmental noise» (Published in the Official Journal – general series – no. 222 of 23 September 2005)

where it can have harmful effects on health; to protect acoustic quality, where this is already present; ensure the dissemination of information and the involvement of the public, with respect to environmental noise and its effects.

The implementation status, in Italy, of Legislative Decree 194/2005, with respect to stage one of Directive 2002/49/EC, features a large number of delays and failures, with respect to the required deadlines.

The implementation status, in Italy, of Legislative Decree 194/2005, with respect to the first round of Directive 2002/49/EC, regarding agglomerations with over 250 thousand inhabitants, road infrastructures with over 6 million vehicles/year, rail infrastructures with other 60 thousand trains/year and main airports with over 50 thousand movements/year, features a large number of failures, compared to the required deadlines. Based on the available data[9] ten agglomerations have been notified[10], five of which (Bologna, Florence, Milan, Rome, Turin) have presented a strategic noise map and only one (Florence) an action plan. Regarding airports, out of nine notified main airports, all have presented a strategic map and six an action plan. The fulfilment rate is higher with respect to vehicle transport infrastructures: out of the thirteen road infrastructures with over 6 million vehicles/year notified, twelve have presented a noise map, while of the eight rail infrastructures with over 60 thousand trains/year notified, only 2 have presented a noise map.

The second round of the directive implementation process regards agglomerations with a population in excess of 100,000, main roads with over 3,000,000 vehicles/year and major rail lines with over 30,000 trains/year. The upcoming deadline, relating to the processing and transmission of the noise maps, strategic noise maps and the information set out in Annex 6 of Directive 2002/49/CE, is 30 June 2012, to the competent authorities, and 30 December 2012, to the Commission.

Prior to Directive 2002/49/CE, the European Parliament and the Council had issued Directive 2000/14 on the noise emission in the environment by equipment for use outdoors, transposed into national law by Legislative Decree 262/2002.

From a technical point of view, this directive – and the related transposition act – required that fifty-seven types of machines should be assessed for conformity before being placed on the market. The equipment found to conform could then be sold accompanied by an EU certificate of conformity, bearing the CE mark and a label showing the Guaranteed Sound Power level given in dB(A).

Analyzing the activities of the Environmental Agencies Network, based on the available data, it emerges that, in 2010, there were 2,529 noise sources subject to monitoring and measurement by the ARPA / APPA, with different percentages in the various sectors. The most highly monitored sources, also in 2010, were service and/or retail activities (52.5%), followed by manufacturing activities (31.5%); road infrastructures remain the most highly monitored transport sources (5.9 %) (Figure 6.1).

[9] Ministry of the Environment, May 2011

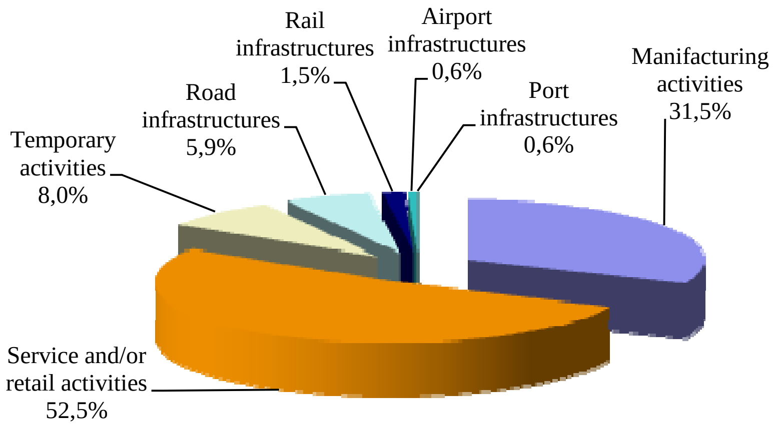
[10] Bari, Bologna, Catania, Florence, Genoa, Milan, Naples, Palermo, Rome,Turin

Year on year, there was an increase in the proportion of service and/or retail activities, compared to the total sources (48.4% in 2009); while the percentage of manufacturing activity sources remained unchanged and that of the road infrastructures monitored by the ARPA / APPA dropped (14.3% in 2009).

Monitoring activities are mainly conducted following reports/complaints by members of the public: in 2010, globally, approx. 89% of sources were monitored due to complaints received. In detail, among the monitored sources, the highest number of complaints was received for temporary activities (99% of total monitored temporary activities) and for service and/or retail activities (97% of total monitored service activities). Complaints regarding activities account for 95% of all complaints received from the members of the public, as a result of which monitoring programs were implemented by the ARPA / APPA.

The large amount of complaints and cases of exceedance of the legal limit values recorded in 2010 (49% of all monitored sources) are proof of the constant attention to noise pollution and to the continuous demand for greater protection by the public, with respect to an effective criticality.

There is a great deal of attention by the public and a demand for personal and environmental protection: 89 controls every 100 are triggered by reports received from members of the public, and 49% of the reported sources feature exceedances of the legal limits.



The monitored sources deemed to be highly disturbing by the public, in order of importance, are commercial/service activities (52.5%), manufacturing activities (31,5%), and temporary activities (8%).

Note:
No data is available for the following regions: Veneto, Liguria, Molise, Campania, Calabria, Sicily and Sardinia

Figure 6.1: Sectoral breakdown of the monitored sources (2,529), by activity/infrastructure (2010)[11]

The principal noise sources

The main sources of noise, namely, road, rail and air traffic, with distinctions in respect of the single sources, after a general increase in volume now feature a steady trend.

In particular, airport traffic data shows that after a 17.7% increase between 2003 and 2007, there was a 6.5% drop during the last four years (2007-2010), although the trend was reversed between 2009 and 2010, rising again by 3.7%. Road vehicle traffic, after a 61% growth between 1990 and 2007, stabilized since 2008 at 83 million

The main sources of noise, namely, road, rail and air traffic, with distinctions in respect of the single sources, after a general increase in volume now feature a steady trend.

[11] Source: ARPA/APPA data processed by the ISPRA

vehicles/km. Regard rail traffic, in 2009 314 million trains/km were recorded on the State Railways network for passenger transport (+5.2% compared to 2004) and 43 million trains/km for freight transport (-32.5% compared to 2004).
The obligation, for the transport infrastructure operators, to introduce Action plans for noise abatement, required by DM 29 November 2000, has not yet been complied with by all the companies concerned, although many infrastructure operators presented their studies in the last year.
The above pressure elements, although declining, along with the inadequate enforcement of the applicable regulations and the lack of synergy and dialogue between key stakeholders, can seriously hinder a comprehensive and shared definition of the necessary actions.
Road vehicle traffic is the main source of noise pollution in urban areas, but we must not overlook other sources, such as, for example, industrial/craft activities, commercial activities and related equipment (air conditioning, refrigerators, etc..), clubs and discos, which generate a significant impact on their surroundings. Even the noisy machines used for road works and building construction and gardening equipment, addressed by Directive 2000/14/EC, influence the noise climate of the surrounding area, therefore representing a considerable cause of disturbance.

Noise abatement actions

The progressive implementation of Directive 2002/49/EC, albeit with differences among the Member States, highlights a greater awareness of the state of the environment, with respect to noise pollution, at Community and Member State level, and a more effective sharing of the issues at stake and the implemented actions.
The need to implement the directive, through the enforcement decrees referred to in Legislative Decree 194/2005, and the harmonization of Community legislation with the complex National legislative system, the cornerstone of which is the Framework Law 447/95 on noise pollution, are the privileged fields of activity, capable of creating an opportunity for reflection and development in the legislative structure.

Forms and procedures of harmonization of the Community and National legislative tools should be identified and shared, in respect of the various fields of this topic.

At Community level, proposals are being advanced to review Directive 2002/49/CE, based on the analyses of the implementation status and the implementation experience of the Member States, by forecasting different scenarios and alternative proposals for solving the problems encountered during implementation.
Moreover, to ensure the accuracy and comparison of the exposed population estimates provided by the Member States, and to implement article 6 of Directive 2002/49/EC, the CNOSSOS (*Common Noise Assessment Methods*) project is approaching completion, for the purpose of defining a common model of determination of the noise indicators L_{den} and L_{night}, for road, rail, airport and industrial noise sources.
At national level, the focus is on ensuring the full integration between the provisions of Directive 2002/49/EC and the complex

legal framework in the field of noise through harmonization, although the lack of measures implementing the directive has been highlighted, despite being provided for by Legislative Decree 194/2005.

The key criticalities found, however, remain, such as: the lack of an organic legislative framework for the sector, at the various levels of application; the failed completion of the implementation decrees provided for by the Framework Law, and in particular those relating to the definition of the criteria for designing, constructing and refurbishing buildings and transport infrastructures; the disregard for the application of the measures for passive noise abatement in buildings; the failure to strengthen the current legislative instruments regarding environmental noise management, which are constantly disregarded.

What clearly emerges is the fragmentation of the actions aimed at the prevention and mitigation of the effects produced by noise pollution. In particular, despite some signs of change, the gap remains, especially in the building sector, between areas featuring a congruent number of actions (transport infrastructures) and those to which little attention is given, as in the integration between regional and noise planning.

But there is undoubtedly a greater focus on environmental communication and information actions and community involvement, also due to the principles and tools introduced at Community level. In this respect, the ISPRA has developed the National Land Register of Noise Sources project, which comprises a database of noise sources, containing useful information for the noise characterization of the main nationwide sources (manufacturing plants, roads, railways, airports and ports) and the possible related noise abatement measures.

However, there are still differences between the implementation status of the various sectors and geographical areas.

The institutional activities of the Environmental Agency Network have nevertheless been stepped up, in order to effectively tackle the needs of the public, with respect to both monitoring and information activities.

The analysis of the data relating to the regulatory measures for the different sectors shows a stationary situation, compared to the previous years, at regional and local level, alongside compliance with certain obligations regarding transport infrastructures.

In particular, the failure to pass a regional law, containing the noise pollution provisions set out in the Framework Law, by some of the regions, highlights the inadequate response at national level: five regions, in fact, have still not approved a regional law on the matter (Molise, Campania, Basilicata, Sicily and Sardinia); the latest region to enact a regional law for implementing article 4 of Law 447/95 was Calabria “Provisions governing noise pollution for protecting the environment of the Region of Calabria” (Regional Law 34/2009), while Tuscany recently enacted Regional Law 39/2011, amending the previous noise pollution measures dating back to 1998.

Regional governments have often passed single provisions – such as noise zoning guidelines or procedures for qualifying noise experts – which, to a certain extent, make up for the lack of organic legislative measures at regional level.

At 31 December 2010, only 46% of local authorities in Italy had approved noise zoning regulations at local level, which is the first necessary step in the implementation of general noise planning actions, for defining land use and enabling the subsequent protection and remediation of critical areas, compared to 43% year on year. Considerable differences remain between the regions in this respect; the top ranking ones are Marche (97.1%), Tuscany (94.1%), Liguria (84.7%), Piedmont (72.7%), Aosta Valley (71.6%), Veneto (63.7%), Lombardy (62.4%), the Autonomous Province of Trento (62.2%), Emilia-Romagna (61.5%), while the lowest ranking – i.e. with percentages below 10% – are Puglia (9.7%), Abruzzo (6.2%), Sardinia (3.2%) and Sicily (1.0%). No noise zoning plans have been introduced, to date, at local level, in the Autonomous Province of Bolzano, Friuli-Venezia Giulia and Basilicata. Lastly, no information is available for Calabria and Molise.

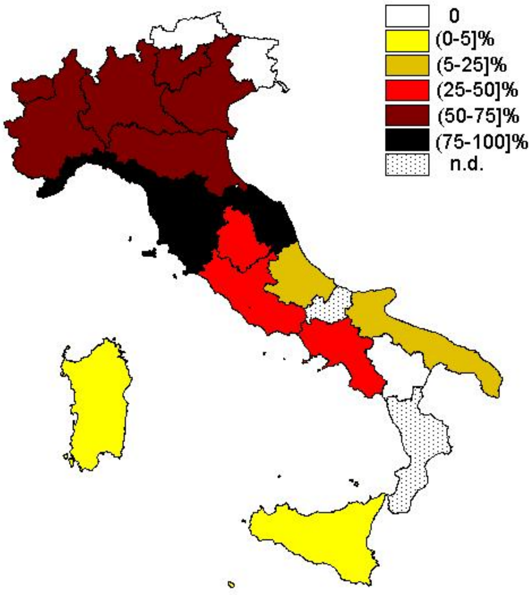
There is also an insufficient enforcement of the noise zoning regulations, which are unevenly applied within the country, with policies that have proven effective in some regions and situations of outright inertia in other areas.

Likewise, there has been a significant increase in the percentage of population living in municipalities that have approved noise zoning regulations, equal to 52%, up from 50% year on year; a similar trend has been measures with respect to land area (from 36.9% of the country’s area in 2009 to 39.9% in 2010) (see Figures 5.3, 5.4, 5.5).

The increased number of local authorities that have approved noise zoning regulations is due to the slight increase in regions already featuring a considerable percentage of compliant local authorities, thus further highlighting the gap between the regions almost fully noise-zoned and those with hardly no noise-zoned local authorities.

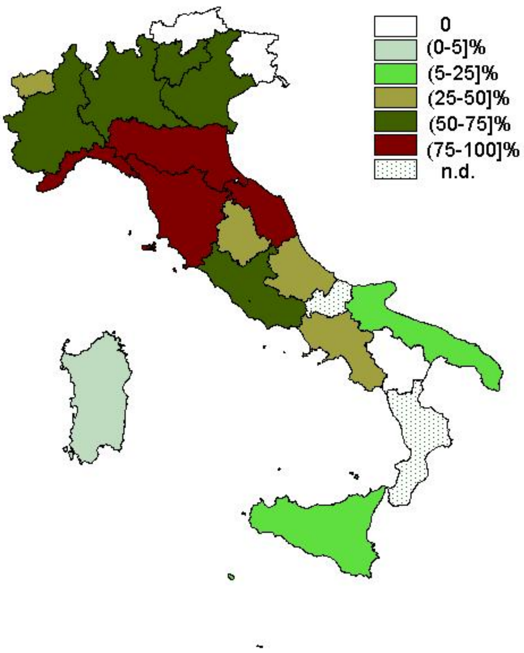
The percentage of Italian local authorities that have approved noise zoning regulations (46%) and the excessive regional differences highlight the insufficient application of this instrument and a marked geographical unevenness, with effective policies in some regions and political inertia in others.

Critical points concern limited awareness of the Plan by the public and its scarce effectiveness on both communities and the quality of the environment, due to insufficient information and the excessive segmentation of this tool, which is not yet fully integrated with the principal regional planning measures and the other environmentally-themed plans.



The percentage of local authorities in Italy that had approved noise zoning regulations, at 31 December 2010, was 46.2%: Marche (97%), Tuscany (94%), Liguria (85%), Piemonte (73%).

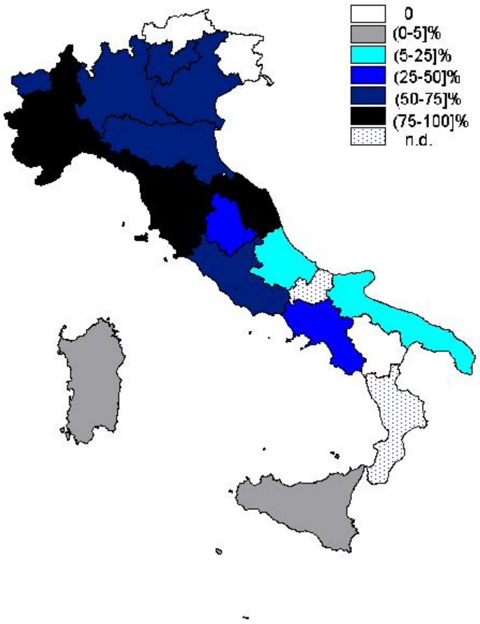
Figure 6.2: Percentage breakdown of local authorities that have introduced noise zoning regulations, compared to the total number of local authorities in each region/autonomous province (data updated to 31/12/2010)[12]



The percentage of the national population living in municipalities that have approved noise zoning regulations is 52%.

Figure 6.3: Percentage breakdown of the population of each region/autonomous province living in municipalities that have introduced noise zoning regulations, compared to the total population (data updated to 31/12/2010)[13]

[12] Source: ARPA/APPA data processed by the ISPRA
[13] Source: ARPA/APPA data processed by the ISPRA



At 31 December 2010, the local authorities that had introduced noise zoning regulations accounted for 40% of the land area, compared to 37% in September 2010.

Figure 6.4: Percentage breakdown of the land area of the local authorities that had introduced noise zoning regulations, compared to the total land area (data updated to 31/12/2010)[14]

The requirement for local authorities to present a two-yearly environmental noise status report, introduced by Law 447/95, as a tool for the analysis and management of "noise pollution" at local level, is widely disregarded.

Regarding compliance by the local authorities, 46% have approved local noise zoning regulations, only 1.7% have introduced noise remediation measures and 15% of the local authorities required to do so have prepared a two-yearly noise status report.

There are no changes, in fact, compared to previous years, in this respect: of the total 149 local authorities with a population in excess of 50,000 required to prepare the report, only 22 local authorities have actually complied and presented a noise report, primarily in Tuscany (11 compliant local authorities out of 13) and Lombardia (5 out of 15).

Moreover, very few local authorities have complied with the requirement, laid down by Law 447/95, of noise remediation measures: based on the available data, only 62 local authorities, in fact, equal to 1.7% local authorities that have introduced noise zoning regulations, have approved a noise remediation plan, primarily in Tuscany, which features 44 approved plans.

Currently, 15 airports out of 40 have approved noise zoning regulations for the airports' surroundings.

Concerning airport noise zoning, as referred to in the enforcement decrees of Law 447/95 on airport noise, at the end of 2010 had been approved for 15 out of 40 airports for which data is available and assessments are currently under way in another 11.

The remediation actions by the operators/owners of transport infrastructures, provided for by the Framework Law, feature sectoral differences: in the case of railways and most of the motorway network, criticality studies have been completed and a first set of mitigation measures designed and scheduled; while in the case of roads and airports there are significant delays in compliance.

With regard to the implementation status of the plans for noise

[14] Source: ARPA/APPA data processed by the ISPRA

abatement (abbreviated as PCAR), introduced by DM 29/11/2000, regarding operators of motorways under private concessions, 18 have sent noise abatement actions plans to the Ministry of the Environment (MATTM) and the regional/local authorities concerned; 3 operators have presented no plans, having declared that the motorways they operate already comply with the applicable limit values and, therefore, need no new measures; lastly, only one operator still needs to comply with this obligation (Table 5.2).
The ISPRA has supervised the preliminary stages of the action plans, sixteen of which have been approved by the Ministry of the Environment, following the agreement reached by the so-called "Unified Conference".
The ISPRA, according to article 4 of Legislative Decree 262/2002, is responsible for performing the market supervision activities established by Directive 2000/14/CE.

In this capacity, to date, it has carried out over two hundred document controls, assisting the regularization of approx. 2,500 noisy machines and equipment, while awaiting the launching of the inspection activities provided for in DM 4 October 2011, at the factories.

94.2% of the kilometers of motorways under private concessions have been monitored, in connection with the preparation of action plans for noise abatement (PCAR), pursuant to DM 29/11/2000; 3.9% of motorways have not yet presented plans, while actions in this respect by the operators have been deemed unnecessary in 1.9% of cases..

Table 6.1: Presentation of the action plans for noise abatement (PCAR), introduced by DM 29/11/2000, by motorway operators under private concessions (December 2011)[15]

PCAR	Km	%
Presented	5,230.30	94.2
Awaiting presentation	218.00	3.9
Declared unnecessary by the operator	106.60	1.9
TOTAL	**5,554.90**	**100**

[15] Source: ISPRA

The need today is to focus on the harmonization of noise pollution prevention/mitigation methods and tools, by exploiting the opportunities offered by the legislative instruments introduced to reorganize the sector, highlighting the critical aspects that have remained unresolved for too long and strengthening the awareness of the relevant domestic and European dynamics.
The prevention, planning and remediation tools envisaged by National legislation, along with those introduced by Directive 2002/49/EC, should be harmonized and their effectiveness enhanced, and accurate, clear and exhaustive information made available to the public, with respect to the key features of the issue and, above all, the effects of noise on both human beings and the environment.

ELECTROMAGNETIC POLLUTION

The issue

In recent years, with regard to electromagnetic fields (EMFs), numerous actions have been undertaken, at national and regional level, in terms of the monitoring and development of information tools, which have made it possible, to a certain extent, to calm down public alarm and improve trust in public institutions.
Currently, in Italy, radio telecommunication systems are being strongly developed, with the switchover from analog to digital television and the introduction, over the next three years, of state-of-the-art systems, such as UMTS 900, LTE and Single Ran devices.
This has entailed the upgrading of National regulations, a process that has created enormous application difficulies at regional level.
The changes in the types of systems and the relevant regulations must, however, continue to be supported by the same tools that, in recent years, have successfully encouraged the social management of this issue.
The enormous strides forward in the legislative and technical-scientific fields, to protect the health of the population, continue to serve as a foundation on which to build further actions for improving knowledge of their repercussions on the environment, nationwide.

It is necessary to continue supporting the strong technological development in the field of radio telecommunication systems by means of targeted actions aimed at improving knowledge of their repercussions on the environment, nationwide.

The principal EMF sources

The following information regards the sources of electrical, magnetic and electromagnetic fields, represented by power lines and radio telecommunications systems (radio/television antennas and BTS), which are covered by the "EMF Observatory" database annually populated by the ARPA/APPA contacts.
Regarding 2010 (Figure 6.5), the density of BTS has increased approx. 3 times compared to that of radio/television broadcasting antennas (0.31 and 0.11 facilities per km^2, respectively), while the density of BTS (0.17 sites per km^2) is approx. 6 times that of radio/television broadcasting facilities (0.03 sites per km^2).
The environmental impact, in terms of the pressure exercised by these facilities nationwide, between 2009 and 2010, has changed

Between 2009 and

primarily in connection with cell phone facilities and sites, which increased by 15% and 12 %, respectively.
Regarding radio/television broadcasting antennas, there was only a slight increase – 5% – of the sites.
This information is based on the full data for the two years, relating to both types of facilities, provided by a limited number of regions (Piedmont, Aosta Valley, Lombardy, Veneto, Emilia-Romagna, Tuscany, Umbria, Marche and Molise).

2010, the cell phone facilities and sites increased by 15% and 12%, respectively, while radio/television broadcasting facilities remained basically unchanged.

Cell phone tower facilities feature a density approx. 3 times higher than radio/television broadcasting facilities, while the density of cell phone tower sites is approx. 6 times higher than that of radio/television antenna sites.

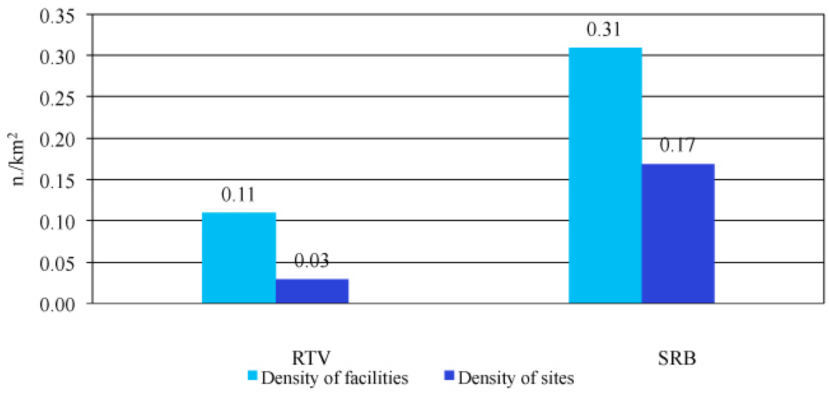
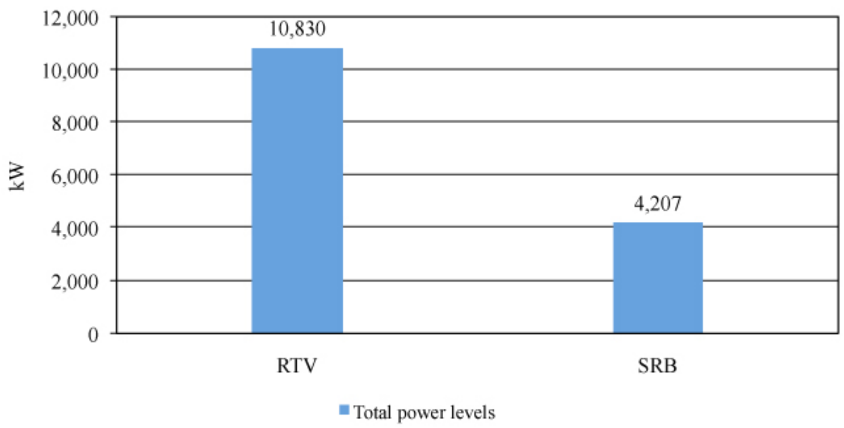


Figure 6.5: Density of cell phone and radio/television broadcasting facilities and sites, for the regions for which complete datasets are available (2010)[16]

The overall power levels of radio/television broadcasting antennas (10,830 kW) is approx 2.6 times that of the BTS (4207 kW).
However, the lower overall power levels associated with BTS entails a greater pressure on the local environment than the radio/television broadcasting antennas, as highlighted above, for the purpose of ensuring nationwide coverage based on the specific needs of the mobile telephone service.

[16] Source: ARPA/APPA data processed by the ISPRA (EMF Observatory)



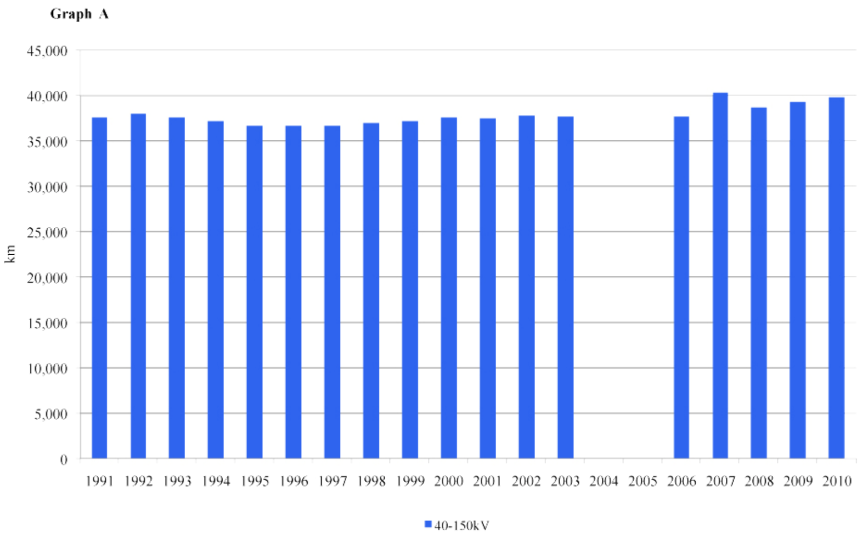
Radio/television broadcasting antennas exercise an environmental pressure, in terms of power levels, that is 2.6 times higher than that of BTS.

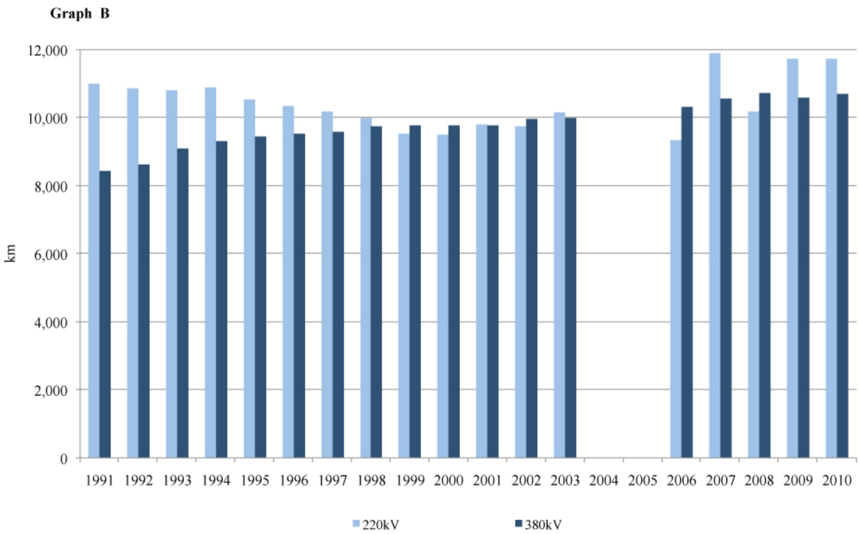
Note:
Due to a printing error by the region of Umbria, the overall power in 2009 was mistakenly reported as equal to 12,309 kW instead of 10,760 kW

Figure 6.6: Total power levels, comparison of radio/television broadcasting antennas and BTS, for the regions where complete datasets are available (2010)[17]

With regard to non-ionizing radiations (NIRs), another important factor is represented by high and very-high voltage power lines (Figure 6.7).
Between 2009 and 2010 no significant changes were recorded in the overall length of these lines.
The information provided in the figure below is related to all the regions and was supplied by the operators Terna SpA, ENEL Distribuzione SpA and Deval SpA.

[17] Source: ARPA/APPA data processed by the ISPRA (EMF Observatory)





There were no significant changes between 2009 and 2010.

Figure 6.7: Overall length of high voltage (diagram A) and very-high voltage (diagram B) power lines[18]

Electromagnetic pollution containing action

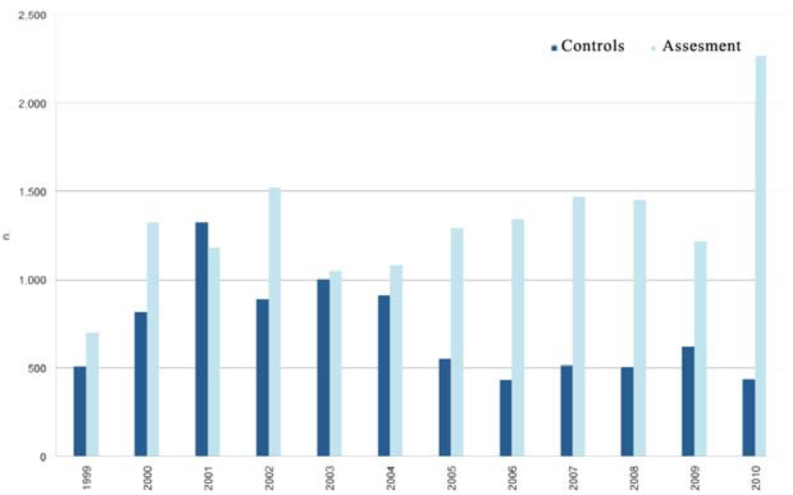
The control and supervisory activities relating to ELF (*Extremely Low Frequency*) facilities, radio/television broadcasting antennas and BTS, which, under the law (article 14 of the Framework Law 36/2001) are the responsibility of ARPA/APPA, significantly support the local and provincial authorities, with respect to both permit-granting procedures (preliminary assessments) and the operating phase (post-activation controls, using forecasting and instrumental models) of radio telecommunications systems. The Environmental Agencies exploit the results of these activities, not only for the primary purpose of checking compliance with the applicable regulations (DPCM 8/07/2003), but also to collect information for improving their knowledge of the repercussions on the environment of certain electromagnetic emissions, and for promoting fuller and more transparent information to the local communities and the public in general. Between 2009 and 2010, there was a significant increase in

Between 2009 and 2010, there was a

[18] Source: Data supplied by Terna S.p.A., Enel Distribuzione S.p.A, Deval S.p.A. and processed by the ISPRA

the number of preliminary assessments, in connection with the related permit-granting process, for cell phone towers (30%) and radio television broadcasting antennas (60%). Regarding the number of post-activation controls, there was a slight reduction for BTS (-3%) and a slight increase for radio/television broadcasting antennas (9%). This information is based on the full data for the two years taken into account, with respect to both types of facilities, provided by a limited number of regions (Piedmont, Aosta Valley, Lombardy, Trentino-Alto Adige, Veneto, Tuscany, Umbria, Marche, Molise, Apulia and Basilicata).
Regarding the assessments/controls relating to power lines (ELF), between 2009 and 2010, the number of assessments rose considerably by 49%, while the number of controls on the operating facilities dropped by 30%. This information is based on the full data for the two years taken into account, with respect to both types of facilities, provided by a limited number of regions (Aosta Valley, Lombardy, Trentino-Alto Adige, Veneto, Tuscany, Umbria, Marche, Molise e Apulia).

significant increase in the number of preliminary assessments for BTS (30%) and radio television broadcasting antennas (60%). Regarding the number of post-activation controls, there was a slight reduction for BTS (-3%) and a slight increase for radio/television broadcasting antennas (9%).



Between 2009 and 2010, the number of assessments rose considerably by 49%, while the number of controls on the operating facilities dropped by 30%.

Note:
The data refers only to the regions/autonomous provinces for which full datasets are available.

Figure 6.8: Trend in the number of assessments and controls, by ELF field sources in Italy[19]

Based on the data supplied by the EMF Observatory, for the regions for which data updated to 2011 are available, with respect to both types of RF sources (Valle d'Aosta, Lombardy, Veneto, Friuli-Venezia Giulia, Liguria, Emilia-Romagna, Umbria, Marche and Abruzzo), we can see how exceedance of the legal limit values by radio/television broadcasting antennas (356) are approx. 10 times higher than the exceedances by cell phone towers (36). Figure 6.9 shows percentage status of the remediation actions, undertaken with respect to the above mentioned cases of exceedance, to the knowledge of the ARPA/APPA. Regarding cell phone towers, a larger number of remediation actions have been completed, compared to radio/television broadcasting antennas, due to the complexity of the

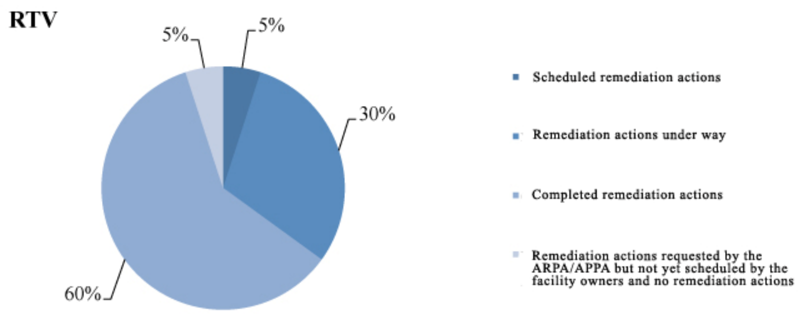
The cases of exceedance of the legal limit values by radio/television broadcasting antennas (356) are approx. 10 times higher than the exceedances by cell phone towers (36).

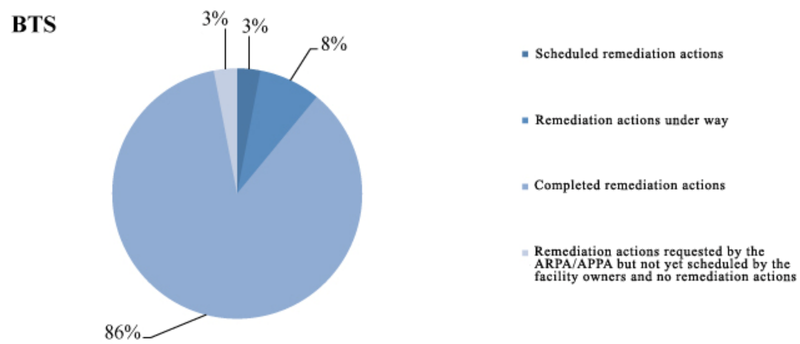
[19] Source: Elaborazione ISPRA su dati ARPA/APPA (EMF Observatory)

remediation procedures, which often require the involvement of multiple facilities, along with the difficulties in maintaining the same quality of service provided for in the concession arrangements, which entails a higher number of remediation actions to be completed, totaling 40%, compared to 14% in the case of cell phone facilities. The domestic legislative framework does not feature any significant changes, regarding the protection of the public from exposure to electromagnetic fields. On the contrary, important progress has been made with respect to the regulation of the authorization procedures for radio telecommunications systems, as a result of the large-scale technological developments affecting the mobile telephone sector, in particular. Based on the data emerging from the EMF Observatory, , for the regions for which data updated to 2011 are available (Aosta Valley, Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia, Emilia-Romagna, Tuscany, Umbria, Marche, Apulia and Calabria), five regions have issued new regulations on electromagnetic fields.

There are no significant changes, regarding the protection of the public from exposure to electromagnetic fields. To date, five regions have issued local regulations on electromagnetic fields.

RTV facilities remediation actions are technically more complex than RTV remediation actions under way and completed are higher than (respectively 5% and 30%) those of BTS facilities (respectively 3% and 5%).





Note:
The data is related only to those regions for which complete datasets are available, updated to 2011, for both sets of RF sources.

Figure 6.9: Remediation status at the sites at which at least one exceedance was recorded due to radio/television broadcasting and BTS (2009)[20]

[20] Source: ARPA / APPA data processed by the ISPRA (EMF Observatory)

GLOSSARY

Physical agents:
"Physical agents" include all the factors that immit energy into the environment and are potentially harmful to human health and the ecosystems, such as noise, electromagnetic fields, vibrations, light pollution, ultraviolet (UV) radiations and ionizing radiations.

Lden:
A day-evening-night noise indicator, for overall annoyance, introduced by Directive 2002/49/EC.

Lnight:
Night-time noise indicator, relating to sleep disturbances, introduced by Directive 2002/49/EC.

NOISE:
The acronym of *Noise Observation and Information Service for Europe*, operated by the European Environment Agency (EEA) and the European Topic Centre on Spatial Information and Analysis (ETC-SIA, formerly ETC-LUSI) on behalf of the European Commission. It contains data on the strategic noise maps provided in accordance with Directive 2002/49/EC relating to the assessment and management of environmental noise.

Decibel (**dB**):
The decibel (dB) is one tenth of a bel (B): 10 dB = 1 B. The bel, although seldom used, remains the fundamental unit of measurement from which the decibel derives; moreover, the corresponding measurements are pure numbers and are obtained as the logarithm of the ratio of two uniform quantities (i.e., that can be expressed using the same unit of measurement and such, therefore, that their ratio is a pure dimensionless number).

National Land Register of noise sources:
Developed by the ISPRA, on behalf of the Ministry of the Environment, it is a database for the characterization of noise sources of nationwide relevance, such as transport infrastructures or plants subject to the AIA. The Register is an extremely useful tool for conducting environmental impact studies and, above all, as a component of the environmental information processes targeting the general public.

EMF Observatory:
The "EMF Observatory" database has been set up in connection with the need to develop a suitable knowledge base, relating to the number of nationwide facilities (high-frequency radio/television broadcasting antennas and cell phone towers and ELF power supply lines), the control activities carried out by the Regional/Provincial Environmental Protection Agencies (ARPA/APPA) and the critical situations resulting from the exceedance of the limit values, under the applicable regulations.

Facility (**RF**):
The number of antennas operating at a given frequency form a facility (this definition is in line with the technical specifications of the EMF Observatory).

Site (**RF**):
A geographical location hosting telecommunications facilities. A site may be simple – featuring only one mast or pylon – or complex, i.e. with may masts and/or pylons, which are generally enclosed by fencing (this definition is in line with the technical specifications of the EMF Observatory).

Radio/television facilities:
Radio and television broadcasting facilities transmit RF electromagnetic waves with a frequency of between several hundred kHz and several hundred MHz.

BTS (**Base Tranceiver Station**):
Mobile telephone facilities receiving and transmitting signals from cell phones and operating at different frequency bands, between 900 and 2,100 MHz, depending on the technological system used.

CHAPTER 7

NUCLEAR ACTIVITIES AND ENVIRONMENTAL RADIOACTIVITY

Introduction

Although nuclear power plants and all other nuclear fuel cycle facilities were decommissioned in Italy many years ago, activities are still ongoing to ensure the safe handling and disposal of the radioactive waste produced before the nuclear energy program was discontinued and with respect to the plant decommissioning operations. Moreover, several small research reactors are still operating, at Universities and Research Centers, and ionizing radiation sources are currently used for medical applications, in certain industrial processes and for scientific research, entailing transport activities of both the sources and the waste. The relevant environmental pressures are varied and still rather significant: the management of radioactive waste, the production and necessary treatment of radioactive waste from hospital (diagnostic and/or radiotherapy applications), the production and worldwide circulation of radioactive materials, natural radiation sources (radon gas and NORM) make sure that radiation protection remains a key feature of environmental protection and of the protection of the population and workers.
In Italy, protection from the ionizing radiations associated with nuclear installations, and from environmental radioactivity in general, is governed by Law 1860/1962, Legislative Decree 230/1995, as amended, and Legislative Decree 52/2007. The current domestic regulations assign specific duties to the operators of activities falling within the scope of the regulations themselves, as well as tasks to the central government (Government Entities and Departments) and the local governments (Prefectures, Regions and Autonomous Provinces). The control of nuclear activities and the monitoring of radioactivity in the environment are priority functions for ensuring a high level of protection of the population and the environment from risks associated with exposure to ionizing radiations.

NUCLEAR ACTIVITIES

Principal activities

The nuclear activities entailing the risk of exposure to ionizing radiation, of both the population and the environment, existing in Italy today comprise, in particular:

- the plants and facilities belonging to the since discontinued nuclear program (undergoing decommissioning) and research reactors;
- radioactive waste storage facilities, many of which are located inside the nuclear plants;

- activities relating to the use of ionizing radiation sources;
- the transport of radioactive materials.

The main nuclear plants currently at various stages of decommissioning are those of Garigliano, Latina, Trino and Caorso, the EUREX and ITREC experimental reprocessing facilities, the Plutonium and OPEC 1 plants of ENEA's Casaccia Research Centre, the Nuclear Fabrications Plant, the Avogadro Deposit, and Ispra's Joint research Centre facilities (VA).

The plants and facilities belonging to the since discontinued nuclear program are currently being decommissioned.

The decommissioning process consists of a series of scheduled activities – carried out strictly in accordance with the applicable HSE and radioprotection requirements, for both the workers and the environment – ultimately aimed at the final dismantling or, in any case, the surrender of the site free of any radiation pollution, so that it may be used for other purposes.

The decommissioning process consists of a series of scheduled activities ultimately aimed at the final dismantling or, in any case, the surrender of the site free of any radiation pollution, so that it may be used for other purposes.

The principal preliminary decommissioning operations are the removal from the plant of any spent nuclear fuel and its transport to an authorised site, located outside the country, for reprocessing, followed by the treatment and conditioning of the radioactive waste produced by the plant.

To ensure the safety of the radioactive waste, and the achievement of the final objective of remozing all radiation hazards from the site, it is necessary to dispose of a suitable national facility for the final disposal and long-term storage of the waste. It goes without saying that, while awaiting the availability of a national facility, suitable storage conditions must be guaranteed at the sites, by providing for adequate temporary deposits conforming to the current international standards.

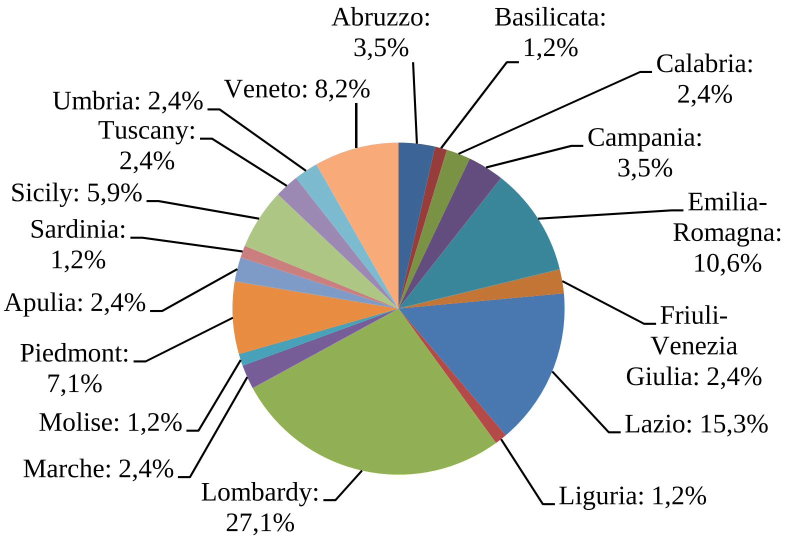
It is necessary to dispose of a suitable national facility for the final disposal and long-term storage of the waste.

The decommissioning activities also entail the production of different types of solid materials, which – subject to compliance with the radioactivity concentration limits – may be removed from the plants without the risk of radiation pollution. Moreover, during the decommissioning activities, liquid and gas effluents may be discharged into the environment, albeit within specifically authorized limits. The criteria laid down by the Italian regulations, based on the definition of the levels of removal for the solid materials and for the release of effluents into the environment, corresponds to the internationally recognized value of "non-significant radiation", equal to 10 microSv/yr.

The decommissioning activities entail the production of solid materials, which may be removed from the plants without the risk of radiation pollution.

The use of ionizing radiation sources continues to be widespread in the field of medical applications, in certain industrial processes and for scientific research purposes, with the necessary transport activities for the distribution of the sources and the disposal of the relevant waste. In the medical field, for example, many hospitals and healthcare facilities use radioactive sources for diagnostic and therapeutic purposes (nuclear medicine units, metabolic treatment, immunological test laboratories, etc.). For diagnostic purposes, the sources are generally unsealed, i.e. they are not incorporated in a solid material or contained in a sealed casing to prevent their dispersion. However, in the industrial field, the use of – mainly sealed – radioactive sources is widespread in a number of sectors (level/thickness gauges, radiation and sterilization systems,

The use of ionizing radiation sources continues to be widespread in the field of medical applications, in certain industrial processes and for scientific research purposes geological introspections, etc.); one of the most widespread applications is industrial radiography (called gamma-radiography, when the radiation source employed is a radioisotope), used to carry out non-destructive tests, for example, on pipe weldings or mechanical components, this method is very similar to the x-ray exams used in hospitals.



Geographical breakdown of the ionizing radiation sources used in medical 0applications, industry and scientific research.

Figure 7.1: Regional breakdown of the plants and facilities using ionizing radiations authorised at central level[1]

As mentioned earlier, the use of radioactive sources requires transport, which is carried out by specially authorized hauliers, which also take care of the disposal of the radioactive waste produced in connection with the above activities and of disused radioactive sources (i.e. those which are no longer used), which are sent to authorized storage facilities operated by expert staff.

The key issues

In connection with the decommissioning of the nuclear plants, the spent nuclear fuel will be moved to France.

Regarding the decommissioning activities of the main nuclear plants, most of the spent nuclear fuel is moved to France, within the framework of an intergovernmental agreement concluded in 2006. 190 tons of fuel have already been removed from the Caorso plant, and the transfer of the remaining 45 tons from the Avogadro Deposit and the Trino plant is under way; furthermore, there are 2 tons of fuel at the ITREC plant at Trisaia (MT), which, lacking an agreement providing for its return to the United States, will be dry-stored at the site in a specific facility that still needs to be built.
The radioactive waste currently in Italy mostly comes from the prior nuclear program and is found at the facilities operated by Sogin S.p.A. – former nuclear plants of Trino, Garigliano, Latina and Caorso, the former ENEA EUREX plants of Saluggia and ITREC at Trisaia (MT), the Plutonium and OPEC plants at the Casaccia Center (Rome), the Avogadro deposit at Saluggia (VC) – and the facilities of the Ispra joint research centre of Ispra (VA) of the European Commission.

The radioactive

This waste, classified in relation to the characteristics and

[1] Source: ISPRA, Ministry for Economic Development

concentrations of the radionuclides present, according to the classification criteria defined in the Technical Guide no. 26 by ENEA-DISP (currently called ISPRA), total approx. 21,600 m^3 for categories I and II and 1,700 m^3 for category III.

waste totals approx. 21,600 m^3 for categories I and II and 1,700 m3 for category III, plus a further 30,000 m3, belonging to category II, produced as a result of the decommissioning operations.

To this waste should be added approx. 30,000 m^3, predominantly belonging to category II, produced as a result of the decommissioning operations.

Then there is radioactive waste from the reprocessing of the spent nuclear fuel, before the nuclear program was discontinued, and most of which has already been transferred abroad (in the UK and France); this waste will be returned to Italy, and its volume totals several tons of m^3 of high-activity conditioned waste.

The waste stored at the above mentioned sites (nuclear plants, experimental facilities, research centers) has mostly not yet undergone the treatment and conditioning operations necessary for its transformation into durable materials that can ensure a suitable degree of isolation of the radioactivity from the environment, suited to transportation, storage and final disposal. These operations, which are preliminary to the dismantling of the plant, need to be speeded up, especially with regard to liquid waste, which is mainly present at the EUREX plant of Saluggia (VC) and the ITREC plant of Trisaia (MT), and to the waste placed in the 1960s and 70s in underground structures, for example, at the Garigliano and ITREC plants.

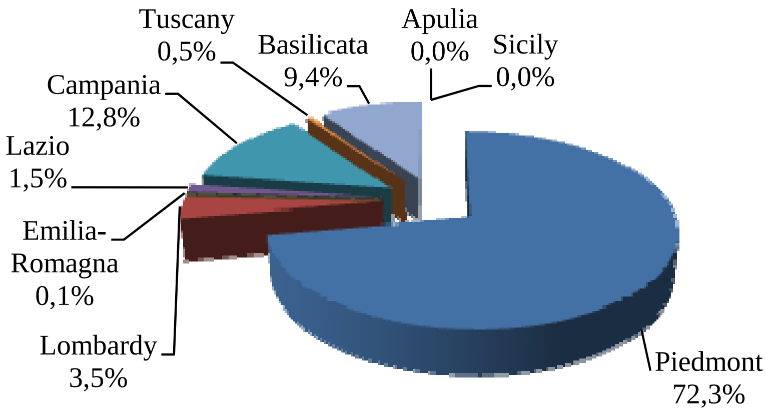
The stored waste needs to be treated and conditioned, to be transformed into materials ensuring isolation of the radioactivity and suited to being transported, stored and disposed of.

Besides the so-called “energetic” waste produced during the nuclear program, radioactive waste is still produced by medical, industrial and research applications, and continues to build up at the various operators’ premises, stored without adequate conditioning in unsuitable facilities for long-term management, with regard to their location. This waste, which today totals about 5,000 m^3, increases by about several hundred cubic metres per year. It may be stored at the authorized facilities of several national operators, some of which may exclusively receive, classify and store the waste containers without handling their contents; others are authorized to handle the contents, albeit very lightly.

The waste produced by medical, industrial and research applications (approx. 5,000 m^3) are stored at the authorized facilities of national operators.

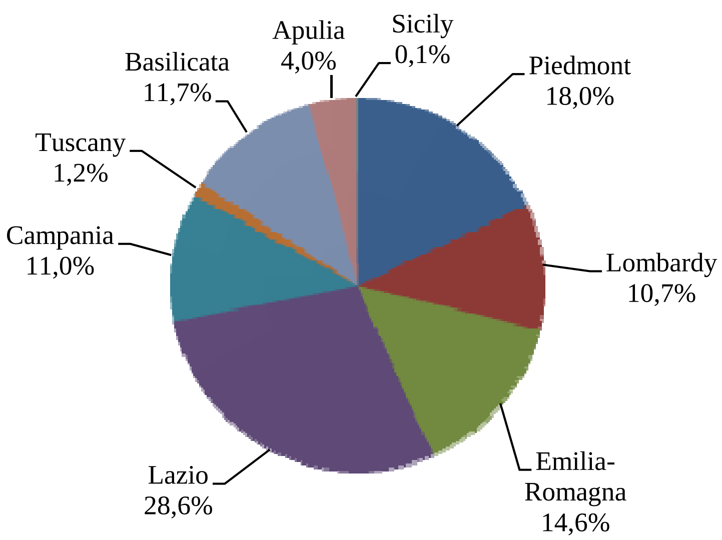
At national level, the Integrated Service for the management of disused radioactive sources and of radioactive waste, operated by the ENEA, provides all round management services (collection, treatment, conditioning and temporary storage) for the disused radioactive sources and radioactive waste from medical, industrial and research activities. In particular, all authorized facilities that perform disused radioactive source collection and temporary storage activities may join the Integrated Service.

The Integrated Service for the management of disused radioactive sources, and of radioactive waste from medical, industrial and research activities of ENEA, guarantees all the management cycle phases.



In Italy, the highest percentage of radioactive waste, in terms of activity, is found in Piedmont (72.3 %), followed by Campania with 12.8 % and Basilicata with 9.4%.

Figure 7.2: Regional breakdown of radioactive waste, in terms of activity (2010)[2]



In terms of volume, the largest concentration of radioactive waste can be found in Lazio with 28.6%, followed by Piedmont (18%) and Emilia-Romagna (14.6%).

Figure 7.3: Regional breakdown of radioactive waste, in terms of volume (2010)[3]

Furthermore, the problem of so-called "orphan" sources should be mentioned, which are frequently found inside scrap metal coming from abroad. A recent case is a source of cobalt 60, found in July 2010 in the Port of Genoa, inside a container from Saudi Arabia, for the safety treatment and disposal of which it was impossible to apply the procedure provided for in Legislative Decree 52/2007, which provides for the sending back (in safe conditions) of the waste, at the shipper's expense, causing a delay in the performance of the operations; the measure was nevertheless imposed by the Prefecture of Genoa and completed in July 2011.

Regarding the emission of liquid and gas effluents from nuclear plants, the situation can be considered stable, on average. In fact, with regard to the plant at Saluggia, the LENA reactor at Pavia and the Latina plant, there was a slight drop in the amount of liquid and

The emission of liquid/gas effluents from the nuclear plants is stable and consistent with the

[2] Source: Nuclear plant operator data processed by the ISPRA

[3] Source: Nuclear plant operator data processed by the ISPRA

gas effluents; on the contrary, at the plants of Trino, Caorso, Garigliano and CCR Ispra there was a limited increase in emissions, with regard to both quality and quantity. However, this limited increase should be viewed within the framework of the overall commitment to the discharging formula – established, as mentioned earlier, in accordance with the principle of so-called "non-significant radiation" – of several percentage units. In particular, the recorded increases are substantially due to the progress of the preliminary activities relating to the scheduled decommissioning process. At the remaining plants, the values are practically unchanged.

principle of "non-significant radiation".

The transport of radioactive materials can be divided into two separate – albeit related – spheres, taking into account either the radioactive characteristics alone or the radioactive and fissile characteristics of these materials:

Transport of radioactive materials.

- transport of nuclear fuel;
- transport of radioactive materials used for medical, industrial and research purposes, such as special form sources for radiating products and for gamma radiographies on the field, sources used for geological prospecting, sources for controlling industrial processes, non-special form sources for diagnostic/therapeutic use, waste from the related facilities.

In view of the Italian situation, in which nuclear activities concern the decommissioning of the nuclear plants and radioactive waste management, fuel-cycle-related transport events are very few, mostly concerning the transport abroad of spent nuclear fuel for reprocessing or the disposal of the fissile material, which operations, moreover, will be completed over the next few years. There is also a small number of transport events of low/medium activity radioactive waste to treatment sites. A different situation may be determined once the national radioactive waste deposit is available.

The transport of nuclear fuel is very limited.

Most transports of radioactive materials in the country concern the sources used for industrial and research purposes and, above all, medical applications (Figure 7.4).

The transport of radioactive materials mostly concerns sources for medical, industrial and research purposes.

Most transports of radioactive materials in the country concern the sources used for medical and research purposes (82.2%) and industrial (6%), while a very small percentage is related to the nuclear fuel cycle.

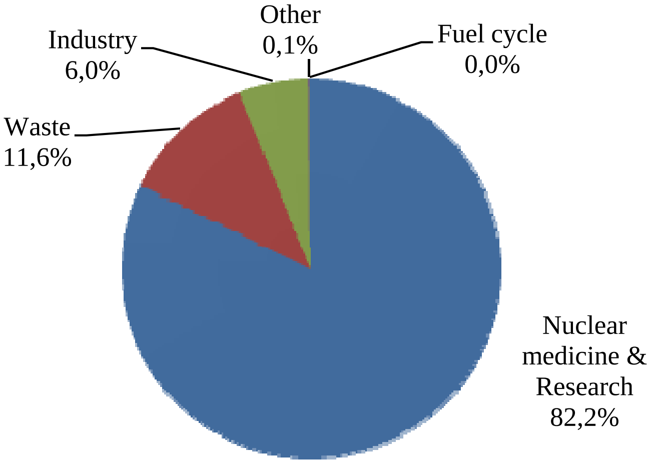


Figure 7.4: Percentage breakdown of the containers transported in Italy by sector of use of the radioactive materials[4]

As mentioned above, the available data show that most radioactive materials transports are for medical purposes. Most of the isotopes used for diagnostic and treatment purposes come from abroad, since there are no facilities in Italy for producing such isotopes (I-131, Mo-99, Tl-201, etc.), except for F-18, which is also produced in Italy. These radioactive materials are imported primarily through road and air shipments, their destination being several handling and distribution centers, from where they are delivered, by road or air, to the final destinations.

Road transport is the main mode of transport of containers with radioactive materials.

Road transport is the most widely used transport mode for the radioactive material containers, followed by air. The latter is used, in particular, for transporting radioisotopes with a very short half-life. The transport of radioactive containers by sea is very limited and concerns both the sources used on offshore oil platforms and transports between the Italian mainland and the two major islands, Sicily and Sardinia. The rail transport of radioactive materials is practically non-existent. In 2006-2010, rail transport only concerned the shipment of spent fuel elements from the Sogin plants to the reprocessing facilities of Sellafield (UK) and La Hague (France).

The possible exposure to ionizing radiation associated with the transport of radioactive materials can also occur in ordinary transport conditions, i.e. without accidents. After the introduction, in 2009, of a computerized data collection system, the trend, closely related to the number of containers transported each year, their type and the type of isotope carried, is fairly stable, although in recent years the overall number of transported containers has dropped, especially in the field of nuclear medicine.

The ranges assumed by the indicator on radioactive transports (Figure 7.5) univocally highlight the provinces hosting important and numerous hospitals and diagnostic centers (Rome, Milan, Turin, Naples, etc.), besides the air transport handling centers.

[4] Source: ISPRA

The transport index is an indicator of the level of radiation present in the proximity of containers with radioactive materials. It is used in connection with the preparation of radiation protection measures, by the carrier, to minimize radiation doses during transport.

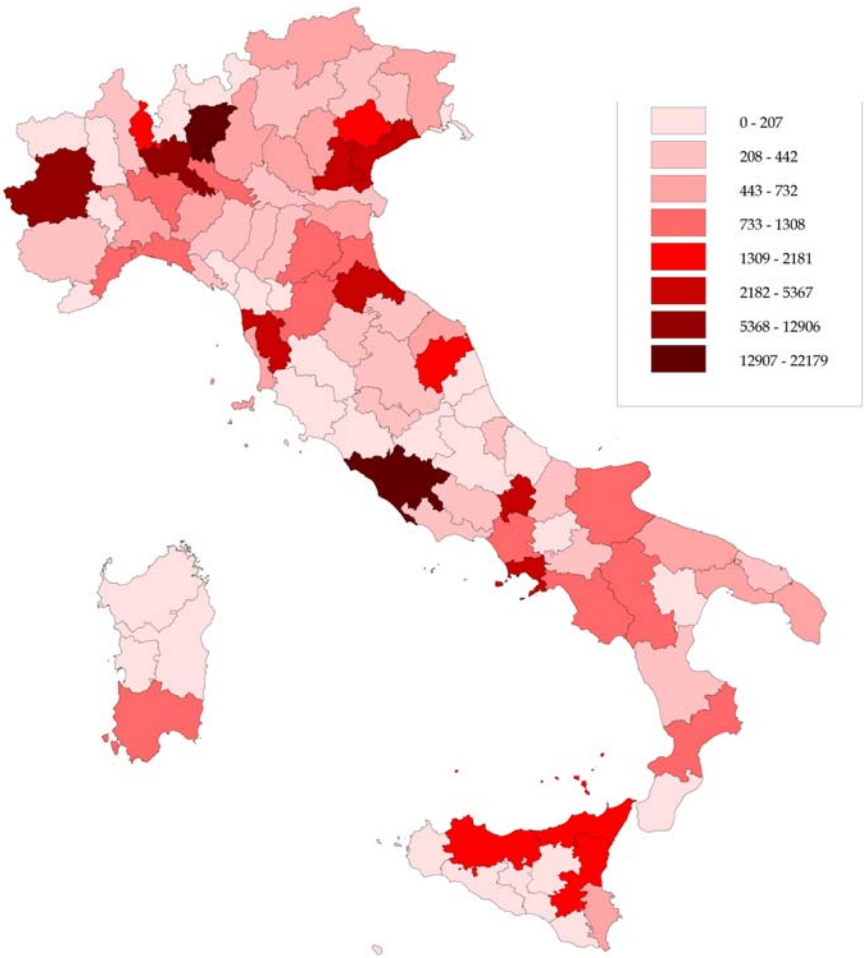


Figure 7.5: Thematic map showing the sum of the transport indices by province (2010)[5]

Control and monitoring actions

Reference legislation for nuclear control activities.

The control of nuclear activities that may involve exposure to ionizing radiation of the Italian population is regulated, in particular, by Law 1860/1962, Legislative Decree 230/1995, as amended, and Legislative Decree 52/2007.

Controls are implemented by means of assessments and checks preliminary to the issuing of the authorizations and inspections carried out in the operating phase.

These controls are implemented, in advance, through the formulation of binding technical opinions by the nuclear safety and other authorities, where required by applicable law, to the permit-issuing authorities (Ministry for Economic Development, Prefectures, etc.). With regard to nuclear plants, in relation to their present status, the opinions concern authorizations for any changes or special operations, also related to the decommissioning process, while awaiting the relevant decommissioning authorization. In this case, they are issued by the ISPRA. The authorizations refer, in particular, to the feasibility of alterations or operations, abiding by the general nuclear safety and radiation protection criteria, and normally affect the launching of the approval implementation phase, by the ISPRA, of a detailed project or operating plan.

[5] Source: ISPRA

The opinions and approvals are formulated by the ISPRA on the basis of the results of the independent reviews and assessments of the documents presented by the operator, and may also include specific requirements. In the case of procedures for decommissioning authorizations, the applicable regulations provide that the competent authorities formulate observations on the documents presented by the operators, in support of the authorization applications transmitted to the ISPRA, which, based on its preliminary investigations and the observations received, formulates its opinion and any specific requirements.

The opinions and approvals are formulated by the ISPRA on the basis of the results of the independent reviews and assessments of the documents presented by the operator.

In the operating phase, the controls, aimed at assessing conformity to the applicable regulations and compliance with the requirements set out in the relevant authorizations, are carried out through inspections by the ISPRA inspectors, who also act as judicial police authorities.

ENVIRONMENTAL RADIOACTIVITY

The issue

Members of the public often associate the word "radioactivity" with the fear of its harmful effects on health. The first effects the word evokes are direct effects, similar to burns, caused by acute exposure; an example of this are the nuclear explosions of Hiroshima and Nagasaki. Technically speaking, these effects are called "deterministic" and are the result of very intense exposure. Other fears are related to less intense exposures, effects that are not immediately visible, but which set on months, years or even generations later and are often associated with the onset of cancer. An example of this are the consequences of the exposure of the population following the incident at the Soviet nuclear power plant of Chernobyl. These effects are called "stochastic", i.e. probabilistic, the probability of which depends on the intensity and duration of the exposure. Lastly, one should not underestimate the impact, on public opinion, of events – such as the incident involving the nuclear power plant of Fukushima – which, although without consequences to health, requires adequate environmental monitoring and proper and transparent information.

Ionizing radiations are almost always associated only with the production of nuclear energy, yet there are case of exposure to ionizing radiations for medical, diagnostic or therapeutic reasons. In these cases, the risks entailed are significantly justified by the benefits for the people undergoing the treatment.

Moreover, in the collective imagination, radioactivity is mainly associated with the production of nuclear power, including the processing and storage of nuclear waste, and these fears often creating a bias against other activities or situations that are sources of ionizing radiation.

On the contrary, exposure to radiation for medical (diagnostic or treatment) purposes, is generally accepted and justified by the benefits inuring to the people undergoing the treatments. "Justification" is one of the key principles of radiation protection of the public and workers. Activities that involve exposure of the public and workers should, in fact, be justified on the basis of their costs/benefits, also taking into account any possible alternatives; moreover, exposure should also be "optimized", i.e. limited to the lowest possible levels, within reason.

A further consideration concerns the extent of the general exposure of the public to natural radiation, compared with the above mentioned exposures. It should be highlighted that, except for nuclear explosions and nuclear accidents, exposures due to manufacturing activities, for example, are much lower than exposure to natural sources of radiation. Both in the universe and on the Earth, in the air and even in our own bodies there are radionuclides which are responsible for most of our exposure to radioactivity.

Based on these considerations, the need emerges to further investigate and spread knowledge of the impact of exposure to ionizing radiations, with a view to making it easier to assess, and enhancing the awareness of, the risks and benefits associated with all sources of radiation.

Exposure primarily occurs at home, at the workplace and in other “indoor” environments, where people spend most of their time, due to the presence, in the air, of a natural gas called radon, which is, generally speaking, the main source of radiation hazard for the population. In some cases this gas can reach unacceptable concentrations, whereby, based on the above mentioned cost/benefit considerations, it is advised – or even mandatorily required – to remediate the premises. Exposure to radon in homes or at workplaces has been associated with the onset of lung cancer. The risk of contracting cancer from exposure to radon for smokers is about 20/25 times higher than for non-smokers. Since we are not yet aware of a threshold below which exposure to radon is harmless, it is generally assumed that by reducing the concentration of radon it is possible to reduce the risk by an equivalent amount. This type of exposure may be controlled, to a certain extent, by implementing strategies and measures aimed at reducing the exposure of the population as a whole, particularly in cases of higher concentration.

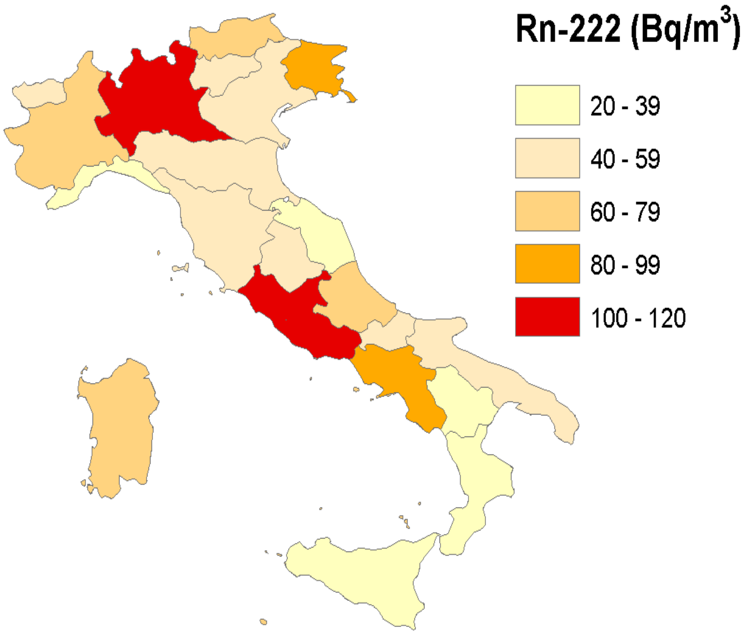
The selection of the most suitable prevention strategies, and of the corresponding risk-abatement measures, depends on a number of factors, such as geographical distribution, the overall impact of any corrective actions, which, in turn, are weighted on socio-economic factors.

Communicating the risks related to radon exposure plays a fundamental role and represents a “challenge” for the stakeholders involved, because the very existence of this gas and of the risks it poses to human health are often unknown by the public.

Hence, the need to further investigate and circulate knowledge about the impact of exposure to ionizing radiations, with the aim to enhance comprehension and awareness of the assessment of the risks and the benefits associated with all the sources of radiation.

Radon exposure

Regarding exposure to radon, a representation of the country comes from the results of a survey carried out in the 1980s and 90s, but which is still valid for the characteristics of the phenomenon, based on full national coverage (Figure 7.6).



In Lazio and Lombardy one can notice high concentrations of radon (Rn-222). The difference with the other regions is due to the different uranium content of rocks and soil, and their different degree of permeability.

Figure 7.6: Activity concentrations of Rn-222 in homes, by region and autonomous province (the ranges are given by way of example only) (1989-1997)[6]

In terms of response, protection from exposure to radon in the workplace was introduced in the legislation with Legislative Decree 241/2000, amending and supplementing Decree 230/1995. The decree introduces certain obligations for both employers and the regional authorities. In particular, the latter are made responsible for identifying the areas where high activity concentrations of radon are most likely to be found. Pending the establishment of the criteria for defining the areas, and the issuing of guidelines on the methods to be applied for their identification, some regions and several ARPA / APPA have started carrying out studies and investigations, with a view to classifying the areas with differing likelihoods of high concentrations of radon. Figure 7.7 shows the regions for which data and assessments concerning radon are available since 2002. Currently, several of the regions that have already conducted surveys on radon, shown in green in the map, are working towards increasing the number of measurements, aimed at completing the regional mapping process.
The information on the remediation of premises featuring high concentrations of radon – regarding both homes and workplaces – are still scarce and sporadic.
The European Commission is addressing radon exposure in a new directive, currently being discussed by the Member States, in view of its final approval, setting out the responses for tackling and reducing this form of exposure.

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[6] Source: Bochicchio, F. et al., *Results of the national survey on radon indoors in the all the 21 italian region, Proceedings of Radon in the Living Environmental* Workshop, Athens, April 1999

Awaiting the definition of the criteria for defining radon risk areas, and indications on the methods for their identification, several regions and ARPA/APPA have started working on studies for classifying the areas with different probabilities of high concentrations of radon.

Figure 7.7: Regions (in green) in which, since 2002, targeted studies/projects have been launched to identify areas subject to radon hazards (November 2011)[7]

Monitoring environmental radioactivity

In Italy, radioactivity monitoring is organized according to a 3-tier system, at local, regional and national level.

The monitoring of environmental radioactivity is organized, pursuant to Legislative Decree 230/95, as amended, and Community legislation, by a 3-tier system of networks, at local, regional and national level.

Local networks monitor the surroundings of nuclear facilities; the regional networks are responsible for monitoring environmental radioactivity in the region; and the nationwide networks collect the necessary data for building a nationwide picture of natural radioactivity, also in connection with the occurrence of anomalous events.

Following are the trends, over the years, of the concentration of cesium-137 in airborne particulate matter, in wet and dry depositions and in cow's milk, representing historic indicators of the presence of radionuclides in the environment (Figures 7.8 – 7.10).

[7] Source: ISPRA, ARPA/APPA

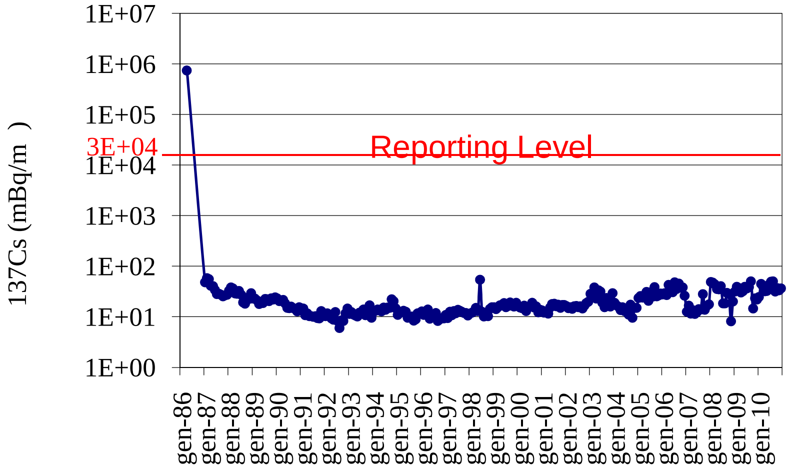
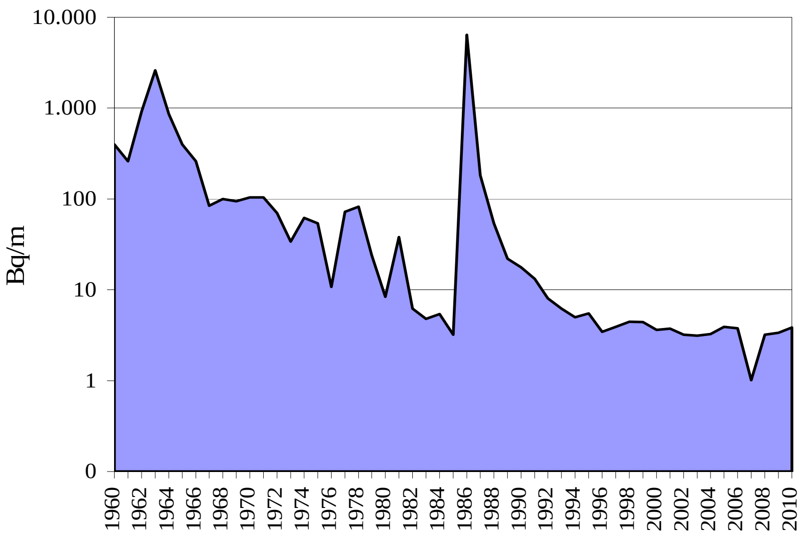


Figure 7.8: Trend of the concentration of Cs-137 in airborne particulate matter in Italy[8]

One can clearly observe the peaks of contamination caused by the arrival, in Italy, of the so-called "Chernobyl cloud" (April 1986), as well as the peak caused by an incident in a Spanish foundry near Algeciras (June 1998), especially in Northern Italy; the values reported in recent years are stable and well below the reporting level established by the EC (30 µBq/m³).



The figure highlights the fallouts associated with the tests in the atmosphere, carried out in the 1950s and 60s, and the peak related to the Chernobyl incident in 1986, from which the contamination values started to decrease. No reporting level has been established for this matrix.

Figure 7.9: Trend of wet and dry depositions of Cs-137 in Italy[9]

[8] Source: ISPRA-processed data supplied by the ISPRA/ARPA/APPA and collected by the environmental radiation laboratory service of ISPRA; OECD-ENEA, 1987, *The Radiological impact the Chernobyl accident in OECD countries*, Parigi; ISPRA

[9] Source: ISPRA-processed data supplied by the ISPRA/ARPA/APPA and collected by the environmental radiation laboratory service of ISPRA; OECD-ENEA, 1987, *The Radiological impact the Chernobyl accident in OECD countries*, Parigi; ISPRA

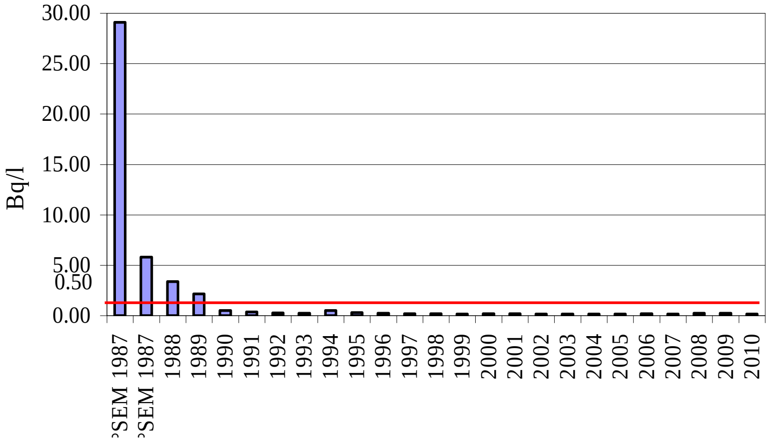


Figure 7.10: Trend of the deposition of the concentration of Cs-137 in cow's milk in Italy[10]

The figure shows the reduction in the levels of contamination in cow's milk, in the years after the Chernobyl incident, and the substantially constant values in the following years, with values below the reporting level established by the EC (0,5 Bq/l).

The Fukushima incident in March 2011 did not result in any significant increase in the amount of radionuclides present in the matrices involved, given the extremely low values found in the period immediately following the incident.

However, in order to meet the public demand for more information, approx. 1,500 measurements were made, on top of the normal monitoring program, in the March – May 2011 period.

In terms of response indicators, the Italian situation is monitored through the implementation of the network monitoring program.

Table 7.1 below shows the scores relating to the national monitoring evaluation, from 1997, based on a method developed in connection with the ECOEHIS - *Development of Environment and Health indicators for EU countries* project.

The annual score is based on the following matrices: airborne particulate matter, gamma-ray dose in the air, cow's milk, surface water and drinking water, for each of which the following aspects have been assessed: measuring frequency, measuring sensitivity, geographical distribution of controls, monitoring regularity, organization of and participation in nationwide intercomparison initiatives.

[10] Source: ISPRA-processed data supplied by the ISPRA/ARPA/APPA and collected by the environmental radiation laboratory service of ISPRA, OECD-ENEA, 1987, *The Radiological impact the Chernobyl accident in OECD countries*, Parigi, ISPRA

Table 7.1: Evaluation of the monitoring status for the nationwide networks[11]

Year	Score	Grade
1997	15	sufficient
1998	17	sufficient
1999	13	insufficient
2000	17	sufficient
2001	17	sufficient
2002	17	sufficient
2003	17	sufficient
2004	17	sufficient
2005	17	sufficient
2006	17	sufficient
2007	17	sufficient
2008	17	sufficient
2009	16	sufficient
2010	17	sufficient

Legend:
Grade: insufficient 0-14 sufficient 15-20 good 21-25

The analysis of the implementation of the monitoring plan has highlighted an incomplete geographical coverage of the country, which, therefore, requires corrective action.

Despite the implementation status of the radiometric measuring programs is by and large consistent with the population protection objectives, there is a certain inconsistency with respect to the nationwide coverage of the monitoring activities, which needs to be remedied by means of appropriate corrective actions.

GLOSSARIO

Decommissioning:
Downgrading, decontamination and dismantling of a nuclear facility, which has the goal of achieving the demolition of the plant and the removal of any constraint due to the presence of radioactive material in the site.

Deterministic effects:
Anatomic lesions with loss of functionality of organs and tissues, induced by very high exposures, such as those received as a result of the Chernobyl accident by the plant workers. The clinical severity increases with dose, is used a specific size called "absorbed dose" whose unit is the Gray (Gy).

Stochastic effects:
Effects affecting randomly exposed individuals or their descendants, they are supposed to be caused by low doses of radiation, such as those typically received in daily life. In order to quantify the risk of this kind of effects it is used a specific size, called "effective dose", whose unit is the Sievert (Sv).

Fallout:
Radioactive particles that are carried into the atmosphere after a nuclear explosion and gradually fall back as dust or in precipitation

[11] Source: Data processed by ISPRA/ARPA Emilia-Romagna

Intensity of the gamma dose:
It is the energy transferred by gamma radiation per unit mass of tissue within a time interval, and it is measured in Sievert/hour (Sv/h). The absorbed gamma dose in the air is due to two main contributions: the radiation of cosmic and terrestrial origin. In particular the terrestrial component varies depending on the characteristics of the surrounding soil and if it is measured outside (outdoor) or inside (indoor) of the buildings.

Ionising radiation:
Particles and /or energy of natural or artificial origin able to modify the structure of the material with which it interacts.

Radiocontamination:
Presence in the environment of a substance or radioisotopes unwanted and harmful.

Radionuclide:
Unstable nuclide that decays by emitting energy in the form of ionizing radiation.

Radon:
Natural radioactive gas produced by the radio, which is everywhere in the soil and in some materials used in building. In the absence of significant nuclear accidents it is the main source of exposure to ionizing radiation for the population. In open air it disperses quickly, not reaching almost never high concentrations, whereas in closed places (homes, schools, workplaces, etc.) tends to accumulate reaching, in special cases, concentrations which are considered unacceptable for health.

SPECIAL FOCUS BOX

THE FUKUSHIMA DAIICHI NUCLEAR INCIDENT

The incident and its radiation consequences

The disastrous consequences of the two natural phenomena combined – the unexpectedly violent earthquake and subsequent tsunami, following each other in a very short space of time – on the security systems of the Fukushima nuclear plant and its six reactors, prompted the Japanese engineers to adopt emergency technical solutions to deal with the event, some of which were somewhat improvised and rather uncommon, engaging in an exhausting struggle to ensure the plant's safety.

When a nuclear reactor is left without power for too long, there can be serious consequences for the primary safety function of ensuring that the residual heat is removed from the reactor and the water cooling tanks where the spent nuclear fuel is stored. The inability to maintain a suitable amount of water and adequate cooling capacity, by means of a dedicated system, eventually led to the overheating of the fuel elements forming the core of the reactor, the partial meltdown of the core (in the case of units 1, 2 and 3), the release of more volatile radionuclides (first and foremost, noble gases, iodine and caesium), initially inside the reactor pressure vessel, then into the outer primary container and, lastly, into the outside environment, due to the natural leaks caused by the overpressure and to the deliberate release into the environment from the container, which, meanwhile, had become necessary to safeguard its integrity. The whole process was aggravated by the production of hydrogen, as a result of the overheating of the fuel and the ensuing explosions that occurred in the reactor building, which, in the case of units 1 and 3, determined the destruction of the upper structures. In unit 2, following a hydrogen-induced explosion, a breach opened in the lower part of the container. Further complications ensued as a result of the overheating of the spent fuel inside the water cooling tanks, in particular in unit 4, with the associated release of radioactivity into the environment.

Faced with this serious sequence of events, the plant engineers put into place emergency measures aimed at minimising the damage to the fuel and limiting the significant deterioration of the unit 1, 2 and 3 containers, attempting to keep up a constant supply of water through alternative means (portable power generators, fire pumps, etc.). In the first phase, they even made use of seawater, since all the water reserves on the site had been damaged. Likewise, they attempted to maintain the water head of the fuel tanks by spraying water from above.

The use of such large quantities of water to ensure adequate cooling determined a complex problem of water management, especially with regard to its considerable contamination, as a result of coming into contact with the damaged fuel in the reactors and the spent fuel stored in the water cooling tanks. Therefore, it was necessary to find suitable storage tanks on the site, also by emptying the existing ones, which contained weakly contaminated water from the plant operations. A programmed release into the sea was therefore authorised for this purpose.

In the case of unit 2, the presence of enormous quantities of contaminated water, combined with probable damage to the container, determined the prolonged release into the sea of a highly radioactive liquid, which convinced the Japanese engineers to adopt specific measures, aimed firstly at identifying and intercepting the flow route into the sea and then containing its dispersion, by erecting containment structures and barriers in the stretch of sea nearest to the plant.

This incident, as a result of the malfunctioning sparked by the succession of an earthquake and a tsunami, besides involving several reactors with an equal level of seriousness, was also characterised by the slow development of events and the generation of large amounts of contaminated water. We might venture a parallel between Fukushima and Chernobyl, but while, in the latter case, events evolved rapidly, featuring an initial explosion followed by an uncontrolled (and uncontrollable) power excursion, which caused the fragmentation of the fuel and the instant vaporization of the cooling water, with the reactor graphite catching fire and thus transporting the radioactivity high up into the atmosphere, in the case of Fukushima events evolved gradually over time and there was a huge production of contaminated water. This led to the release of lower amounts of radioactivity into the air – although, overall, the incident was rated level 7 on the INES scale, exactly like Chernobyl – limiting the area concerned by significant fallout to the surroundings of the plant alone. The fallout area, of course, includes the stretch of sea near the coastline, in which, due to the dilution and dispersion by the ocean currents, there will be a gradual and continuous drop in the concentration of radioactivity, once the leaking ends and the plant no longer releases contamination into the sea.

Based on a first analysis of the nuclear incident at the Fukushima Daiichi plant, and in relation to the various events that occurred simultaneously and then later on in time, we can see how the management and evolution of the radiation consequences, at both the nuclear site and in its surroundings, take on specific and peculiar characteristics.

In particular, regarding the site itself, and the radioprotection of the workers involved in the emergency operations, the plant operator was faced with the complex problems related to the simultaneous deterioration of several units – comprising a reactor and its spent fuel decay pool – and not just a single source, which heavily affected and weighed on the management of the incident and the programmed plant recovery operations, as a whole, along with the operations for mitigating the contamination of the surrounding environment. The whole situation being aggravated by the high intensity of the radiation doses, not just inside the single units, but outside and in between the buildings as well, and inside the site even at a distance from the units, as well as the presence of highly contaminated waters in various parts of the plant, for example, in the turbine building. In the first few days after the incident, peaks were measured in the gamma-ray doses, with an intensity considerably higher than the natural background gamma-radiation dose, inside the site, for example, between 14 and 18 March 2011; on the edges of the plant peak values were measured – associated with the significant events that had occurred in units 2 and 4 – of approx. 12 mSv/h, while at units 3 and 4 peak values of 400 mSv/h were recorded.

Having regard to the radiation impact of the incident on the population and the environment, besides the release into the atmosphere of radionuclides commonly found after incidents of this kind (such as, for example, noble gases, halogen elements, such as iodine and tellurium, caesium and stronzium), the key feature of the incident at the Fukushima Daiichi plant was the contamination of the stretch of sea in front of the plant, caused by the release of radioactive liquids from the damaged systems, the atmospheric fallout on the surface of the sea and the leaching into the sea of the contaminated soil. In particular, highly radioactive water was leaked from unit 2, which, however, was subsequently stopped by the adoption of specific measures. The programmed release of less contaminated water (produced by normal plant operations and the disposal of which would have occurred according to the timeframe and within the limits laid down by the Japanese authorities in the plant's operating licence) was also carried out, offshore, to make space for the storage of more highly contamined water accumulated during the accident management operations.

Already in the week following 11 March, based on the environmental monitoring data supplied, from 16 March, by the Japanese Ministry of Education, Culture, Sport and Science (MEXT), measurements were made of the dose intensity values in the various Japanese prefectures, and it was found that, in some of them, the values were significantly higher than the natural background dose; moreover, the Japanese Ministry of Health confirmed the presence of radioactive iodine in the food products measured in the proximity of the plant. On the basis of the radiometric surveys carried out, the Japanese authorities decided to adopt the following measures: evacuation of the population within a radius of between 20 and 30 km; supply of stable iodine to the distribution centers, for administration; intake of stable iodine by the people still inside the evacuation area.

Following the measurement of the dose intensity in the air, deposition on the ground and contamination of food products (values above the threshold limit values established by Japanese law in emergency situations, for the adoption of countermeasures, were found not only of iodine 131, but of caesium 137 as well), the first restrictions were introduced in several Prefectures relating to the distribution and consumption of certain foodstuffs (such as milk and leafy vegetables) and drinking water. The contamination of drinking water within a short space of time, in fact, is another specific trait of the Fukushima incident, probably due to the water supply methods used in Japan.

Control of foodstuffs and drinking water has been carried out continuously and is ongoing; moreover, at the beginning of April 2011, the Japanese Ministry of Health published the criteria for the weekly updating of the list of foodstuffs the distribution and consumption of which is prohibited. These measures, enforced across entire prefectures or within single cities, concern the distribution and consumption, in particular, of fresh milk, drinking water, leafy vegetables (e.g. spinach, lettuce), cauliflower, broccoli, mushrooms and certain root vegetables.

Environmental radioactivity measurements in Italy

From the day after the incident, the ISPRA requested the Regional and Autonomous Provincial Environmental Agencies to initially intensify the measurement of airborne particulate matter, within the framework of the nationwide environmental radioactivity supervision network (RESORAD), for the purpose of monitoring the presence of any radioactivity produced by the incident, with a special focus on the iodine-131, caesium-137 and caesium-134 isotopes. After the first positive results, it requested the Agencies to control the presence of radionuclides in the particulate matter deposited on the ground, in vegetables and in milk, to monitor the possible transfer of the radionuclides from the environment into the food matrices.

The data, after having been validated, was immediately loaded into the ISPRA's DBRad database, to allow a speedy assessment of the situation. The same data was also posted daily on the ISPRA website, as well as the websites of the regional and provincial Environmental Agencies.

The airborne particle measurements highlighted, during the period immediately after 25 March, the presence of traces of iodine-131 ranging between 0.0021 and 3.10 $mBqm^{-3}$ and of caesium-137 ranging between 0.001 $mBqm^{-3}$ and 1.20 $mBqm^{-3}$. Certain measurements featured traces of caesium-134, ranging between 0.00061 $mBqm^{-3}$ and 0,25 $mBqm^{-3}$. In the samples containing both caesium-137 and caesium-134, the average isotope ratios of the two radionuclides amounted to approx. 0.86, in line with the other European countries. The presence of caesium-134, and its ratio with caesium-137, confirmed the link with the Japanese incident. The measurements carried out to detect the presence of iodine gas too confirmed the presence of traces of this isotope, ranging between 0.061 and 3,90 $mBqm^{-3}$. Moreover, traces of iodine-131 were also found in the particles deposited on the ground, ranging between 0.058 and 25,4 $mBqm^{-2}$ and of caesium-137 between 10.0 and 76 $mBqm^{-2}$. The results of the measurements performed in milk and leafy vegetables highlighted, from 30 March, minimal traces of iodine-131 and caesium-137, in which case, however, the latter cannot be directly linked to the incident in Japan, due to the low values and the presence of the same radionuclides in the environment prior to the incident, and probably due to the fallout of the nuclear tests carried out in the 1960s and to the Chernobyl

incident, and also due to the absence of caesium-134 (or its presence below the detection limit of the instruments).
Figures 1 and 2 show the trends in the activity concentrations of iodine-131 and caesium-137, in the aftermath of the incident.
From May onwards all the values either dropped below the detection limit of the instruments, or appeared in line with the measurements made prior to the incident and which are normally found in the examined matrices.
The values surveyed in Italy were in line with those of the other European countries, were of no radiation relevance and did not represent a health hazard.

The incident at the Fukushima plant in March 2011 did not determine a significant increase in the presence of radionuclides in the matrices involved, given the extremely low values measured in the immediate aftermath of the incident.

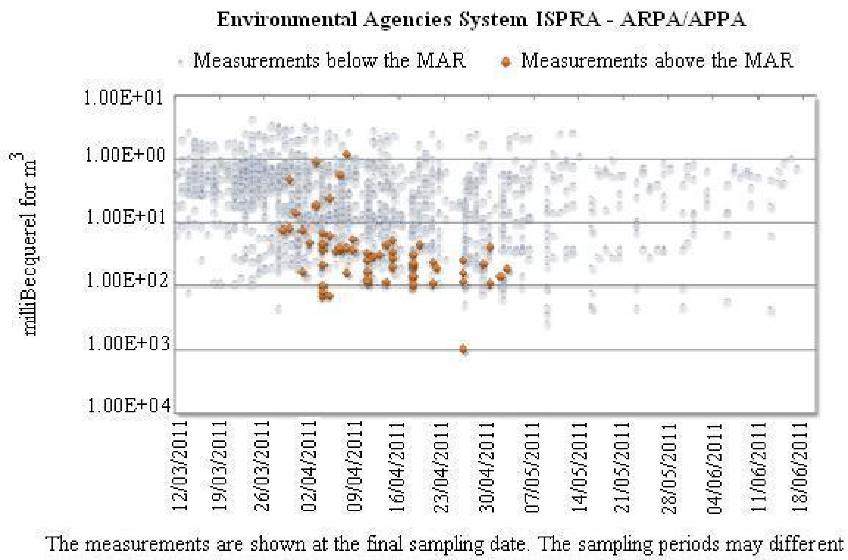


Figure 1: Trends in the concentration of caesium-137 in the airborne particulate matter[12]

In March - May 2011, about 1,200 measurements were made, on top of those normally scheduled in connection with the environmental radioactivity monitoring program.

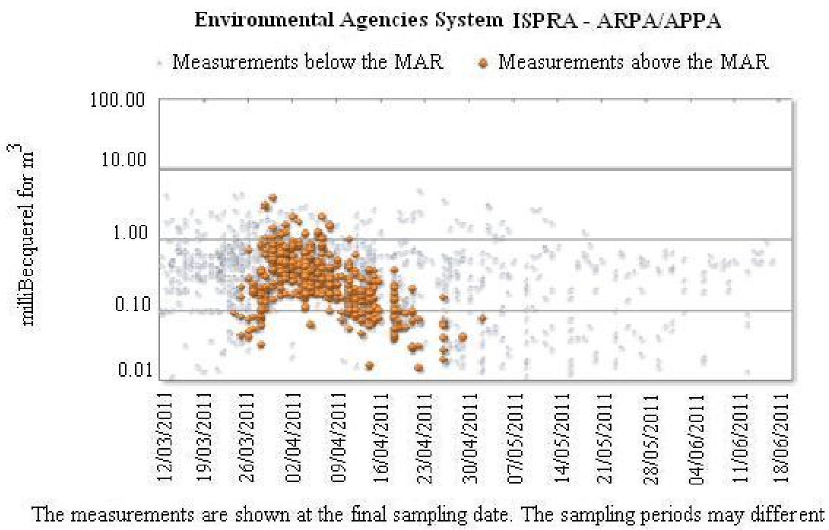


Figure 2: Trends in the concentration of iodine-131 in the airborne particulate matter[13]

[12] Source: ISPRA
[13] Source: ISPRA

Actions and reflections

In the years to come, the Fukushima incident will be analysed in all its details. The seriousness of its consequences and the peculiarities of the origin and development of the incident have stimulated the launching, internationally, of a great number of initiatives to reassess the safety of the existing nuclear power plants, aimed at investigating the measures that can be put into place to tackle scenarios like Fukushima and identify any improvements that can be made (in terms of brand new safety systems or the strengthening of the qualification of the existing ones, new accident management procedures, etc.).

The actions include those undertaken by the European Union for conducting “stress tests” on the nuclear plants operating in Europe, and the implementation by the AIEA, acting on the basis of the mandate received from the meeting of the Member States in June, in Vienna, of a dedicated plan for strengthening the nuclear safety systems worldwide.

One thing is for sure, however, that the incident at the Fukushima nuclear plant has dramatically confirmed the unacceptability of scenarios entailing serious consequences for both human beings and the environment, and the absolute necessity of the continuous remodulation of the safety objectives of the plants, accompanied by an increasingly stringent control of the safety levels achieved, along with the effective monitoring of environmental radioactivity. This is the challenge facing nuclear plant operators, which have the primary responsibility for the safety of their plants; governments, which are dutybound to put into place and maintain a suitable legislative and institutional framework, grounded on an effectively independent regulation and control system; and the safety authorities, responsible for laying down regulations and conducting inspections of the plants, throughout their lifecycle, within the framework of clear authorization procedures and through the implementation of stringent controls.

CHAPTER 8

ENVIRONMENT AND HEALTH

Introduction

In recent years, in relation to the prevention of health risks arising from environmental factors, greater attention has been paid to indoor pollution, that is to say the air quality of indoor living environments, such as homes and schools. These environments may be affected by conditions of pollution having a different nature and origin that may prove detrimental to the health of those who spend there most of their time. In fact, these persons are potentially exposed on a daily basis and for extended periods of time to biological, chemical or physical pollutants with which they come into contact mostly through the air they breathe. Various studies have highlighted that not only is the indoor concentration of some pollutants higher than their concentration on the outside, therefore confirming that there are also indoor sources of pollution, but also that even at low concentrations they may affect human health, especially for subjects particulary vulnerable such as children and allergic and asthmatic individuals.

In indoor living environments, such as homes, schools and workplaces, people are exposed on a daily basis to biological, chemical or physical pollutants with which they come in contact mostly through the air they breathe.

Our current prevention systems and the regulations that regulate indoor pollution address for the most part a few types of indoor environments, such as workplaces, and fewrisk factors, such as radon, asbestos, electromagnetic fields and noise. Still, the protection of the biological and chemical quality of indoor air lacks a reference system that may be likened to the one provided for outdoor air pollution and this also applies at a Community level and in many Countries outside the European Union.

This situation is leading to a growing awareness among researchers and policy makers in consequence both of the outcome of epidemiological studies, which stress the health-related significance of airborne chemical and biological contaminants, and of the increasing qualitative and quantitative spread of outdoor and indoor pollution sources. Outdoor sources , such as vehicle traffic,release chemical substances contaminating indoor air through ventilation, while air pollution from indoor sources is caused by furniture, furnishings, building materials, home detergents and other consumer goods. At the same time, even the changing local meteoclimatic conditions (warmer winters and more frequent summer heat waves, heavy rains or floods alternated with periods of drought) not only promote the spread of other biological risk factors, such as pollens, vector insects, and pests, but may also alter indoor humidity level, facilitating the proliferation of moulds or other pathogens that affect the human body (Table 8.1).

The air quality is affected more and more by both outdoor sources of pollution, which release chemical substances that spread indoor (vehicle traffic), and indoor sources of pollution peculiar to indoor environments (furniture, furnishings, building materials, home detergents, etc.).

Indoor air quality, therefore, depends on many factors that are subject to different policies and/or sectors, such as transports, productive activities and salubrity of consumer goods, and last but not least environmental monitoring and health prevention systems. There are also other potentially perturbing elements that need to be

The protection of the indoor air quality depends on a variety of factors that, in their turn, are subject to

taken into account, such as introduction of new building materials, the need of an effective thermal and acoustic insulation, and the increasing use of mechanical ventilation and air conditioning systems in newly built buildings. While these new techniques meet the modern energy saving requirements, on the other hand, in absence of adeguate design and building maintenance, can lead to insufficient ventilation of indoor environments and to increased airborne pollutants concentrations.
If quit a few sectors are involved,many are the responsible parties: central institutions, governments and local authorities, designers and manufacturing firms and, last but not least, the individuals with their choice of consumer goods and furnishings. There are also several types of indoor environments (offices, homes, schools, etc.) that differ in exposure patterns. Hence, indoor air quality is a complex issue from the point of view of both science and governance.
In line with the major European and national guidelines (as specified later on), this document focuses on the quality of indoor air in schools for prevention of acute respiratory and allergies diseases in children, with the aim to prevent the most frequent causes of both absences from school and poor school performance. Hence, this document does not take into account other classical risk factors, such as radon or noise – already dealt with in different reports – which, as everybody knows, imply different effects on health.
As usual, the ultimate goal is not only to inform but also incite remarks and comments on the environmental monitoring and control system and its potential role in protecting e indoor air quality .

different policies and/or sectors, such as means of transport, productive activities and salubrity of consumer goods, environmental monitoring and health prevention systems.

Table 8.1:Indoor quality and health risks[1]

Pollutants/Allergens		Sources	Health risks
Biological agents	Bacteria (Gram-negative endotoxins)	Infected carriers Animals Environments with temperature and dampness favoring their spread Materials damaged by dampness Conditioning/ventilation systems Air conditioning systems Dehumidifiers Contaminated sanitary fixtures	Diseases of the upper respiratory tract Pneumonia Bronchial affections
	Mite	Wall-to-wall carpeting Carpets Pillows, mattresses, eiderdowns Upholstered furniture Soft toys Dust	Rhino-conjunctivitis Eczema Bronchial asthma
	Moulds	Damp environments (walls, floors) Mattresses Sofas/upholsteries Wall paper Air conditioners Humidifiers Gaskets of refrigerator doors Unsuitably preserved food Indoor plants	**Acute effects:** Irritation of the mucous membranes Migraine Difficulty in concentrating **Chronic effects:** Hay fever Allergies Asthma Rhinitis Mixed-type hypersensitivity Extrinsic allergic alveolitis (EAA) Hypersensitivity pneumopathy

Health risks determined by the presence of pollutants in indoor environments.

[1] Source:ISPRA processing of data taken from: *Qualità dell'aria nelle scuole: un dovere di tutti, un diritto dei bambini*,Annex 1: *Principali inquinanti e allergeni indoor*, MATTM-REC,2010, http://isprambiente.gov.it/site/it-IT/Progetti/SEARCH/; US-EPA: *An introduction to Indoor Air quality* (IAQ), http://www.epa.gov/iaq/ia-intro.html; ISPRA - Inquinamento indoor: Agenti inquinanti, http://www.indoor.apat.it/site/it-IT/AGENTI_INQUINANTI

Pollutants/Allergens		Sources	Health risks
	Allergens of animal origin (dog, cat, horse scurf)	Dust Pillows/mattresses Blankets/ eiderdowns Clothes	Breathing difficulty Eye irritation/conjunctivitis Eczema Allergic rhinitis
	Pollens	Spread from the outdoor environment	Allergies in general (rhinitis, conjunctivitis, cough, dispnea, asthma)
Chemical substances	Carbon dioxide (CO_2)	Motor vehicles Human metabolic processes (breathing)	Trouble in concentrating Respiratory ailments **In high concentrations:** Loss of consciousness Death
	Carbon monoxide (CO)	Gas, kerosene, wood burning boilers/heating plants Ovens/cookers Gas, kerosene, coal/wood burning stoves Fireplaces Passive smoking Motor vehicles	Headache Nausea Dizziness **In high concentrations:** Hypoxia Death
	Nitrogen dioxide (NO_2)	Gas, kerosene, wood burning boilers/heating plants Ovens/cookers Gas, kerosene, coal/wood burning stoves Welding processes Environmental tobacco smoke Motor vehicles and machinery	Irritation of the mucous membranes Pulmonary edema Asthma Increased risk of respiratory infections
	Sulfur dioxide (SO_2)	Natural sources (volcanoes/fires) Solid/liquid fuels Industrial processes Incineration of wastes Stoves/ovens Gas/kerosene heating plants	Chronic bronchitis Tracheitis Asthma Tachypnea, tachycardia Irritation of the mucous membranes
		Tobacco smoke	
	Volatile organic compounds (VOC)	Cleaning products Paints, glues and adhesive products Pesticides Cosmetic and personal hygiene products Car products Furniture and textiles Building materials Printers and photocopiers Tobacco smoke Industrial emissions Motor vehicles	Irritation of the mucous membranes Headache Nausea Dizziness Asthma **In high concentrations:** Kidney/liver failure Damages to the central nervous system Carcinogenic action
	Formaldehyde	Upholsteries/wall-to-wall carpeting Particle board/plywood Insulating materials Coloring agents Plastic materials Textiles Detergents/cleaners Glues Additives Disinfectants Tobacco smoke	Irritation of the skin and mucous membranes Neurological effects Migraine Nausea/dizziness **In high concentrations:** Carcinogenic action
	Benzene	Tobacco smoke Stoves/heating plants Glues Paints Furniture wax Detergents Motor vehicles Industrial emissions	Dizziness Drowsiness Tachycardia Neurological disorders (confusion, memory disorders, blackouts) **In high concentrations:** Acute toxic effects **Chronic exposure** Carcinogenic action
	Polycyclic aromatic hydrocarbons (PAH)	Wood-fired ovens/fireplaces Cooked/smoked food Tobacco smoke Industrial processes Fossil fuels	Carcinogenic action
	Ozone (O_3)	Photocopiers/laser printers Ultraviolet lamps Air purifiers Outdoor air	Headache/nausea Cough Irritation/Inflammation of the airways Reduced respiratory functionality Asthma
	Particulate	Cooking	Respiratory ailments

Pollutants/Allergens		Sources		Health risks
	matter (PM_{10}-$PM_{2,5}$)	Home detergents/sprays Heating plants Tobacco smoke Bacteria Spores/pollens Dried secretions of house pets Vehicle traffic Sands/dusts Volcanic eruptions Combustion and industrial processes		Asthma Chronic bronchitis Heart trouble Changes in the immune system Increased sensitivity to allergens
	Environmental tobacco smoke (ETS)	Combustion of tobacco products		Chronic respiratory ailments Chronic obstructive pulmonary diseases/asthma Bronchopneumonia Otitis Ischemia Atherosclerosis Thrombosis Increased infarction risk Carcinogenic action **Exposure during pregnancy:** Reduced weight at birth Increase SIDS (Sudden Infant Death Syndrome) risk
	Asbestos	Resulting from materials used in the past in: Buildings (plates, panels, pipes, tanks, flues, linings, plaster, false ceilings, floors) Industry (raw material for manufactured products/objects, thermal insulating material, sound absorbent material) Products for home use (hair driers, ovens/stoves, irons, oven gloves, ironing sheets, fire wire mats and fire-resistant elements) Means of transport (insulation of trains/ships/buses, brakes/clutches, fireproof screens, gaskets)		Asbestosis Pulmonary carcinoma Mesothelioma Carcinogenic action in general
	Pesticides	Products for home use (wood preserving agents, plant products, cleaning products and disinfectants, kitchen products) Products for gardening and agriculture		Headache/dizziness Muscular contractions/tingling sensation Weakness Nausea Irritation of the mucous membranes Damages to the central nervous system Liver damages Renal damages A few pesticides are classified as potential or possible carcinogenic agents
	Lead	Drinking water (pipes) Food Paints		Brain damages Damages to the central nervous system Renal damages Blood damages **In children:** Delayed development Low intellectual faculty Reduced attention span Behavioral problems
Radon		Natural sources (lava, tuff, granite, etc.)		Carcinogenic action (in particular, pulmonary neoplasia)
	Electro-magnetic fields (EMF)	Static fields (0 Hz)	Magnetic levitation trains Industrial electrolytic devices Diagnostic imaging equipment (MR)	The subject is still controversial
				ELF: classified by IARC as **possible human carcinogens** based on epidemiologic studies relative to child leukemia
				Intermediate frequencies: to date, no final judgment has yet been made

Pollutants/Allergens		Sources		Health risks
		Extremely low frequencies (ELF) from >0 to 300 Hz	Electric energy production devices (50-60 Hz) Electrical appliances Trains	**Radiofrequencies:** to date, just the thermic effect has been confirmed
		Intermediate frequencies (IF) from >300 to 10 MHz	Antitheft devices Induction heaters Video display units	
		Radio-frequencies and micro waves from 10 MHz to 300 GHz	Cellular phones Telecommunication equipment Radar Medical appliances Diathermic units Micro wave ovens	
	Noise	Road traffic Railway traffic Air traffic Noisy (industrial and craft) working activities Discos/nightclubs Indoor sources (electrical appliances, service plants, heating systems, etc.)		**Auditory effects:** Progressive loss of one's hearing **Extra auditory effects:** Annoyance Psycho-physiological effects Effects on performance and learning Cardiovascular effects (adults)

INDOOR AIR QUALITY IN SCHOOLS AND CHILDREN'S HEALTH

The indoor air quality in schools and the respiratory health of children

The air quality in school buildings is important owing to both the long exposure linked to the time children spend there and the greater susceptibility of children and teens to the exposure to pollutants.

The air quality in school buildings, or rather the air quality determined by conditions of microclimatic comfort and concentrations of some pollutants, is important for long time exposure of children to spend in their classrooms (on average, 6-8 hours per day), and the higher susceptibility of children and adolescent to the exposure to those environmental factors. Therefore, it is considered an important factor for the prevention of respiratory and allergic diseases. The issue have also quantitative aspects: it has been estimated that 15% of the population, that is nearly 10,000,000 persons including schoolchildren and teachers, study or work on a daily basis in nearly 45,000 public buildings throughout the national territory[2].

Many studies have shown a positive association between acute respiratory diseases, asthma, allergies and numerous factors present in a school environment, including dampness and pollutants such as particulate matter, ozone, volatile organic compounds (VOC), CO_2, formaldehyde and allergens. Studies have also shown that poor air quality combined with non optimal microclimatic conditions adversely affect the pupil's school performance as well as their educational continuity.

The Agreement of 18 October 2010 focuses the attention on the relevance of the hygienic and air quality conditions in school environments for the health of children.

One of the latest national institutional documents, the Agreement of 18 October 2010[3] among Government, Regions, Autonomous Provinces of Trent and Bozen, Provinces, Municipalities and Mountain Communities concerning the "Guidelines for the prevention of indoor risk factors in schools for allergies and asthma"[4], focuses the attention on the relevance for children's health of hygiene and air quality conditions in school . Furthermore, it lays emphasis on the inadequacy of the normative framework governing a number of aspects connected with school buildings, indoor air quality and microclimate., Current regulations appear to be ineffective or not up-to-date with respect to the latest scientific evidence and fail to comply with the building energy saving and bio-climatic requirements and with the characteristics of salubrity and safety of materials and furnishings[5].

With a view to preventing allergic and respiratory diseases, it has been ascertained that the indoor air quality depends on various factors, including:

- architectural, constructive and plant-engineering characteristics of the building, which affect the microclimate (temperature,

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2 GARD Italia – *La qualità dell'aria indoor nelle scuole and rischi per malattie respiratorie e allergiche - Quadro conoscitivo sulla situazione italiana e strategie di prevenzione*, 2011.

3 O.G. of 13 November 2011, G.S. no. 9.

4 http://www.normativasanitaria.it/normsan-pdf/2001/36589_1.pdf

5 GARD Italia – *La qualità dell'aria indoor nelle scuole and rischi per malattie respiratorie and allergiche - Quadro conoscitivo sulla situazione italiana and strategie di prevenzione*, 2011.

humidity, ventilation) and, therefore, comfort;

- presence of sources of biological (mite, moulds) and chemical (tobacco smoke, VOC, $PM_{2,5}$ and PM_{10}) indoor pollutants
- input of pollutants originating from the outside as particulate matter, NO_x, benzene, PAH and ozone.

In Europe, quite a number of initiatives and projects deal with indoor pollution. The purpose is to study the pollutants, their sources , their effects on health and the monitoring methods , as well as to develop more effective solutions to counter and limit the impact of the phenomenon. At any rate, the studies that have dealt specifically with indoor pollution in schools and children's health are quite limited (Table 2). From this point of view, SEARCH (School Environment and Respiratory Health of Children, 2007-2010) Project is one of the earliest European multicentric experiences.

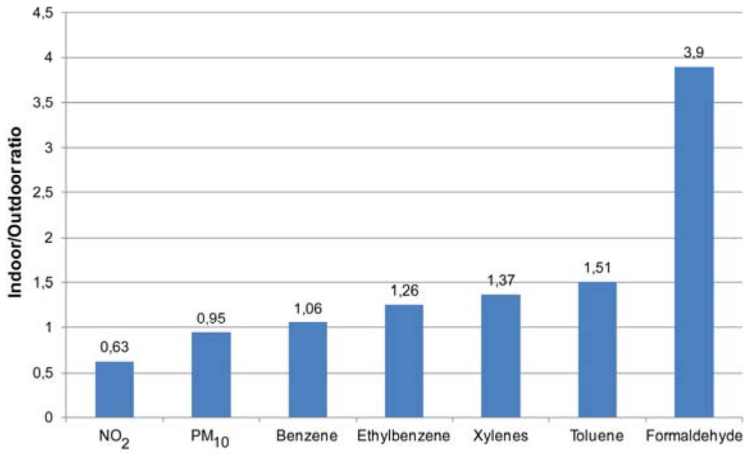
The European initiatives and projects that deal with indoor pollution in schools and the health of children include the SEARCH project (2007-2010). The latter is one of the earliest European multicentric experiences. It has provided for the administration of questionnaires and the monitoring of pollutants deemed relevant for their respiratory and allergic risk.

The Project - promoted and financed by the Ministry of the Environment and the Protection of the Territory and the Sea (MATTM) through the Italian Trust Fund of the REC (Regional Environmental Centre for Central and Eastern Europe) – has been conducted at the same time in six European Countries (Italy, Albania, Bosnia-Herzegovina, Serbia, Slovakia and Hungary). It has entailed the inspection of 60 schools and 243 classrooms, with the measurement of the main environmental pollutants deemed relevant for their respiratory and allergic risk, such as PM_{10}, NO_X, aldehydes, including formaldehyde and the so-called BTEX (benzene, ethyl-benzene, toluene and xylenes). Over 5,000 children between 11 and 12 years of age have been interviewed through questionnaires and checked with spirometric analyses[6].

The "SEARCH Italy" working Group (coordinated by MATTM and ISPRA) has involved the ARPA (Regional Agency for the Protection of the Environment) of six Italian Regions (Piedmont, Lombardy, Emilia-Romagna, Lazio, Sicily, Sardinia), the Maugeri Foundation and Federasma, a non-profit association. The investigations have been carried out in 55 classrooms of 13 lower secondary schools, and entailed the study of over 1,100 schoolchildren. The main project results, presented by ISPRA on the occasion of a national Conference[7], have shown that, considering the same pollutants, the indoor concentrations are higher than those reported outdoor (Figure 8.1),confirming indoor sources contribution in the release of chemical substances.

[6] The international results have been presented at the 5th Ministerial Conference on "Environment and Health" held in Parma and organized by the WHO and the Italian Government. http://www.salute.gov.it/salaStampa/dettaglioEvento.jsp?id=47

[7] http://www.isprambiente.gov.it/site/it-IT/Progetti/SEARCH/ISPRA_per_indoor_scuole/Progetto_SEARCH_I/



In Italian classrooms, the indoor concentrations of the pollutants being monitored proved higher than the outdoor concentrations of those very pollutants.

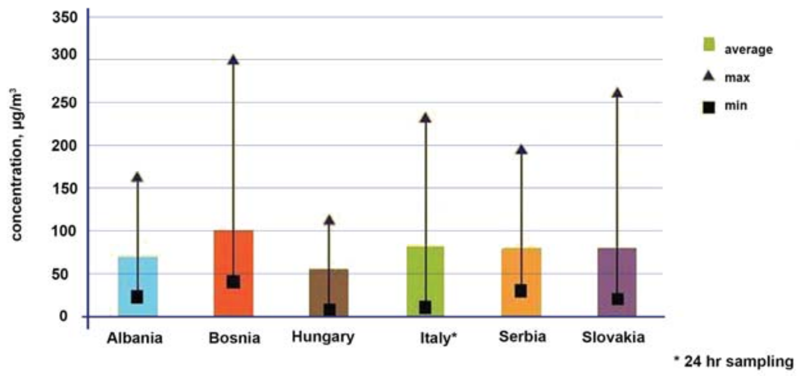
Figure 8.1: SEARCH-I Project: Relationship between indoor and outdoor concentrations of pollutants in school environments[8]

In particular, PM_{10} concentration inside schools proved to be higher than the concentration in outdoor air (on average, 80 $\mu g/m^3$). Furthermore, formaldehyde values discovered in the Italian schools were found to be the highest among all the European schools being investigated (Figure 8.2)[9].

[8] Source: *School environment and respiratory health of children* (SEARCH). *International research project report within the Indoor air quality in European schools: Preventing and reducing respiratory diseases program.* Edited by Eva Csobod, Peter Rudnay, Eva Vaskovi, Szentendre, Hungary, February 2010.

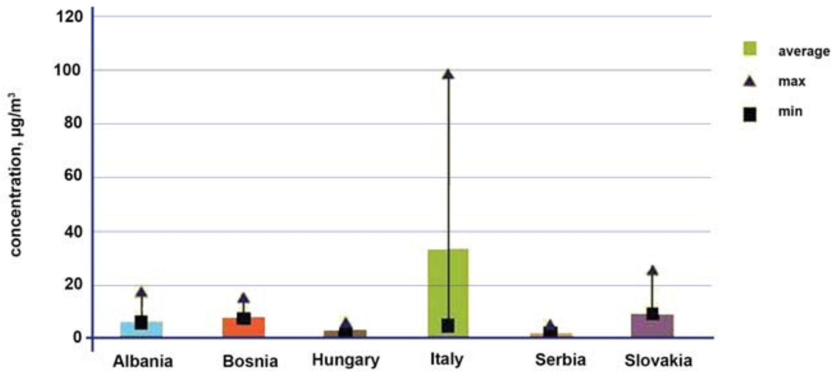
[9] http://www.isprambiente.gov.it/site/it-IT/Progetti/SEARCH/

(A)



(A) The average concentration of PM_{10} in Italian schools proves higher than the outdoor concentration of the same pollutant.

(B)

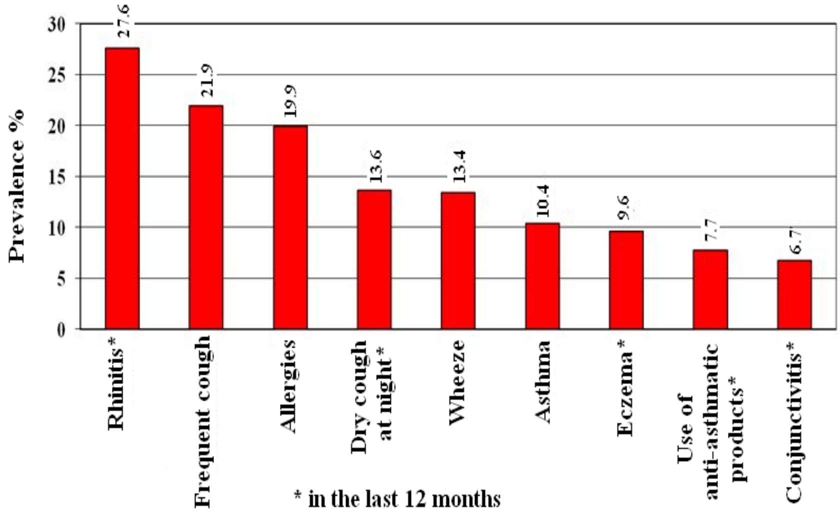


(B)In Italian schools, the levels of the formaldehyde concentration proved to be the highest of all the European schools being monitored.

Figure 8.2: SEARCH-I Project: concentrations of PM_{10} (A) and formaldehyde (B) in the classrooms[10]

The examination of children's respiratory health has also confirmed the prevalence of some symptomatologies, as already observed in other epidemiologic studies (Figure 8.3).

[10] Source: *School environment and respiratory health of children* (SEARCH). *International research project report within the Indoor air quality in European schools: Preventing and reducing respiratory diseases program.* Edited by Eva Csobod, Peter Rudnay, Eva Vaskovi, Szentendre, Hungary, February 2010.



Respiratory/ allergic health of schoolchildren

Figure 8.3: SEARCH project in Italy. Prevalence of respiratory symptoms in schoolchildren[11]

There are additional projects currently under way, such as SEARCH-II and SINPHONIE, which see the REC among the coordinators and Italy as a partner.

The SEARCH-I Project has, also, promoted the start of additional project activities involving REC as a coordinators and Italy as a partner. The ,

- SEARCH-II Project
- SINPHONIE Project

are currently under way and the results should be available by 2013.

The SEARCH-II Project[12], which sees the participation of the SEARCH-I Countries and a few Countries in central Asia, purposes to continue and complete the study and the analysis of indoor risks in schools. the 2nd phase of SEARCH Project want deepen the study of other risk factors, for instance, the use of energy and the energy requirements, which - combined with the constructive features of school buildings - affect such important variables for the individual well being as temperature and humidity., These data shall be a very useful source of information in Italy where, very soon, every school will be required to have an energy certification, as it has already been done in many Regions.
The Italian workgroup of SEARCH-II project has been entrusted, in collaboration with other experts of the participating Countries, with the draft of a working paper on the causes and risks and health effects of indoor pollution, with specificr eference to the salubrity of the cleaning products and building and furnishing materials, including materials used to improve energy performance.
The SINPHONIE Project (Schools Indoor Pollution and Health: Observatory Network in Europe)[13], promoted and financed by the European Commission through the DG SANCO (Directorate

[11] Source: *Qualità dell'aria nelle scuole: un dovere di tutti, un diritto dei bambini*. MATTM-REC publication, 2010, http://www.isprambiente.gov.it/site/it-IT/Progetti/SEARCH/
[12] http://www.isprambiente.gov.it/site/it-IT/Progetti/SEARCH/ISPRA_per_indoor_scuole/Progetto_SEARCH_II/
[13] http://www.rec.hu/sinphonie/about.html. The project falls within the European Environment and Health Action Plan 2004-2012.

General for Health and Consumers), involved 38 institutions operating in the environmental and health fields in 25 different Countries. By focusing on schools and children facilities, this project aims to develop recommendations for policy maker and to improve school environment and prevent respiratory and allergic diseases in children.

Table 8.2: Indoor air quality: major European-wide projects and surveys[14]

Main projects and surveys promoted over the last ten years throughout the European territory that deal with indoor air quality.

Study areas	Projects and surveys
Policy-Science framework	EnVIE (Co-ordination action on IAQ & Health Effects) –Porto University (2004-2008) IAIAQ (Impact Assessment of IAQ) – JRC (2009-2011)
Identification of priority pollutants/health risks	THADE (Towards Healthy Indoor Air in Dwellings in Europe – EFA (2002-2004) INDEX (2005), SCHER report (2007), WHO (2007 – dampness/mould, 2010 – chemicals)
Definition of standards/guideline values for priority pollutants	WHO IAQ (2007 – dampness/mould, 2010 – chemicals) INDEX and INDEX-UPRIC – JRC (2003-2005, 2009-2010) HEALTH-VENT (Health based ventilation guidelines) – DTU (2010-2012)
Patterns of exposure for priority pollutants	Danish EPA National Survey of Chemical Substances in Consumer Products (2006) CLEAR-UP (Clean and resource efficient buildings for real life) – Tübingen University (2008-2012) RADPAR (Radon Prevention and Remediation) – UoWM (2009-2012) OFFICAIR (On the reduction of health effects from combined exposure to indoor air pollutants in modern offices) – UoWM (2010-2013) EFHECT (Exposure Patterns and Health Effects of Consumer Products in the EU) – VITO (2010-2013)
Indoor setting and vulnerable groups: indoor school air and children's health	HESE (Health Effects of Schools Environment) – Siena University HESE-INT (Interventions on Health Effects of School Environment) – Siena University (2009) EFA project (Indoor Air Pollution in Schools) (2003) BIBA (Indoor Air Pollution in Schools) – VITO French Schools Monitoring – French Observatory for Indoor Air Quality (OQAI) 2001-2005 SEARCH (School environment and respiratory health of children) – ITF Italian Ministry of the Environment /REC (2007-2009) SINPHONIE (Schools Indoor Pollution and Health: Observatory Network in Europe) – REC 2010 SEARCH II (energy and comfort assessment in schools/children's health) – ITF MATTM/REC (2010-2013)
Indoor sources/preventing the emission of pollutants	BUMA (Building materials prioritization as indoor pollution sources) – JRC/UoWM (2006-2009) HEALTHY AIR (Effects of building materials on indoor air quality, health and comfort) – TNO (2008-2010) European Collaborative Action: Urban Air, Indoor Environment and Human Exposure (JRC Ispra): Report 18: Evaluation of VOC emissions from building products (1997) Report 24: Inventory of existing emission labeling schemes in the EU (2005) Germany research project (BAM, TU Berlin, UBA): Building products: Determining and avoiding pollutants and odors

[14] Source: ISPRA processing of data taken from JRC, *Promoting actions for healthy indoor air* (IAIAQ) Directorate General for Health & Consumers, 2011.

The quality of indoor and health of children in European and national policies and guidelines

European policies and guidelines

The World Health Organization (WHO) has highlighted the relevance and the urgency for each Country to adopt a "National Plan for the creation of a sustainable indoor environment" and, since 1999, has disseminated a publication specifically designed to identify the optimum strategies for the implementation of that Plan. In the last ten years, it has, also estabilish a set of reference guidelines for managing indoor environments:

The WHO stresses the relevance and urgency for each Country to implement a "National Plan for the creation of a sustainable indoor environment".

- WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur (2005)[15], applicable to indoor environments and including actions, schools and means of transport;
- WHO Guidelines for indoor air quality: dampness and mould (2009)[16], dealing with dampness and moulds in buildings, health risks and prevention measures;
- WHO Guidelines for indoor air quality: selected pollutants (2010)[17], determining the limits for a number of priority chemical pollutants.

Besides, the latest WHO policies for the European Region focus on the protection of children's health from environmental risk factors.

Italy has been one of the signatories of the Parma Declaration on "Environment and Health" signed in March 2010 on the occasion of the 5th Ministerial Conference of the Health and Environment Ministers of 53 Countries in the European Region of WHO. With this document, the governments reconfirmed the commitments they had undertaken in the previous Conference held in Budapest (June 2004), which enphatized the importance of protecting children's health from environmental threats, a goal that had been re-proposed with even greater emphasis among the priorities of the CEHAPE (Children's Environment and Health Action Plan for Europe)[18]. In fact, the third priority goal of the CEHAPE is to guarantee that, by 2020, all children enjoy a healthy indoor environment particularly at home, at school and in childcare facilities, with a view to prevent the main childhood diseases related to air pollution (bronchial asthma, allergies and respiratory diseases).

The Parma Declaration on "Environment and Health", signed on the occasion of the 5th Ministerial Conference, lays emphasis on the relevance attached to protecting the health of children from environmental threats.

In recent years, even the European Union has promoted several initiatives[19] to fight chronic childhood diseases and raise the awareness of the institutions, particularly health institutions, to promote intersectoral policies between health, education, environment, labor and research. Among these the most important

Quite a number of initiatives addressing such intersectoral policies as health, education,

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15 http://whqlibdoc.who.int/hq/2006/WHO_SDE_PHE_OEH_06.02_eng.pdf

16 http://www.euro.who.int/__data/assets/pdf_file/0017/43325/E92645.pdf

17 http://www.euro.who.int/en/what-we-publish/abstracts/who-guidelines-for-indoor-air-quality-selected-pollutants

18 http://www.hpa.org.uk/AboutTheHPA/WhatTheHealthProtectionAgencyDoes/InternationalWork/ChildrensEnvironmentAndHealthActionPlanForEuropeCEHAPE/

19 *Childhood asthma - The Council's Conclusions*, 2 June 2004 [9507/04 (Press 163)]; Warsaw Conference, *Prevention and control of childhood asthma and allergy in EU from the public health point of view: an urgent need to fill the gaps*, Ossa (Poland), 21-22 September 2011.

are:

- The SCALE Environment and Health Strategy[20] of the European Union, which aims primarily at preventing childhood respiratory diseases, asthma and allergies.
- The Sixth Community Action Program concerning Environment and Health (2001-2012)[21], which stresses the need "to reduce environmental pollution down to levels that may minimize adverse effects on human health, with special reference to the vulnerable groups, and on the environment as a whole".
- The Environment and Health Action Plan 2004-2010 that, within the framework of Action 12 concerning the improvement of the air quality, stresses the need to develop networks and guidelines on other factors that adversely affect indoor air quality (dampness, moulds, building materials, indoor pollutants) through research, exchange of information and best practices.
- The Report and Resolution of the European Parliament on the Action Plan (2005)[22] that, among the major research areas, includes the impact of new building materials on health, inviting the Commission, in cooperation with Member States, to introduce a system for the environmental and health labeling of building products and materials. Furthermore, the Report stresses that the indoor building quality may not be improved without having a multidisciplinary approach that takes into account the variety of pollution sources present inside buildings (heating system, plants, furnishings, and activities being carried out).

environment, employment and research have been promoted in recent years by the European Union.

<u>Indoor air in the national health policies: regulations and initiatives</u>

At present , our Country still lacks an organic regulation designed to ensure the protection of health from the risks related to confinated space. The regulations governing the salubrity of housing premises are laid down in each Municipality by the Hygiene and Health Regulation (Table 8.3).

Our Country still lacks a regulation ensuring the actual protection of health from the risks connected with indoor environments.

Based on the Consolidated Health Law (Royal Decree no. 1265 of 27 July 1934 – Title III, Chapter IV, on the sanitation of urban and rural built-up areas and houses), the local hygiene and health regulations estabilished the standards for the salubrity of the urban and rural built-up areas and houses according to the outline guidelines issued at present by the Ministry of Health. Hence, the Municipal Regulation represents an important regulatory tool to deal with the salubrity of indoor environments, as it maintains a specific usefulness even further to the implementation of the Health Reform (Law 833/78) that transfers to the Regions the authority to regulate the performance in the matter of public health and hygiene.
Legislative Decree 502/92 (amended by Legislative Decree 517/93) has introduced considerable innovations with respect to both the

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[20] http://europa.eu/legislation_summaries/environment/general_provisions/l28133_en.htm
[21] http://europa.eu/legislation_summaries/agriculture/environment/l28027_it.htm
[22] http://www.europarl.europa.eu/sides/getDoc.do?type=REPORT&reference=A6-2005-0008&language=IT#title1

overall setup of the health system and the specific sector of prevention, laying down that the Regions are required to create a Prevention Department (PD) within each Local Health Authority (LHA). The DP is going to be entrusted with the public health and hygiene duties that were previously performed by the LHA services that had been set up by Law 833/78. Subsequently, Legislative Decree 229/99 redefined the functions of the Prevention Departments, their organization and inner and outer coordination with other bodies and institutes (Regional environment agencies, Centers for infectious diseases in animals, Labor inspectorates and INAIL, etc.). Hence, it entrusted the Departments with additional tasks detection and removal of the causes of harmfulness and diseases having an environmental origin. In order to carry out these tasks, they could have recourse to the Regional and Provincial Agencies for the protection of the environment. Furthermore, it laid down that the collective prevention and environmental control functions carried out by PD and ARPA should also provide for coordinated and integrated measures. At present, from the point of view of operations, these provisions are implemented with different instruments and methods in the various local authorities and, regarding indoor expertise no clear competences have so far been well defined, nor sectors of joint action and the relative programs of operations have been identified.

With the National Health Plan for 1998-2000, it is the first time that Italy has dealt with the health issues with a multidisciplinary and intersectoral approach.

Based on the international health indicators and targets ("Health for All-21"), the National Health Plan (NHP) for the 1998-2000 period[23] has dealt for the first time (compared to the previous planning documents) with main health issues through a multidisciplinary and intersectoral approach, where inherent health and environment issue has been taken jointly into account. The 3rd objective of the NHP, "improvement of the environmental context" had set the reduction of the health risks related to indoor pollution as a priority to be implemented in the three-year reference period within the context of the NHS competences and in concert with not heath related institution.

Since 1998, the Ministry of Health to implement the NHP objectives by the Ministerial Decree of 8 April 1998, has appointed the "National Indoor Commission", which was entrusted with the task of developing technical guidelines to reduce health risks related to indoor pollution. The Commission had a multidisciplinary nature, as it comprised engineers, architects, occupational health-care professionals, hygienists, oncologists, allergists, epidemiologists, physicians, chemists, biologists, etc. In July 1999, the Commission drafted the first report on Italy's major health problems arising from indoor pollution and provided a series of general guidelines for the implementation of a national program for prevention health promotion in confined space.

In the "Guidelines for the protection

The outcome of the said report has led to the State-Regions Agreement of 27 November 2001[24] containing "Guidelines for the

[23] http://www.salute.gov.it/imgs/C_17_pubblicazioni_947_allegato.pdf
[24] O.G. of 27 November 2001, no. 276 G.S., O. S. no. 252.

protection and promotion of health in indoor environments”[25]. Based on this Agreement, the Minister of Health meant to implement a countrywide “Pact” for the prevention of indoor risks through the involvement of both health institutions and stakeholders. The Agreement provided for regulatory measures based on public health standards, arrangement of technical tools, training campaigns for the technical staff of the NHS and other sector's, and the support of a national research plan, as well as the information and education of the population (to raise the awareness of its role in the prevention of risks and the promotion of health) and the involvement of the social partners and associations.

and promotion of health in indoor environments” included in the State-Regions Agreement of 27 November 2001, the Minister of Health proposed the implementation of a “Pact for the prevention of indoor risks”

To promote the implementation of the national indoor prevention program, the Agreement of 27 November 2001 was followed by a series of provisions and guidelines, including:

The State-Regions Agreement of 27 November 2001 has led to a series of provisions and guidelines that purposed to promote the implementation of the national program for the prevention of risks arising from indoor environments.

- Guidelines for the prevention and control of the Legionnaires’ disease of 4 April 2000[26] ;
- State-Regions Agreement of 13 January 2005, laying down the “Guidelines containing information about the Legionnaires’ disease for tourism operators and receptive facilities and spas”[27];
- State-Regions Agreement of 5 October 2006, containing “Guidelines for the definition of technical protocols for the diagnostic maintenance of air conditioning plants”[28];
- National Radon Plan (NRP)[29] “to reduce the risk of lung cancer in Italy arising from the exposure to radon”, which was an organic and coordinated series of measures aimed to reduce the radon risk in Italy (including standards, mappings, information, training). The NRP obtained the favorable opinion of the Higher Health Council and the State-Regions Conference and, starting from 2006, it has been partly financed within the context of the project of the Center for the Prevention and Control of Diseases (CCD);
- Agreement of 18 October 2010[30] among Government, Regions, Autonomous Provinces of Trent and Bozen, Provinces, Municipalities and Mountain communities, concerning “Guidelines for the prevention of indoor risk factors related to allergies and asthma in schools”[31], which focused on the relevance of hygiene and air quality in schools for children's health. Within this Agreement, the regulatory framework, governing a number of aspects connected with school buildings, indoor air quality and microclimate proves inadequate or outdate with respect to the latest scientific evidence. Besides, it is not in keeping with the building energy saving and bio-climatic requirements and with the characteristics of salubrity and safety

25 http://www.radon.it/site/download/lineeguida.pdf
26 O.G. of 5 May 2000, G.S. no. 103
27 O.G. of 4 February 2005, G.S. no. 28
28 O.G. of 3 November 2006, G.S. no. 256
29 http://www.iss.it/binary/tesa/cont/PNR-Testo%20completo.1195145887.pdf
30 O.G. of 13 November 2011, G.S. no. 9
31 http://www.normativasanitaria.it/normsan-pdf/2001/36589_1.pdf

of both materials and furnishings.

- e fight against passive smoking is another important objective of the National program for the prevention of indoor risks developed by the Ministry of Health . The Law no. 3 of 16 January 2003[32], "Legislative provisions concerning the Public Administration". Under article 51 "Health protection of non-smokers", the law extended the smoking prohibition to all the indoor environments, the only exceptions being smoking rooms and strictly private environments. Furthermore, with a view to protecting the health of children and unborn children, it has introduced higher sanctions against those who smoke in presence of children or pregnant women.

Furthermore, a series of important projects and programs were promoted in recent years to contrast the main environmental risk factors for chronic respiratory diseases through specific projects and programs initiated within the context of the activities of the National Prevention Plan by the Center for the Prevention and Control of Diseases[33] and GARD Italia (Global alliance against chronic respiratory diseases in Italy)[34].

A series of important projects and programs promoted in recent years aim at countering the main environmental risk factors for chronic respiratory diseases.

- The three-year (2009-2012) project financed by the CCD, "Exposure to indoor pollutants: guidelines for assessing the risk factors in schools and definition of the measures to protect the respiratory health of school children and adolescets" (Indoor-School), is coordinated by the National Institute of Health (NIH) and includes in the study the schools of seven Italian Regions (Lombardy, Friuli, Tuscany, Lazio, Apulia, Sardinia and Sicily).
- The activities of GARD Italia are coordinated by the Ministry of Health together with the CCD. GARD is a voluntary association established in Rome in June 2009 on the occasion of the 4th general assembly of the International Global Alliance against Chronic Respiratory Diseases, an alliance established by the WHO in order to promote common strategies for reducing the impact of chronic respiratory diseases. An *ad hoc* workgroup "for the prevention of indoor risks in schools" set up within GARD Italia has been entrusted specifically with the task of facilitating the implementation of the State-Regions Agreement of 18 November 2010 to prevent allergy and asthma risk factors in schools. The working group comprises university and institutional experts, including representatives of the Ministries of Education and Environment, ISPRA and HIH. Finally, the State-Regions Agreement of 29 April 2010 launched the New National Prevention Plan 2010-2012[35], which includes strategic guidelines addressing the improvement of sanitary requirements for indoor air in schools and in all the other

The new National Prevention Plan 2010-2012 includes specific strategic guidelines addressing the improvement of the sanitary requirements for indoor air quality

32 http://www.parlamento.it/parlam/leggi/03003l.htm

33 http://www.ccm-network.it

34 http://www.salute.gov.it/gard/gard.jsp

35 Just as in 2005, further to the State-Regions Agreement of 29 April 2010, the Regions and the Autonomous Provinces have appropriated 200 million Euro for the full implementation of the Prevention Plan for the 2010-2012 three-year period.

premises attended by children. Based on these guidelines, a number of Regions have already developed their respective Regional Prevention Plans.

in all the premises attended by children.

Table 8.3: Current national and international standards inherent to indoor air quality[36]

Subject	Standard	Synthesis
International technical regulations and standards for microclimate and ventilation control	Standard ISO/FDIS 7730	Guidelines for qualifying and assessing comfort.
	UNI EN 13779	Ventilation in non-residential buildings.
	UNI 15251	Assessment of the energy performance of buildings.
Control of plants	Guidelines dated 4 April 2000 for the prevention and control of the Legionnaires' disease,	It provides plant management guidelines for preventing the Legionnaires' disease.
Passive smoking regulations	Law no. 3 of 16 January 2003	It bans smoking in public environments.
Regulation concerning dangerous chemical substances and compounds	REACH – EC Regulation no. 1907/2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals	Registration, evaluation, authorization and restriction concerning all the substances produced or imported in the European Union.
Hygiene regulation	Decree of the Ministry of Health of 5 July 1975	It lays down the main hygiene and sanitation requirements concerning housing premises, specifying the minimum housing space in relation to the anticipated number of occupants.
Directives relating to construction products	89/106/EEC, implemented in Italy with DPR no. 246 of 21 April 1993	It requires the compliance of construction products with the fundamental health requirements.
	Regulation no. 305/2011 relating to construction products	
Regulations concerning the environmental performance, sustainability and environmental energy savings of buildings	ISO 21931-1:2010	It aims at improving the performance of buildings laying down a single reference framework on the methods to assess their impact.
	ISO 13823:2008	It defines general principles and suitable procedures for assessing the durability/ resistance of building structures to natural events.
	Directive 2002/91/EC implemented with Legislative Decree no. 192 of 19 August 2005	Methodology for calculating the energy performance of buildings.
	Standards UNI TS 11300	Technical standards for calculating the energy requirements of buildings.
	Directive 2010/31/EC	It promotes the improvement of the energy performance of buildings.
Ecolabel	EC Regulation no. 66/2010	Community trademark ensuring the environmental quality of a product.
Radon	Decree Law 241/2000	The decree sets a reference level of 500 Bq/ m^3: where exceeded, the employer is required to step in with more in-depth assessments and, in case of need, with remedial

Standards that, promoted in recent years at both a national and an international level, are currently in force for the prevention of risks arising from indoor air quality.

36 Source: ISPRA

		actions affecting workplaces, including schools.
	Recommendation 90/143/Euratom	It lays down the reference values for the home radon concentrations: where exceeded it recommends remedial actions for reducing the radon concentration: 400 Bq/m^3 for existing buildings and 200 Bq/m^3 for future constructions.
	National Radon Plan	Coordinated action plan designed to reduce the risk of health effects connected with the exposure to radon.
Noise	Law no. 447 of 26 October 1995	General policy law on acoustic pollution and subsequent implementation decrees.
	Directive 2002/49/EC of 25 June 2002, implemented with Legislative Decree no. 194 of 19 August 2005	It relates to the assessment and management of environmental noise and provides for remedial actions in the presence of health risks.

The prevention of risks arising from the indoor air quality in sectoral policies: the role of environmental policies

The prevention of risks arising from the indoor air quality involves a series of sectors that are affected by the environmental policies through rules and regulations that limit the release into the atmosphere of pollutants and provide for a direct control of the sources present in indoor environments.

As previously pointed out, the prevention of risks arising from the indoor air quality involves a series of sectors such as, for instance, productive activities and certification systems, urban mobility policies, as well as climatic and the energy policies. In a few of these sectors, the environmental policies play a peculiar role of their own, contributing to the prevention of the risks arising from the indoor air quality through two main groups of rules and standards:

- the rules and standards that limit the release into the atmosphere of pollutants from industrial activities, transports, agriculture, waste management, household activities, such as Legislative Decree no. 155 of 13 August 2010, the IPPC Directives, AIA and EMAS, the regulations that fixes and update the performance standards for new cars and commercial vehicles and the policies for a sustainable mobility;
- the rules and standards that provide for a direct control of the sources present responsible for the release of pollutants and hazardous substances in indoor environments and promote the use of ecological products and sustainable building materials. They include the REACH Regulation, the Ecolabel Regulation (EU trademark of ecological quality), the recent Regulation no. 305/2011 concerning construction products, the strategies and the action plans for the promotion of eco -friendly products (Integrated Product Policy, Action Plan for green purchases, Strategy for the sustainable use of resources, Eco-innovation plan), the regulations relative to the ecological design of products as well as the development of specifications useful for the ecologically compatible design of energy-using products (ECODESIGN), the policies promoting the purchase of clean products (such as cars, motor vehicles, electrical appliances, etc.) and the development of environmental friendly buildings.

An important role is also played by the policies addressing the energy efficiency of buildings adopted at an EU-wide level through the energy efficiency plan (COM (2011) 109) that is progressively being implemented in our Country. The latter contributes to the reduction of the emissions into the atmosphere (therefore, to the prevention of outdoor pollution) and it should also ensure a better microclimatic indoor comfort thanks to an adequate design (including the choice of healthier materials for buildings and furnishings) and an adequate maintenance, in order to avoid adverse effects on the indoor air quality. In fact, even though the air-conditioning/heating systems using air recirculation to avoid thermal losses, in association with the techniques for building insulation (i.e., use of special window and door frames for thermal and/or acoustic insulation), lead to proper energy savings, they may adversely affect internal ventilation, reducing the dispersion of pollutants and favoring the concentration of pathogens (i.e., Legionnaires' disease, as well as in general viral and bacterial infections) and the increase in indoor concentrations of dusts and airborne pollutants (CO_2, CO, TSP, etc.) with repercussions on their salubrity.

At present, an important role is also played by the policies addressing the energy efficiency of buildings that, promoted at a European level through the Energy Efficiency Plan provided for by COM(2011)109, are progressively being implemented even in Italy.

Last but not least, as previously mentioned, in our Country shall be better addressed competences and indoor air monitoring systems, for which to date is not yet a system knowledge and reference as for outdoor air pollution.

In general, the role of the policies mentioned is not subordinate to the protection of respiratory health.

As summarized in Figure 8.4 and in Table 8.4, a recent JRC study [37] analyzed the impact of the indoor air quality on health (IAIAQ), assessing the main pathologies attributable to exposure to indoor pollution (asthma, pulmonary carcinoma, chronic obstructive bronchitis, respiratory infections/symptoms, acute intoxications).

the study quantified the impact attributable to indoor pollution in approximately 2 million DALYs[38] per year.

Then, it assessed the health benefits from 2004 to 2010 in terms of DALY/year of the EU policies (the REACH regulation, the directives on construction products, the energy efficiency of buildings and the labeling of products, the green paper on tobacco smoke, and the WHO guidelines on indoor air).

Finally, different scenarios have been taken into consideration depending on the implementation of the European policies.

A recent JRC study analyzed the impact of the air quality on health, taking into consideration the main pathologies linked to the exposure to indoor pollutants and quantifying the impact attributable to indoor pollution and the health benefits resulting from the EU policies for 2004-2010.

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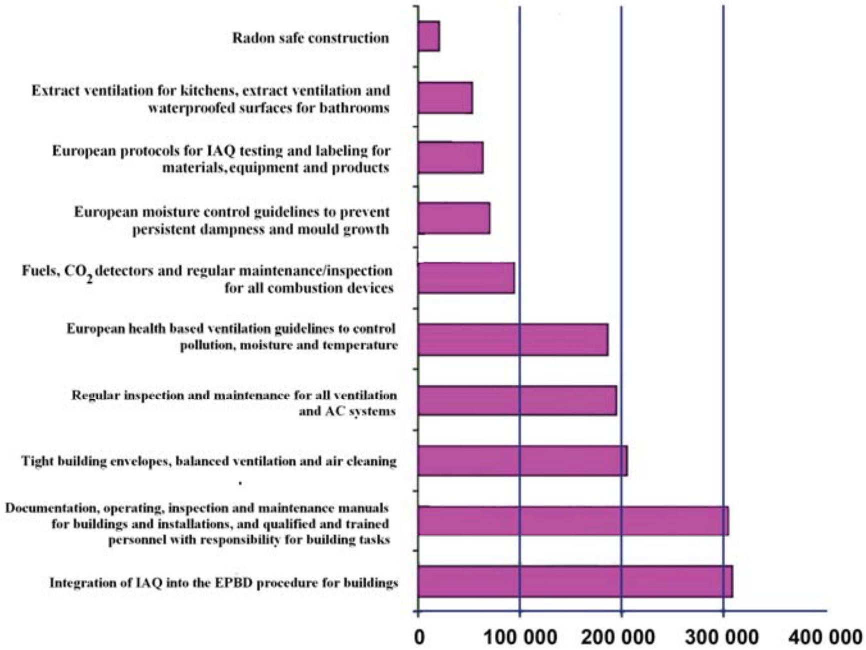
37 JRC, *Promoting actions for healthy indoor air* (IAIAQ), Directorate General for Health & Consumers, 2011.

38 DALY (*Disability-Adjusted Life Year*): years of life lived net of disability. The DALY is a measure of the overall disease burden and is the result of the sum of the numbers of years lost (YLL) due to an early death with the years lived with disability or disease (YLD). This method has been developed by Harvard University in 1990 and has been adopted in 2000 by the WHO.



Assessment of the health benefits in terms of DALY/year resulting from the implementation of the EU policies on the air quality in indoor environments.

Figure 8.4: DALY benefits at the 10th year of implementation of the indoor air quality policies[39]

[39] Source: ISPRA processing of data taken from: JRC, *Promoting actions for healthy indoor air* (IAIAQ), Directorate General for Health & Consumers, 2011.

Table 8.4: Temporal increase in the public health benefits in terms of DALY thanks to the implementation of the policies concerning the energy efficiency of buildings and building materials[40]

Increase over time of the public health benefits (expressed in terms of DALY) resulting from the implementation of the EU policies dealing with the energy efficiency of buildings and building materials.

EU-regulation and IAIAQ scenarios		**Start year**	**Annual health benefit in DALY/ year**					∞
			2000	**2005**	**2010**	**2015**	**2020**	
Scenario 1	CPD (89/106/EEC Construction Products)	2000	0	35	70	100	120	400
	GPSD (2001/95/EC General Product Safety)	2002		2	5	6	7	9
	EPBD (2002/91/EC Energy Perfor□ance of Build□ngs)	2003		60	190	300	400	800
	REACH (EC/1907/2006 Chemicals)	2007			5	10	13	17
Scenario 2	REACH implementation	2011				10	15	30
	CPD+GPSD+ Integration of IAQ impacts of indoor combustion equipment	2011				100	180	600
Scenario 4	European protocols for IAQ for buildings and indoor materials and products	2011				60	120	300
Scenario 5	Fuels, CO monitoring systems, regular operation/maintenance of combustion systems	2011				100	180	300
Scenario 6	EPBD + Integration of IAQ	2011				160	350	1,200
Scenario 7	Integration of IAQ into EU CLIMT ACTS and Energy Policies	2011				300	600	2,000

POSSIBLE INDICATORS OF INDOOR AIR QUALITY IN SCHOOLS (DPSIR MODEL)

A set of indicators, that may be actually populated, in order to characterize the state of indoor air quality or its pressures and impacts on health, is still no available at the moment since there is no structured system to gather the necessary data.

At present, there is still no set of indicators that may be populated in order to characterize either indoor air quality, or its pressures and impacts on health.

Therefore, to describe indoor air specifically in schools, an attempt was made to identify a series of possible indicators that could be effectively developed if adequately supported by available and up-to-date data. This would require the commitment and willingness of the institutions involved at a national level (Ministry of Education, Ministry of Health, Ministry of the Environment, etc.) as well as at a local level (Municipalities, ARPA and Health Departments) to gather and d share data and information needed through the implementation of institutional instruments (standards, regulations, guidelines, etc.) and ad hoc databases.

40 Source: ISPRA processing of data taken from: JRC, *Promoting actions for healthy indoor air* (IAIAQ), Directorate General for Health & Consumers, 2011.

As shown in Table 8.5, the indicators for the characterization of indoor air quality may be split in two categories. The former relates to pollutants (PM, VOC, benzene, radon etc.), while the latter relates to the microclimatic comfort (CO_2, temperature, dampness, ventilation, noise, lighting, etc.).

Table 8.5: Indoor air quality indicators classified based on pollution and microclimatic comfort categories [41]

	Pollution	Comfort
Determinants/ Pressures	Sources of pollution (roads/ industrial facilities) close to schools Existence of school protocols for the use of non-toxic detergents, furnishings and school materials	Classroom crowding Number of schools in the A energy class
Status	Concentrations of PM, O_3, NO_x, VOC, benzene, radon (survey)	CO_2, temperature, dampness, change of air, moulds (survey), Lighting, noise
Impact	Non-infectious respiratory diseases (asthma, allergies, OBP)	Viral/bacterial affections (influenza, bronchitis, pneumonia, exanthematous diseases, etc.), headache
Responses	Number of firms/manufacturers of school furnishings and materials with Ecolabel certification Health monitoring/ supervision protocols in schools Number of policies to improve the school air quality (survey)	Number of Regions that have made laws on the energy efficiency of school buildings (energy certification requirement)

The indicators for characterizing the quality of indoor air may be broken down in two categories. The first category relates to pollutants (PM, VOC, benzene, radon, etc.), while the second one relates to microclimatic comfort (CO_2, temperature, dampness, ventilation, noise, lighting, etc.).

DETERMINANTS-PRESSURES

<u>*Possible indicators associated with pollutants*</u>

Different furnishing materials and teaching accessories, as well as sanitation and cleaning products may be responsible for the emission of pollutans such as TSP, VOC, PAH and POP[42] in the areas attend by schoolchildren. For instance, the use of chalk for traditional blackboards promotes the dispersion and accumulation of dust, particularly if during school hours doesn't take place aproper

Furnishing materials, teaching accessories, and sanitation and cleaning products may be responsible

[41] Source: ISPRA

[42] TSP: Total Suspended Particulate; VOC: Volatile Organic Compounds; PAH: Polycyclic Aromatic Hydrocarbons; POP: *Persistent Organic Pollutants.*

and regular ventilation of the classrooms .

for the emission of polluting substances (TSP, VOC, PAH, POP).

From this point of view, organization and management of the operations of environmental hygiene s become essential In fact, if these operations are not scheduled after school hours and are carried out without an adequate ventilation of the premises and without the use of specific products that do not release pollutants in the air after they have been used, they are likely to promote the dispersal of potentially toxic substances, thereby increasing the exposure of student attending the school . Even the choice of furnishings that are certified for low emissions of formaldehyde and other VOC is relevant to the elimination of these pollutants from the indoor environment.

At the same time, the location of the school buildings and, therefore, an adequate town planning represent additional indoor air quality determinants. A school located in an area with high vehicle traffic or close to an industrial area will be characterized by higher concentrations of indoor pollutants ($PM_{10-2,5}$, NO_2, PAH, CO_2, etc.) than a school located in a less polluted area.

Possible indicators associated with comfort

The crowding[43] may be considered an environmental quality determinant. In fact, several studies have shown that a large number of schoolchildren per cubic meter is associated with both higher concentrations of CO_2 and a higher risk that bacterial and viral infections might spread in indoor environments. Besides, it may result in a decreased attention (and learning) of the schoolchildren and the onset of headache·

The comfort is also described by the energy class of school building. Information about the latter is gathered through the energy certification procedure that is gradually being implemented in various Regions. The certification provides for an assessment with respect to the class of thermal insulation and the quality of the high-energy efficiency plant engineering· An energy-efficient building have to combine living comfort and energy –saving.

[43] Decree of the Minister of the Interior (fire-preventing regulations for school buildings) of 26/08/92 that, in addition to specifying the building characteristics, has provided for a “maximum crowding” limit of 26 persons per classroom (including schoolchildren, teachers, support staff, etc.) with no mention at all to the minimum area.

ELEMENTARY SCHOOLSLOWER SECONDARY SCHOOLSNURSERY SCHOOLS/ SECTIONSUPPER SECONDARY SCHOOLSGross sq. m/classroomsfrom 153 to 167from 201.50 to 275.50from 198 to 210from 166 to 307Gross sq. m/studentfrom 6.11 to 6.68from 8.06 to 11.02from 6.06 to 7 from 6.65 to 12.28Technology and Design, Rosario Berardi, 2010

STATUS

Possible indicators associated with pollutants

In susceptible individuals, the indoor pollutants may give rise to allergies, eye and skin irritations, infectious diseases as well as non-specific symptomatologies, such as headache, trouble in concentrating, etc.

High concentrations of indoor pollutants, whether chemical or biological in origin, may result in an increased risk of allergies, eye and skin irritations and infectious diseases as well as non-specific symptomatologies, such as headache, impaired concentration, etc in susceptible individuals. Within this context, one of the indicators suggested by the WHO to assess indoor air quality is represented by the actual exposure to specific indoor pollutants (PM, O_3, NOX, VOC, benzene, radon, noise) in schools. This datum is assessed through surveys[44] that provide also for the monitoring of the concentration values of these pollutants. The methodology suggested for these surveys provides for the collection of passive diffusion samples in at least three classrooms , one outdoor location (average concentration in a week) and analysis in QA/QC accredited laboratory . The three classrooms should be monitored in the period when the heating system is on, while the schools, ranging in number from a minimum of 100 to a maximum of 300, should be selected in different geographical and climatic areas considering both urban and rural buildings.

Possible indicators associated with comfort

The microclimate, that is the series of physical and chemical factors (such as CO_2 concentrations, poor temperature conditions, dampness, lighting, noise) that characterize air in indoor environments, contributes to the individual psychophysical wellbeing, which is based on a delicate balance between individuals and environment. Any alteration of this balance may have an impact on children by negatively affecting their school performance and health conditions. Two indices are often used to assess microclimatic comfort: the katathermometric index that assesses thermal exchanges and the actual temperature index.

One of the indicators proposed by the WHO to assessindoor air quality is the insufficient ventilation of classrooms45. This indicator may be characterized through surveys that measure CO_2, temperature, dampness and ventilation values, as well as the presence of moulds inside the classrooms.

Carbon dioxide is one of the pollutants most often found in high concentrations in indoor environments as it comes from the normal processes of people breathing in a closed environment. The use of simple CO_2 monitoring devices could significantly support the management of indoor air quality. In fact, CO_2 represents an air quality indicator and, therefore it may be used to assess the performance of air treatment systems. CO_2 health effects become manifest at high concentrations (3,500 ppm of CO_2) and adverse effects become manifest above 5,000 ppm, but generally people start having a negative perception of the indoor air quality when

[44] M. Krzyzanowski, *Current WHO activities on IAQ*, WHO European Centre for Environment and Health, Bonn Office, 2011.

[45] M. Krzyzanowski, *Current WHO activities on IAQ*, WHO European Centre for Environment and Health, Bonn Office, 2011.

CO_2 indoor level of exceeds 600 ppm. For this reason it is recommended to increase the indoor ventilation starting from a CO_2 concentration of 800 ppm.
The temperature in indoor environment should be affected as little as possible by changes in the outdoor temperature in order to promote the constant presence of thermal wellbeing conditions . Optimum temperature values are between 20 and 25 degrees during the winter, while they should be a few degrees lower during the summer. Even the level of humidity is an important determinant of environmental comfort: values lower than 12% give rise to symptoms such as dryness of the mucous membranes, while values in excess of 80% are perceived as an uncomfortable sense of humidity. In fact, optimum relative humidity values are between 30 and 60%46 and are affected by the hygrometric levels present inside the buildings, the number of persons present within the premises and the actual structure of the building walls (i.e., dampness oozing from inadequately water-proofed walls).

Another microclimatic parameter that should be taken into account is the indoor ventilation: a poor ventilation lead e to an increase of both humidity and temperature, as well as to an accumulation of CO_2, resulting in a variable symptomatology that includes headache, generalized indisposition, tiredness, irritability.
On the other hand, even an excessive ventilation,especially if related to extreme heat or cold, or at least to considerable differences between the internal and external temperature, can be unpleasant and /or harmful.

Table 8.6: Optimum microclimatic values[47]

Period	Temperature	Humidity	Ventilation
winter	19-22°C	40-50%	0.05-0.1 m/s
summer	24-26°C	50-60%	0.1-0.2 m/s

Optimum microclimatic values of temperature, humidity and ventilation referred to the winter and summer periods

Noise is another status determinant that affects health and wellbeing of the individuals in special indoor environments. In fact, it has been shown that noise values exceeding 65Db(A) cause annoyance and fatigue and may trigger psychic and neurovegetative damages. Specifically, many studies have shown that the exposure to noise may cause a decline in school performance, disturbing verbal communication, memorization process and reading comprehension (learning disturbances), and it may even lead to behavioral changes with an increased aggressiveness. Children represent a particularly

It has been shown that noise values exceeding 65Db(A) cause annoyance and fatigue and may trigger psychic and neurovegetative damages. In children, who are particularly

46 P. Marinelli, *Igiene, medicina preventiva e sanità pubblica*, Piccin, Padua, 2002.

47 Source: ISPRA processing of data taken from: P. Marinelli, *Igiene, medicina preventiva and sanità pubblica*, Piccin, Padua, 2002.

vulnerable group to these effects. As a rule, they still lack adequate cognitive tools to understand and anticipate stressors and they have not developed strategies to cope with them. Furthermore, the fact that children are still in full cognitive and psychic development may cause stressors such as noise to determine irreversible negative consequences. At any rate, it should be noted that these effects do not occur in a uniform manner to all the exposed subjects[48].

vulnerable, the exposure to noise may cause a drop in school performance and may even lead to behavioral changes.

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48 S. A. Stansfeld, B. Berglund, C. Clark, I. Lopez-Barrio, P. Fischer, E. Ohrstrom, M. M. Haines, J. Head, S. Hygge, I. van Kamp, *Aircraft and road traffic noise and children's cognition and health: a cross-national study*, Lancet, 2005, vol. 365, no. 9475, pp. 1942-1949.

IMPACT (exposure/effects)

Even though the exposure to airborne indoor pollutants is not likely to determine acute effects, it may lead to a variety of adverse health effects (including the onset of specific diseases or the worsening of existing pathologies) the severity of which depends on personal characteristics (health status, genetic predisposition, sensitivity, etc.), the type of pollutant and its concentration, and the mode and time of exposure.

Even though the exposure to airborne indoor pollutants is not likely to determine acute effects, it may give rise to adverse health effects the seriousness of which depends on personal characteristics, the type of pollutant and its concentration, and the type and time of exposure.

Children who spend most of their day at school (on average, 6 to 8 hours per day) are exposed to a series of multiple risk factors such as:

- chemical, biological and physical pollutants, sometimes in high concentrations;
- inadequate microclimatic comfort (inadequate temperature, ventilation, lighting and humidity);
- excessively noisy environment;
- classroom crowding.

The resulting health effects resulting may be divided into two typologies:

Building Related Illness (BRI) and Sick Building Syndrome (SBS).

<u>Possible indicators associated with pollutants</u>

The building related illnesses (BRI) are pathologies that are clearly defined by a clinical point of view and are consequence of a specific contamination within the premises. They include non-infectious respiratory diseases,(such as allergies arising from the household dust mite, cat hair or moulds) and the respiratory affections caused by moisture dampness, which may aggravate existing pathological conditions such as asthma, COBP, etc.

<u>Possible indicators associated with comfort</u>

Various viral/bacterial affections of the respiratory system, such as the so-called legionellosis (caused by the *Legionella* bacteria), the humidifier lung (a form of allergic alveolitis) and the humidifier fever, are associated with buildings and, in particular, with the crowding of indoor environments. As a rule, these pathologies result from an improper maintenance of the humidification, ventilation and air-conditioning systems.

Table 8.7: Relationship between exposure and health effects [49]

Correlation existing between the different types of pollutants and their effects on human health.

Disease/symptoms	Exposure	Model
Allergy or asthma	Bio-aerosols, PM, VOC, ETS	Attributable fraction
Lung cancer	Radon	Dose/response
	PM of indoor combustion origin, ETS	Attributable fraction
Cardiovascular disease	PM of indoor combustion origin, ETS	Dose/response
Chronic obstructive bronchitis	PM of indoor combustion origin, ETS	Attributable fraction
Respiratory infections	Dampness, ETS	Attributable fraction
Intoxication	CO	Incidence

The sick building syndrome (SBS) is a widespread syndrome with an undefined etiology and a non-specific symptomatology. While the BRIs affect a limited number of subjects, the SBS affects a large number of persons (50-60%) attending confined unhealthy evnviroment. With this type of syndrome, the symptomatology disappears when leaving the building.

The sick building syndrome is a widespread syndrome with an undefined etiology and a non-specific symptomatology. Nearly 50-60% of the individuals that spend time in unhealthy indoor environments complain of it.

The SBS includes a series of general health problems such as irritation of the eyes, nose, skin and respiratory tract, as well as general symptoms such as headache, asthenia, slight illness, dizziness and difficulty in concentrating. There are a variety of causes for the SBS, generally triggered by a number of factors, including inadequate ventilation, unhygienic air-conditioning systems, emission of odors and irritating substances by materials and equipment, moisture damages, as well as an unpleasant climate in the premises, permanent and irritating noises, and inadequate placement of workstations. Unfortunately, there are no European data on the incidence or causes of the SBS[50].

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[49] Source: ISPRA processing of data taken from JRC, *Promoting actions for healthy indoor air* (IAIAQ) Directorate General for Health & Consumers, 2011.

[50] M. Jantunen, THL, E. Oliveira Fernandes, FEUP, P. Carrer, *Promoting actions for healthy indoor air* (IAIAQ), Milan University, Kephalopoulos S., EC/JRC/IHCP, 2011.

RESPONSES

Possible indicators associated with pollutans -

it is possible to have a general picture of the effectiveness of the measures implemented to minimizing exposure to indoor risk factors. By identifying a series of response indicators, ranging from the management of indoor hygiene to the reasoned choice of certified furnishings and consumer goods,

By determining a series of response indicators, ranging from the management of the sanitation and environmental building of schools to the reasoned choice of certified furnishings and consumer goods, it becomes possible to have a general picture of the effectiveness of the measures implemented with a view to minimizing the indoor exposure risk factors

At present, the environmental quality of materials/products is mrun by the Ecolabel regulation (EC Regulation no. 66/2010). The latter is of particular important in identifying the low-emission consumer and furnishing products and building materials that should be preferred in school management programs. Hence, a response indicator could be represented by the number of firms and manufacturers of building materials, furnishings, school and consumer products Ecolabel certified.

Within this context, a further indicator could be represented by the number of policies implemented to improve air quality in schools. A survey could single out and register all the town planning measures and programs throughout the national territory that provide for the strategic location/zoning of new school buildings in strategic areas far away from sources of atmospheric and noise pollution, and the air quality and mobility management plans providing for mitigation and possible reorganize of road traffic in the areas where school buildings are already present.

Possible indicators associated with comfort

At present, the new Directives on the energy efficiency of buildings have to be taken into account (Directive 2002/91/EC implemented with Legislative Decree n. 192 of 19 August 2005; Standard UNI TS 11300; Directive 2010/31/EC). At any rate, these regulations require an careful evaluation and application in order to avoid that buildings energy performance is achieved to the detriment of the indoor air quality. The response indicator used in this context could be represented by the number of regions which have legislated on the energy efficiency of school buildings (energy certification requirement).

GLOSSARY

Allergens:

Substances recognized as alien to a given organism (antigens) that may give rise to an immediate hypersensitivity.

Allergies:

Hypersensitivity reactions of the body immune system to a variety of substances (allergens).

Indoor environments:

Non-industrial living and working premises such as homes, offices, schools, libraries, hospitals, barracks, hotels, recreational facilities, means of transport.

Microclimatic comfort:
Psychophysical state that causes individuals to be satisfied with the microclimate that characterizes the environment where they spend their time.

Formaldehyde:
Volatile organic substance having a carbonylic nature, occasionally present in the air of living premises. It is a colorless gas with a strong and pungent odor. Upholsteries, chipboards, insulating materials, coloring agents, plastic material, wall-to-wall carpeting, textiles, detergents, additives, disinfectants and tobacco smoke represent the main sources of emission.

Indoor pollution:
Pollution that affects indoor environments and arises from the accumulation of generally airborne pollutants emitted by various sources both indoor and outdoor.

Outdoor pollution:
Atmospheric pollution of the outdoor environment.

Airborne pollutants: chemical substances that may be present in the air in such a concentration as to adversely affect human health, other life forms or materials.

Indoor air quality:
Quantitative assessment of the air pollution in indoor environments.

Radon:
Naturally occurring radioactive noble or inert gas. It is produced by the radio present everywhere in the soil by "nuclear decay" and is present in the environment particularly in the areas having a volcanic origin. Its dangerousness is higher in indoor environments since the latter hinder its dispersion in the atmosphere.

CHAPTER 9

ENVIRONMENTAL HAZARD

Introduction

Mankind has always had to face natural hazards (volcanic eruptions, earthquakes, tsunamis, floods, drought, landslides, etc.). In recent years the effects of these events have become increasingly catastrophic, also because they are amplified, or even induced, by the numerous human-related actions affecting the environment. The development of new technologies has significantly improved the quality of living, but it has also given rise to new hitherto unknown hazards.

The development of new technologies has significantly improved the quality of living, but it has also given rise to new hitherto unknown hazards.

An environmental hazard, in fact, is the likelihood of a particular event (carrier/cause of negative effects for human beings and/or the environment) occurring, with a certain intensity, in a given area and in a certain interval.

The definition of environmental hazard should, therefore, take into account the role of the various environmental, natural components and of their interaction with human activities.

Environmental hazard is one of the components of environmental hazard. The latter, in fact, is defined as the product of the three parameters included in the following equation: $R = P * V * E$, where P stands for hazard, V for vulnerability, i.e. the propensity of a good to undergo damage when hit by a certain disastrous event, and E is the exposure, i.e. the value of the vulnerable goods present within the exposed area.

This chapter will exclusively address hazards, with some references to vulnerability, while hazards will not be addressed here, since hazard assessment is an extremely complex and delicate matter and requires accurate calculations and estimates, which clearly lie outside the scope of this chapter.

Among the natural hazards, we have chosen to address the earthquake and hydrogeological hazards, which are two criticalities for Italy. These two natural hazards occur directly in the geosphere.

Earthquakes and hydrogeological hazards are two criticalities for Italy.

NATURAL HAZARDS

Natural events that can turn into hazards are grouped into two main categories, based on their genetic mechanism: endogenous events, which are related to the geodynamic activities of the lithosphere (e.g. volcanic eruptions, earthquakes), and exogenous events (e.g. floods, landslides, avalanches, etc.), which originate on the Earth's surface.

Natural events can be classed as either endogenous or exogenous.

Their intensity and frequency can vary considerably.

Some events occur suddenly and paroxysmally, while others happen slowly, over a prolonged period of time (such as subsidence or coastal erosion, for example). Both types of events, however, can be equally dangerous for human beings and their activities.

Natural hazards are primarily the result of processes that take place according to the dynamics of the geosphere.

Inappropriate land use and management can either amplify existing

However, we should also consider the mutual interaction between the natural phenomena and human-related activities and structures: it is often the case, in fact, that inappropriate land use and management can amplify existing environmental imbalances or trigger new ones.

environmental imbalances or trigger new ones.

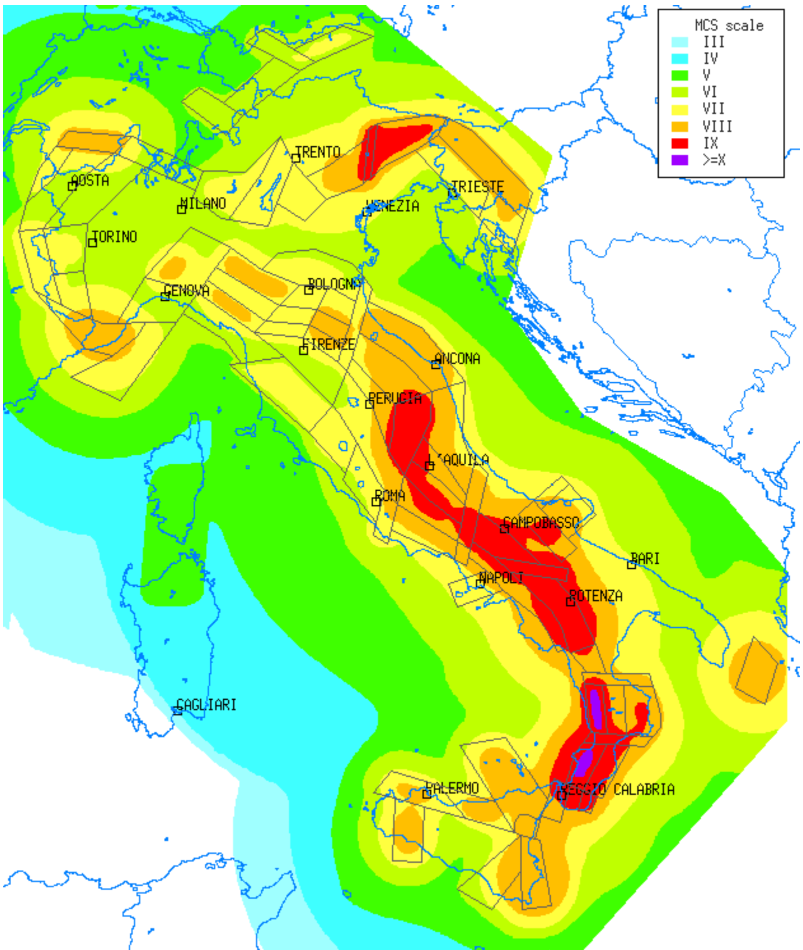
SEISMIC HAZARD

The current situation

The specific location of Italian territory within the Mediterranean geodynamic setting (convergence of the European and African plates, interposition of the Adriatic micro-plate, presence of the Alpine and Apennine chain, opening of the Tyrrhenian basin) make Italy one of the European countries facing the greatest seismic danger.

Italy is one of the European countries facing the greatest seismic danger.

The areas facing the greatest seismic hazard are found in the Friuli area, along the central-southern spine of the Apennine range and especially in the sectors of the inter-Apennine basin, along the Calabrian edge of the Tyrrhenian and in Southeast Sicily (Figure 9.1).



The map shows seismic hazard in terms of expected macroseismic intensity with turnaround times T = 475 anni.

Figure 9.1: Seismic hazard map of Italy[1].

These zones, in fact, are where the largest historic earthquakes in Italy occurred, which, as shown in Figure 9.2, sometimes reached a magnitude in excess of 7 in Calabria, eastern Sicily and the central-southern Apennines, and around 6.5 along the entire Apenninic chain and the eastern Alps.

[1] Source: Experimental Geophysical Observatory of Trieste. Document delivered to the Undersecretary of State for Civil Protection Coordination on 15.07.1996

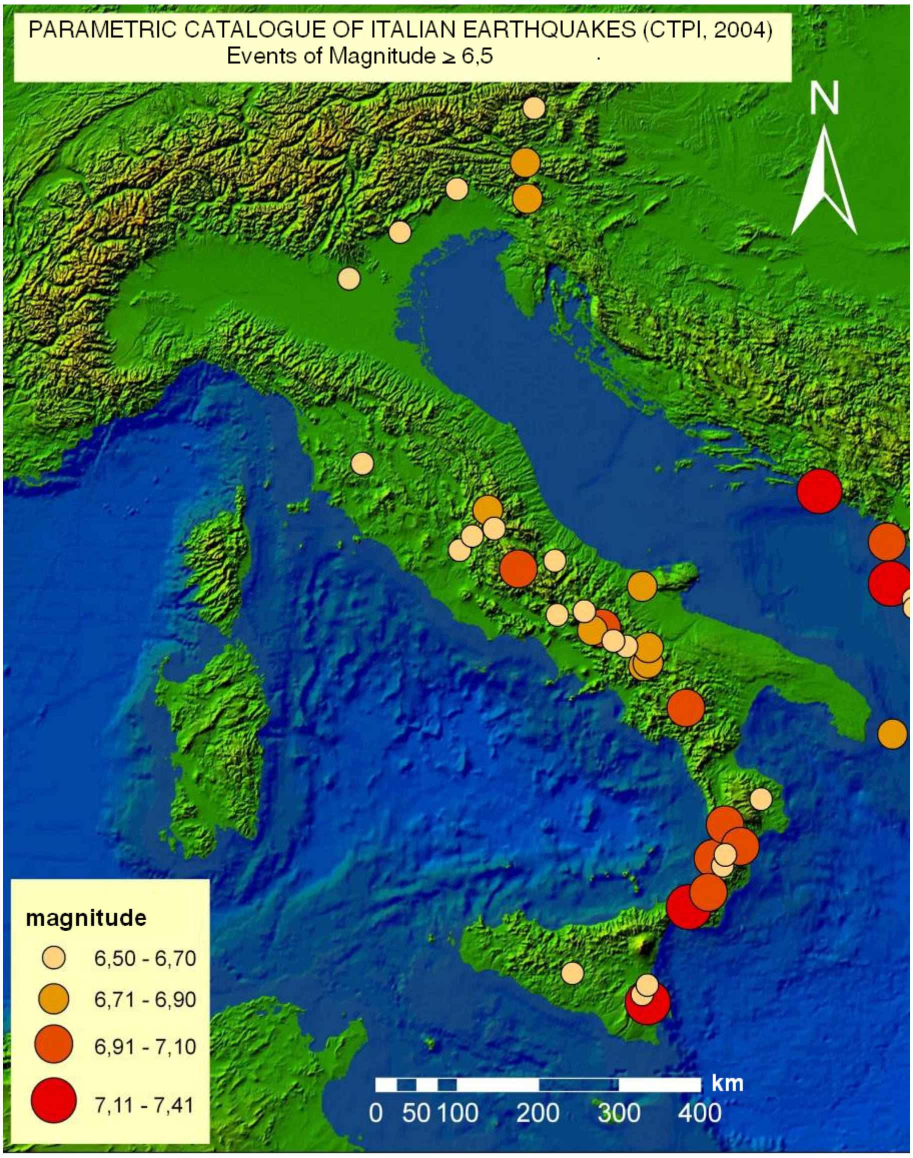


Figure 9.2: Nationwide distribution of the largest historical earthquakes in Italy (Local magnitude ≥ 6,5)[2].

Less intense earthquakes are also possible, albeit with very different probabilities, throughout the country. Earthquakes with a local magnitude of 2 or more, recorded in Italy between 1 October 2010 and 31 October 2011, are shown in Figure 9.3, which also shows the main features of Italian earthquakes of magnitude 4.7 or more. The instrumental seismicity recorded in this time interval is comparable – in terms of frequency and distribution – with that of the same period in the previous year. Over 2,000 earthquakes of magnitude 2 or more were also recorded, essentially distributed along the Apennine chain and, to a lesser extent, in the Alps as well. The highest frequency of earthquakes was recorded in the regions of Calabria, Abruzzo and Sicily. Several significant events also occurred in the Po Valley: in particular, a magnitude 4.7 earthquake in the Veneto part of the Po Valley, with hypocenter within the first ten kilometres of the crust. The epicenter was located between the provinces of Mantova and

[2] Source: Data from the Parametric Catalog of Italian earthquakes–INGV processed by ISPRA

Rovigo, although the shakes were also felt in the provinces of Padova, Vicenza, Verona and Ferrara. Generally speaking, only minor damage was reported. The most serious effects were recorded at Poggio Rusco (MN), with only limited damage to the parish church. The highest magnitude of 5.4 was produced by an earthquake located in the southern Tyrrhenian sea, with a very deep hypocenter, so deep as to be hardly felt on the surface. Overall, except for the Veneto Po Valley event, the earthquakes occurring in Italy in the period in question did not cause any significant damage, nor did they have any effects on the environment. Lastly, two major earthquakes of magnitude 4 and 4.7 were recorded at sea, opposite the western coast of Corsica (Figure 9.3), in an area thought to be tectonically stable, where events of such a magnitude are rather unusual.

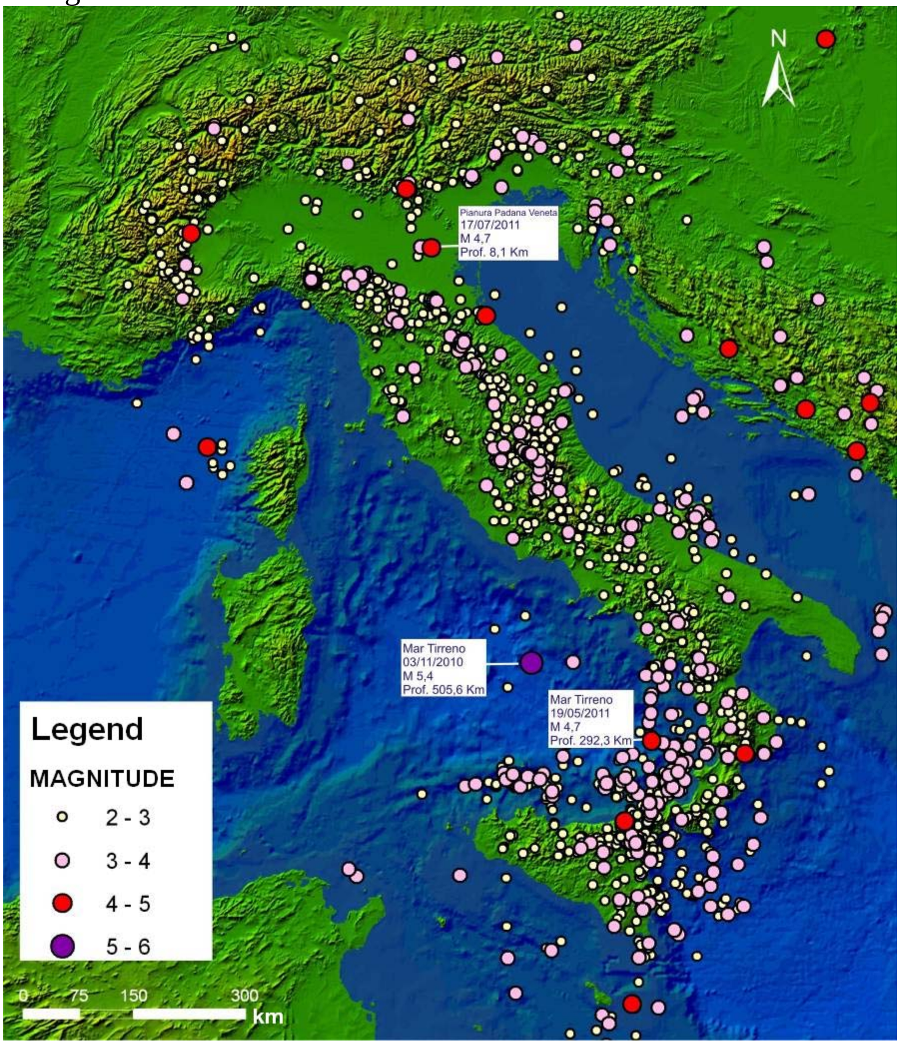


Figure 9.3: Distribution of earthquakes with a local magnitude of 2 or more, recorded between 1 October 2010 and 31 October 2011 and main characteristics of the events with a magnitude of 4.7 or more[3]

[3] Source: INGV data processed by ISPRA

Countermeasures

Seismic hazard can hardly be controlled, but its effects on the environment can be minimised by improving the vulnerability of buildings in earthquake-prone areas.

It is necessary to improve the vulnerability of buildings in seismic hazard areas.

A very useful tool for this purpose is the seismic hazard classification. This reflects the state of the art of seismic hazard knowledge in Italy.

Steps forward have been made since the Irpinia earthquake in 1980 and, more recently, after the Molise earthquake in 2002, following the issue of the Ordinance of the President of the Council of Ministers (OPCMs) n.3,274 of 20 March 2003 and 3,519 of 28 April 2006.

Currently, the blueprint for the project is the seismic hazard map of Italy developed by the INGV, the Italian Institute of Geophysics and Volcanology (Figure 9.4).

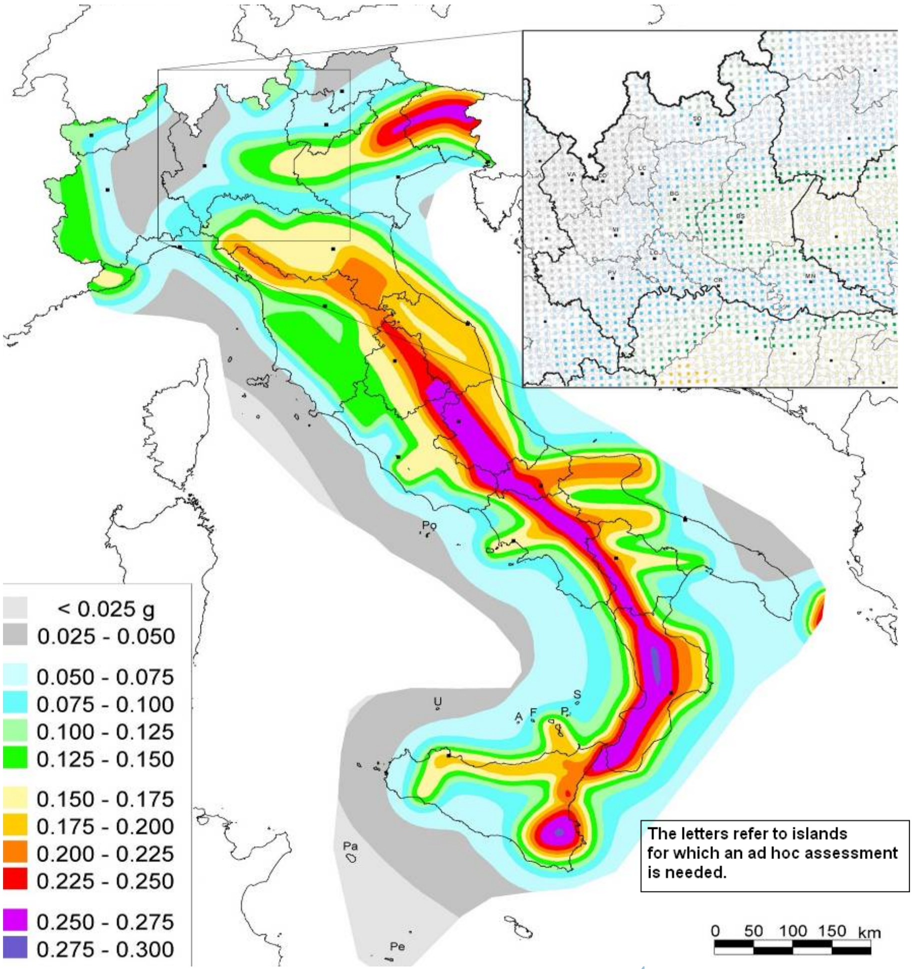
The Ordinance no. 3,519/2006 by the Civil Protection Authority sets out the seismic hazard zonation criteria at local level, according to the new approach whereby seismic zonation should be carried out based on the actual seismic hazard of a geographical area regardless of the administrative boundaries.

This new approach has been improved and integrated into the Technical Building Regulations issued on 14 January 2008 by the Ministry of Infrastructures, in partnership with the Civil Protection Department.

The seismic building design regulations set out in the Government ordinance of 14/1/08 refer directly to the INGV seismic hazard map.

The new regulations serve as a reference for seismic building design and construction, based directly on the so-called “basic seismic hazard”, i.e. the INGV seismic hazard map mentioned above (Figure 9.4).

This map provides the peak ground acceleration (ag) values for the grid points of a mesh the nodes of which are located at no more than 10 km from each other (0.05° mesh) for rates of exceedance in 50 year periods and/or different return periods (Tr).



The map shows seismic hazard in terms of peak ground acceleration (ag) with an exceedance likelihood of 10% in 50 years, referred to stiff soils (Vs30 > 800 m/s; cat. A, paragraph 3.2.1 of DM 14/09/2005). The ground accelerations values (ag) are provided for the grid points of a mesh the nodes of which are located at no more than 10 km from each other (0.05° mesh, see the example for the region of Lombardy in the box in the top RH corner).

Figure 9.4: Seismic hazard map of Italy (2004)[4]

Unfortunately, a large part of buildings in Italy fails to comply with the necessary seismic protection requirements, because historic buildings are rarely upgraded to the applicable requirements and because the large-scale post-World War II urbanization process developed haphazardly, without any serious urban and regional planning, and also due to widespread unauthorized but tolerated building.

The considerable vulnerability of the Italian building stock poses serious structural problems, the solution of which will require a great deal of time and the implementation of expensive nationwide improvement programs.

Moreover, since public funds are hardly sufficient for ensuring the seismic upgrading of the entire private building stock, it is necessary for ordinary people to start realizing that the seismic hazard is a concrete hazard and to therefore take the necessary actions, within each person's means, of course.

Increased awareness of the seismic hazard could become, in the best of cases, a deterrent to illegal building, which, as a rule, does not provide for the use of seismic protection techniques.

In any case, heightening awareness about this issue would inevitably lead to good results.

[4] Source: Government Ordinance no. 3519 of 28 April 2006, Schedule 1b Nationwide seismic hazard.

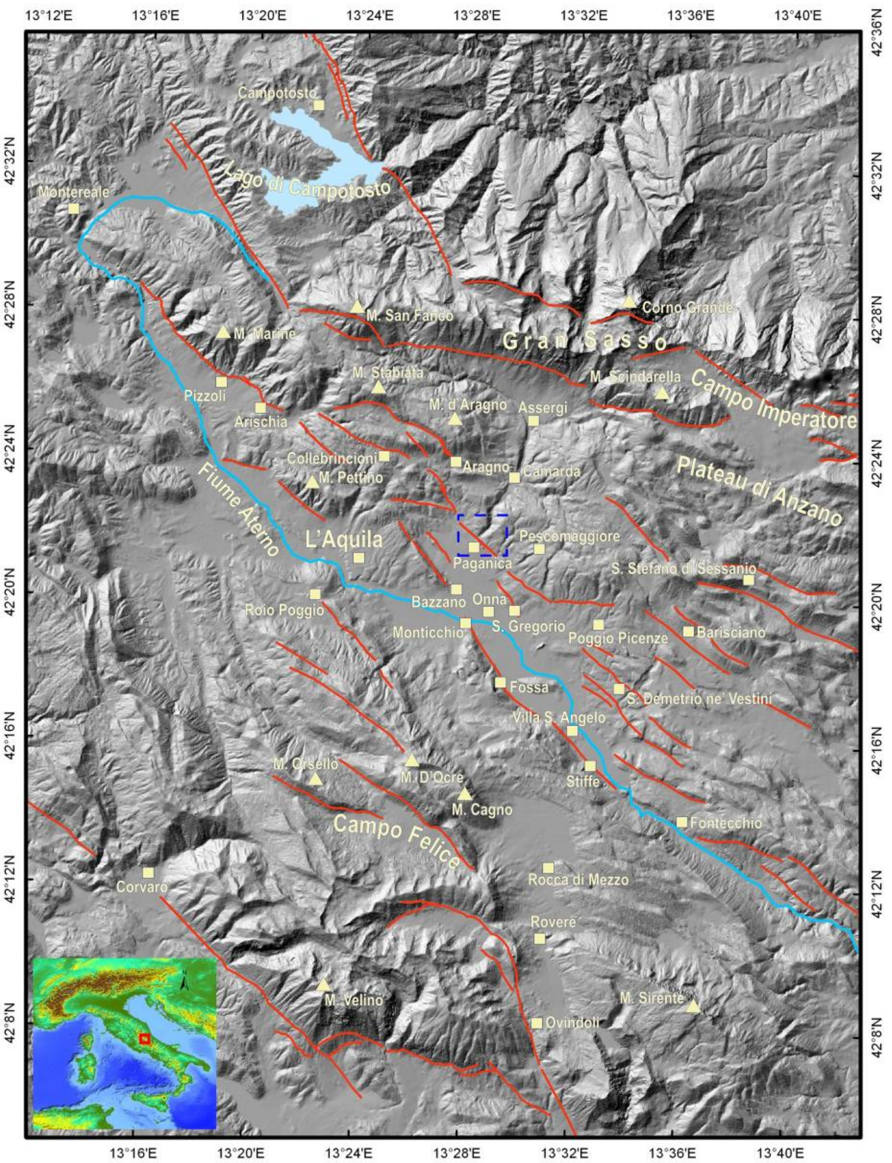
We do have a number of fact finding instruments for assessing the vulnerability of buildings. There are studies on the vulnerability of public buildings by the local and regional authorities and by the Civil Protection Department (e.g., one conducted in 1999: Census on the vulnerability of public, strategic and special buildings in the regions of Abruzzo, Basilicata, Calabria, Campania, Molise, Apulia and Sicily), which should be effectively taken into account by the authorities to ensure the safety of the general public.

To date, seismic hazard assessments have been carried out based on the potential effects on buildings of shaking, while the effects of surface dislocation produced by the activation of seismogenic structures are not explicitly taken into account by the seismic safety regulations.

This topic has been tackled in the Environmental Data Yearbook for several years now, through two dedicated indicators: “Surface faulting (capable faults)” and “Surface faulting index in urban areas”.

In Italy, in fact, a large number of capable faults have been detected, which – according to the definition by the IAEA (International Atomic Energy Agency) – are faults that, in the event of a strong or even only moderate earthquake, can produce significant deformation and/or dislocation (surface rupture) on or in the proximity of the earth’s surface in the near future (IAEA, 2003).

Mapping and cataloging these faults is an important measure for ensuring protection from surface fracturing. The information relating to these faults, including their attitude, geometry, kinematics, associated earthquakes and mean deformation rate, is all collected in a catalog (ITHACA-*ITaly HAzard from CApable faults*) managed by the ISPRA, comprising a constantly updated database and detailed GIS maps (Figure 9.5).



During the earthquake of 6 April 2009, the surface reactivation of the Paganica fault (shown in the map inside the blue dotted-line box) caused the Gran Sasso aqueduct to break.

Figure 9.5: Capable fault map of the part of the region of Abruzzo struck by the earthquake of 6 April 2009 of moment magnitude Mw 6.3[5]

In Italy, following the implementation into national law of the European earthquake resistance regulations (Eurocode 8), there is the obligation that certain types of sites at hazard and/or of strategic importance "*must not be built in the proximity of faults recognised as seismically active by the official documents published by the competent domestic authorities*" (Par. 4.1.1).

[5] Source: ISPRA

In Sicily alone, in particular in the surroundings of Mount Etna, where surface faulting is particularly widespread with a significant impact on buildings and infrastructures, the relevant urban and regional development plans provide for a series of restrictions in the proximity of capable faults.

In Sicily alone, in particular in the surroundings of Mount Etna, the relevant urban and regional development plans provide for a series of restrictions in the proximity of capable faults.

On the contrary, domestic legislation has failed to introduce any urban and regional planning instruments aimed at regulating construction in capable fault areas, unlike in other countries (California, Japan), which provide for no-build areas based on detailed studies.

However, the problem of surface faulting has recently been included in the “Guidelines and criteria for seismic microzoning” published by the Civil Protection Department in March 2009.

This document, which contains only non-binding guidelines, recommends the necessity of conducting detailed seismotectonic and paleoseismological studies (through the excavation and analysis of exploration trenches) for fault zone mapping purposes (main track and setback), at a scale of 1:5,000.

It is necessary for the future, in fact, to tackle the problem of the regulatory void on the subject of capable faults, to solve which specific urban and regional planning measures should be introduced aimed at limiting urbanisation in areas crossed by capable faults.

HYDROGEOLOGICAL HAZARD

The situation

Italy is particularly susceptible to hydrogeological disruption, due to both its geological and geomorphological peculiarities, and to the characteristics of its climate and weather.

Large-scale urbanisation, especially after World War II, has significantly increased this hazard and, therefore, its socio-economic impact, in terms of both casualties and damage.

Since 2002, ISPRA has launched an in-depth catalog of the principal floods occurring in Italy, collecting information on rainfall and the associated disasters, the number of persons involved and the emergency and other measures put into place to face the events and/or remedy the damage.

Since 2002, the ISPRA has launched an in-depth catalog of the principal floods occurring in Italy, collecting information on rainfall and the associated disasters, the number of persons involved and the emergency and other measures put into place to face the events and/or remedy the damage.

This edition of the Yearbook shows the hydrometeorological data relating to the floods occurring between September 2010 and December 2011, based on an analysis of the main technical reports published by the Regional Environmental Protection Agencies, the National Civil Protection Department, the Functional Centers and the Regional Agrometeorological Centers, and the information relating to the amount of people involved, the damage to the economy and the legislative measures introduced, mainly drawn from sources such as the ISTAT, CNR, DPC, CIA, MiPAF, press agencies. This information is given in detail in the fact-sheet of the "Flooding events" indicator contained in the Environmental Data Yearbook database (http://annuario.isprambiente.it).

In Italy, between 1951 and 2011, 1,511 people died as a result of the major floods.

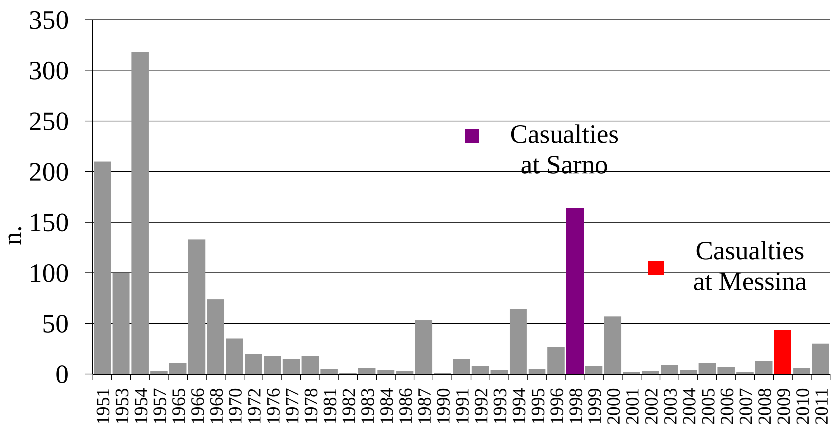


Figure 9.6: Casualties of the major floods in Italy, between 1951 and 2011[1]

Following is a short description of the major floods occurred between September 2010 and November 2011.

[1] Source: Data collected by Coldiretti; CIA, MiPAF, CNR; DPC, press agencies, Civil Protection Department, Benedini & Gisotti (1990) "Il dissesto idrogeologico", "Floods" directive 2007/60/EC, ISTAT (National Statistics Office) and processed by the ISPRA

31 October – 2 November 2010 – Veneto, Liguria, Emilia-Romagna, Tuscany: between Sunday 31 October and Tuesday 2 November bad weather affected first the region of Liguria, then the north eastern corner of Tuscany and finally the regions of Emilia-Romagna and Veneto.

31 October-2 November 2010: In north-east Tuscany, the maximum cumulative rainfall generally exceeded 100 mm.

In north east Tuscany, the maximum cumulative rainfall recorded during the 48 hours of the event generally exceeded 100 mm, reaching 352.8 mm at Boscolungo near the Abetone (in the Serchio river basin, a sub-basin of the river Lima).
Veneto was affected by persistent rainfall, turning into showers at times, especially in the Alpine foothills, where a total of 300 mm of rain were recorded, with local peaks in excess of 500 mm.
The event was due to an Atlantic system that gave rise to a large cyclonic circulation between the Ligurian and the Tyrrhenian Seas, determining an intense flow of hot and humid currents towards Veneto.
The situation caused widespread rain throughout the region, with two deaths.

8-10 November 2010 - Campania: starting on 7 November 2010 an intense flow of hot and humid unstable currents arrived in Italy, due to the deepening of an Atlantic depression towards the North African coastline. On Monday 8 November, the depression reached Italy. In the following days, the persistence of the southerly currents, loaded with the humidity acquired during their passage over the Tyrrhenian, determined a series of storms over Campania for the entire period in question, concentrated in the central-southern part of the region. The persistent rainfall caused the rivers Sele, Teglio, Tanagro, Sarno, Solofrana to break their banks, with widespread flooding in the province of Salerno, which caused one death and the interruption of the drinking water supply to 18 towns in the province of Salerno.

8-10 November 2010: the persistent rainfall caused the rivers Sele, Teglio, Tanagro, Sarno and Solofrana to break their banks, with widespread flooding in a number of areas in the province of Salerno.

21-25 December 2010 - Veneto, Liguria, Emilia-Romagna, Tuscany: this weather event primarily concerned northern Italy between 21 and 25 December 2010, especially the north-west of the country, hitting first Liguria and then slowly moving eastwards to Emilia-Romagna and Veneto. In the province of Belluno, approx. 325 mm of rainfall were recorded in 24 hours, while in the province of Lucca (Orto di Donna) the cumulative rainfall exceeded 380 mm. Regarding the Tuscan rivers, critical flooding occurred in the area of Pistoia, by the Ombrone river (especially in the downstream section). In Liguria there was localised flooding of roads, while in Emilia-Romagna (especially in the centre-west of the region) and Veneto (which had already been severely hit by the 1 November floods) numerous rural and urban areas were flooded.

1-3 March 2011 - Marche, Abruzzo: an area of low pressure centred over Sardinia, and fed high up by cold Arctic air, stationed between 28/02/2010 and 4/03/2011 on the lower Tyrrhenian causing two air masses to collide over Marche, a warmer and more humid one from the SE and a cold and dry one from NE, causing first storm surges along the coast followed by severe rainfall affecting the entire region of Marche and part of Abruzzo (in the province of Teramo, with 270 mm of rain falling in 24 hours). The abundant cumulative rainfall, due to the stationary nature of the system, determined widespread situations of hydrogeological criticality in all the areas concerned, with numerous floods and landslides and causing the death of 3 people.

15-16 March 2011 - Piemonte: the rainfall affected the region after a period of widespread rain, thus heightening its effects on the ground. The most rainfall fell in the Alpine foothills, with about 160 mm in 24 hours at Piano Audi-Corio (TO). The statistical analysis shows that the event was characterised by short return periods, below 10 years.

15-16 March 2011: about 160 mm of rain were recorded over 24 hours at Piano Audi-Corio (TO).

20 October 2011 - Rome: the capital was hit by several violent self-regenerating storms coming in from the Tyrrhenian, which discharged about 130 mm of rain between 6:30 and 8:30 am, equal to about double the rainfall that normally occurs in a month concentrated in the space of just over one and a half hours, with an interval of only 20 minutes. There was widespread flooding in certain areas, with many roads and underground railway stations closed: at the end of the day, one person had died and damage had been caused for over 2 million euros.

20 October 2011: violent rainstorms discharged about 130 mm of rain between 6:30 and 8:30 am over the city of Rome.

25-26 October 2011 - Lunigiana and Cinque Terre: in the night between 24 and 25 October, a storm system passing between eastern Liguria and north-western Tuscany, discharged huge amounts of rain. At Brugnato (SP) alone 472 mm fell in 6 hours. The most critical situation occurred at Aulla and Mulazzo (MS), where the river Magra broke its banks invading roads, squares, farmland and industrial plants. The town of Aulla (MS), in particular, was submerged by a 6-metre tall torrent of rainwater and mud. About fifty people whose homes had been flooded were rescued or evacuated. In the parallel streets connecting the motorway toll booth to the Matteotti district, the huge mass of water and mud swept away everything in its path, damaging over 400 vehicles and killing two people.

4 November 2011 - Genoa: at about 9 am the city of Genoa started to be hit by exceptional rainfall. Precipitations typically discharged by cumulonimbus clouds, which continued until about 2:30 pm. The rain gauges recorded over 400 mm of rain between 9:30 am and 2:30 pm, with peaks in the Rio Fereggiano river basin area. The greatest damage (Figure 9.7) occurred at the outlets of the smaller drainage basins, which channelled huge quantities of water, mud and debris (including tree trunks and boulders), which caused the death of six people.

4 November 2011: exceptional rainstorms hit Genoa. The rain gauges recorded over 400 mm of rain between 9:30 am and 2:30 pm, with peaks in the Rio Fereggiano area.

6 November 2011 - Isola d’Elba: the Island of Elba was affected by abundant rainfall. The weather station of Marina di Campo recorded 243 mm of rain, three times the monthly average for that location. The sudden heavy rainfall caused the Anzi ditch to break its banks killing one person.

The Genoa flood killed six people, all due to the flooding of the Rio Fereggiano.

Figure 9.7: Damage caused by the flooding of the Rio Fereggiano (Genoa)[2]

Regarding slope failure, Italy has been affected by over 486,000 landslides between 1116 and 2007, concerning 20,700 km^2 or 6.9% of the area of the entire country. Landslides are extremely widespread, due to geological reasons and the morphology of the country (75% of Italy is made up of mountains and hills) and are the most frequent natural disasters, causing the most casualties and damage to built-up areas, infrastructure, environmental, historical and cultural assets after earthquakes. A picture of how landslides are distributed across the country can be had by the so-called "landslide susceptibility index" (LSI), which is the ratio of the landslide area to the total area, calculated on a 1 km grid (Figure 9.8). This data comes from the IFFI Project (Inventory of Landslides in Italy), carried out by the ISPRA and the regions and autonomous provinces, for the purpose of identifying and bounding landslides, according to standard and common methods. The data relating to the regions of Basilicata, Calabria and Sicily are underestimated, compared to the actual disruption because, to date, landslide surveys tend to focus primarily on urban areas or on the main communication infrastructures.

In Italy, landslides are extremely widespread, due to geological reasons and the morphology of the country (75% of Italy is made up of mountains and hills).

The most common types of landslide, classified according to the type of predominant movement, are rotational/translational slides (32.4%), slow flows (15.6%), fast flows (14.5%) and complex movements (11.3%). Most landslides can be reactivated in time, often with periods of quiescence lasting several years, or even centuries, followed by remobilization, especially after heavy rainfall. Newly-formed landslides are most common in the case of fast movements, such as rock falls or mud and debris flows. Not all landslides are equally dangerous; the highest number of casualties and most damage are caused by fast-moving slides and those involving large volumes of rock or soil.

The most common types of landslide, classified according to the type of predominant movement, are rotational / translational slides (32.4%), slow flows (15.6%), fast flows (14.5%) and complex movements (11, 3%).

[2] Source: ISPRA

Italy has been affected by over 486,000 landslides, up to 2007, concerning 20,700 km2 or 6.9% of the area of the entire country.

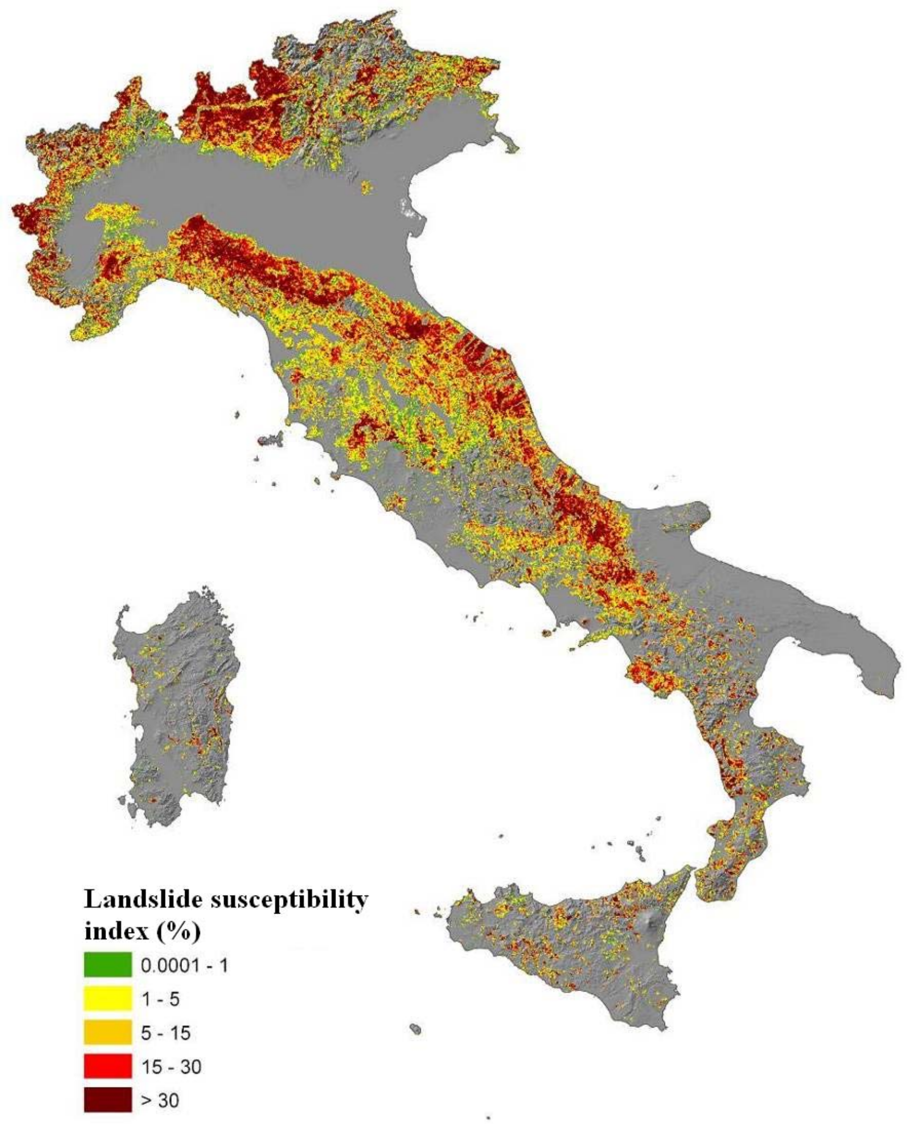


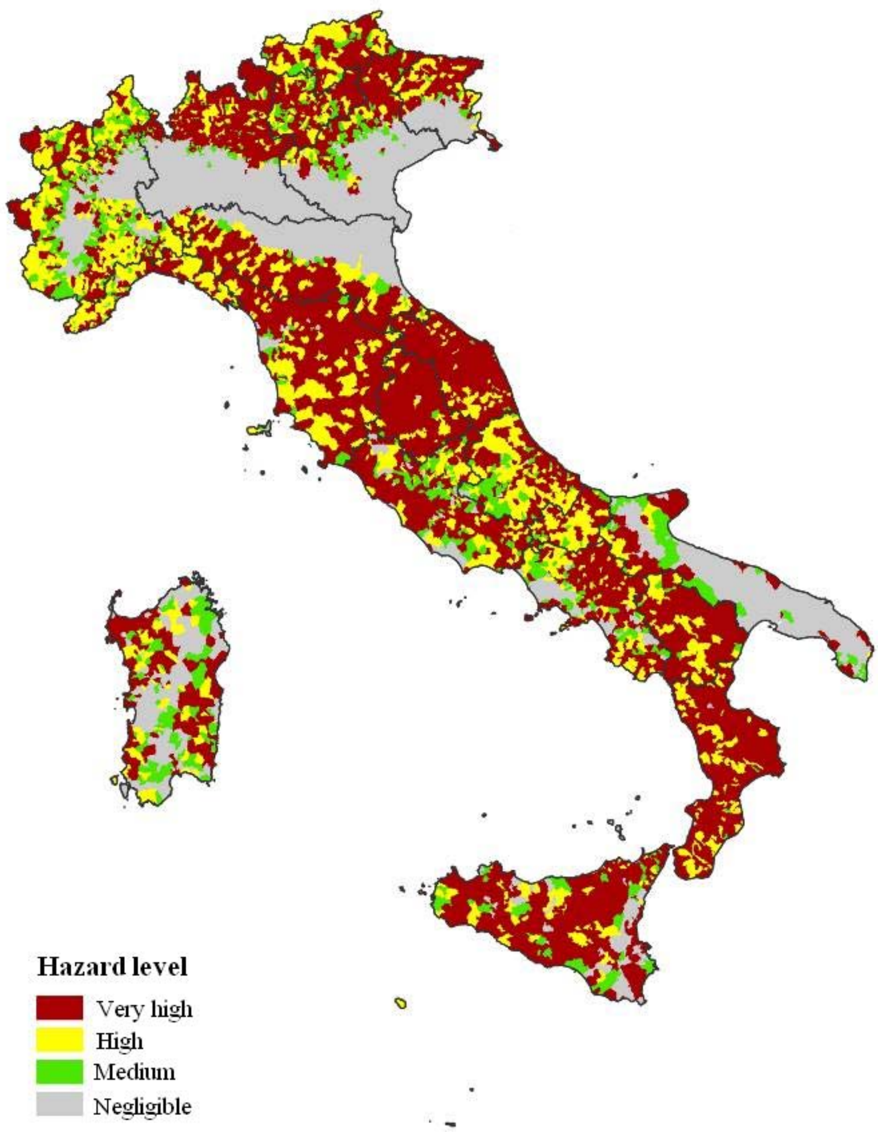
Figure 9.8: Landslide susceptibility index[3]

In order to carry out an initial assessment of the landslide hazard affecting Italy, the landslides surveyed in the IFFI project have been intersecated with the exposed elements (urban centres, infrastructure, etc.) taken from the Corine Land Cover.

At present, 5,708 Italian municipalities are affected by landslides, equal to 70.5% of the total: 2,940 have been classified as posing a very high hazard (landslides affecting continuous and discontinuous built-up areas, industrial or commercial facilities), 1,732 pose a high hazard (landslides affecting motorways, railways and roads, mines/quarries, landfills and construction sites) and 1,036 as posing a medium hazard (landslides affecting farmland, wooded areas and semi-natural environments, green urban areas and sports/leisure areas).

The remaining 2,393 Italian municipalities feature a small landslide hazard because no landslides have been surveyed there (Figure 9.9).

[3] Source: ISPRA



In Italy, 708 Italian municipalities are affected by landslides, equal to 70.5% of the total: 2,940 have been classified as posing a very high hazard, 1,732 a high hazard, and 1,036 a medium hazard. The remaining 2,393 Italian municipalities feature a small landslide hazard.

Figure 9.9: Landslide hazard level at municipal level [4]

A complete picture of the damage caused by landslides in Italy can be had from the AVI Project (Italian Vulnerated Areas), carried out by the CNR-GNDCI based on information collected from local newspapers, technical and scientific publications and interviews with soil protection experts.

In 1900-2002, landslide events caused 5,278 fatalities and missing persons, 2,216 injured persons and 162,300 evacuees and homeless persons.

Italy is one of the European countries most affected by landslides, along with the Alpine region countries, Norway and Turkey.

In Europe, a total of 712 thousand landslides have been surveyed, based on a 2010 study by the ISPRA and EuroGeoSurveys[5].

Having regard to the events occurring in Italy in 2011, the ISPRA, based on the information collected from newspapers and news

[4] Source: ISPRA

[5] *Mapping the impacts of natural hazards and technological accidents in Europe – An overview of the last decade*. EEA Technical report No 13/2010

agencies and the technical reports prepared by the regions and autonomous provinces, ARPA, Civil Protection Department, Functional Centers, CNR and local authorities, has surveyed 70 major landslides causing a total of 18 casualties, various injured persons, the evacuation of buildings and/or significant damage to urban areas and primary communication infrastructure (Figure 9.10).

In January-December 2011, the ISPRA surveyed 70 major landslides.

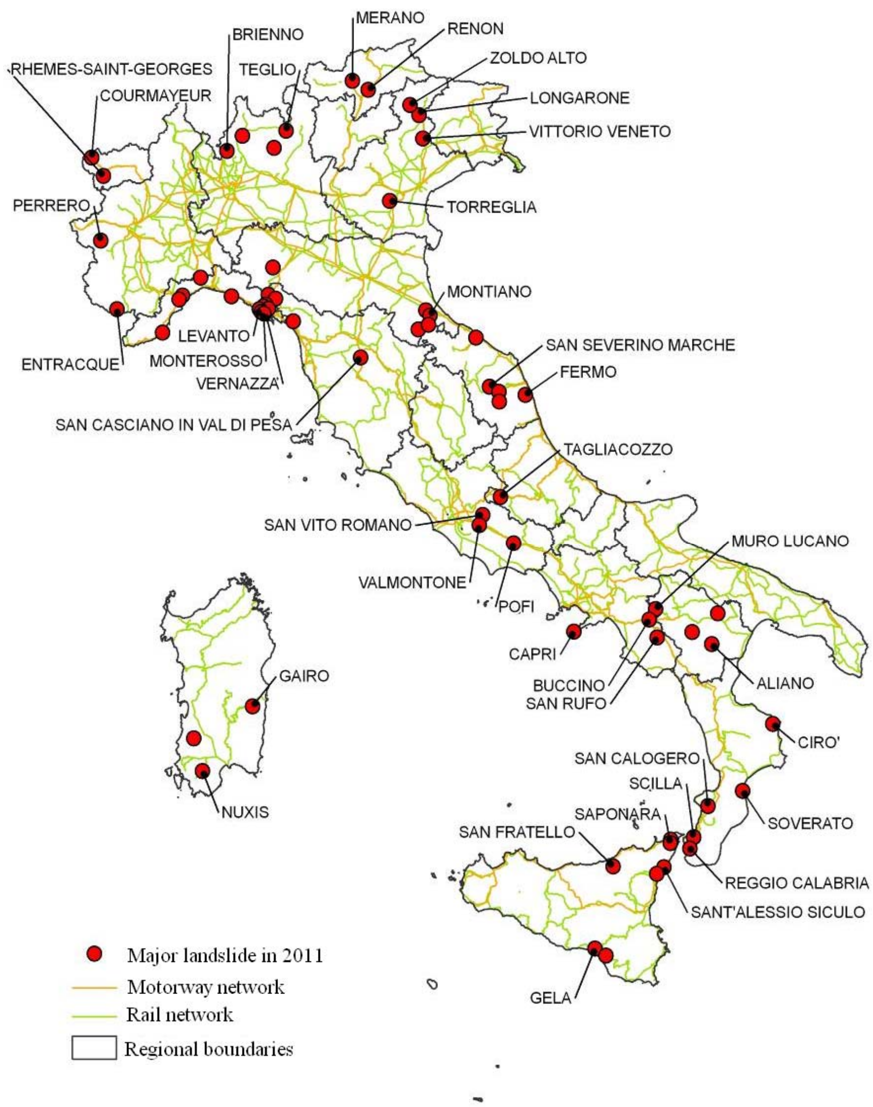


Figure 9.10: Major landslides occurring in January-December 2011[6]

Following is a short description of the major landslides.

March 18th 2011: a landslide of approx. 300 m^3 invaded the northbound carriageway of the A1 Milan–Naples motorway, at the 633 km point in the stretch between Ceprano and Frosinone, killing one person and injuring two.

July 7th 2011: multiple landslides formed on the slope above the western shore of Lake Como blocking the 340 Regina main road. The

[6] Source: ISPRA

town of Brienno was invaded by mud and debris. Several houses were damaged and a Medieval bridge destroyed. About a hundred people were evacuated. The landslides were triggered by strong rainfall associated with a whirlwind in the mid-upper area of the basins; the predisposing factors were steep slopes with a large amount of debris from the limestone mountains above.

Multiple landslides formed on the rocky slopes above the western shore of Lake Como affecting the town of Brienno with a flow of mud and debris.

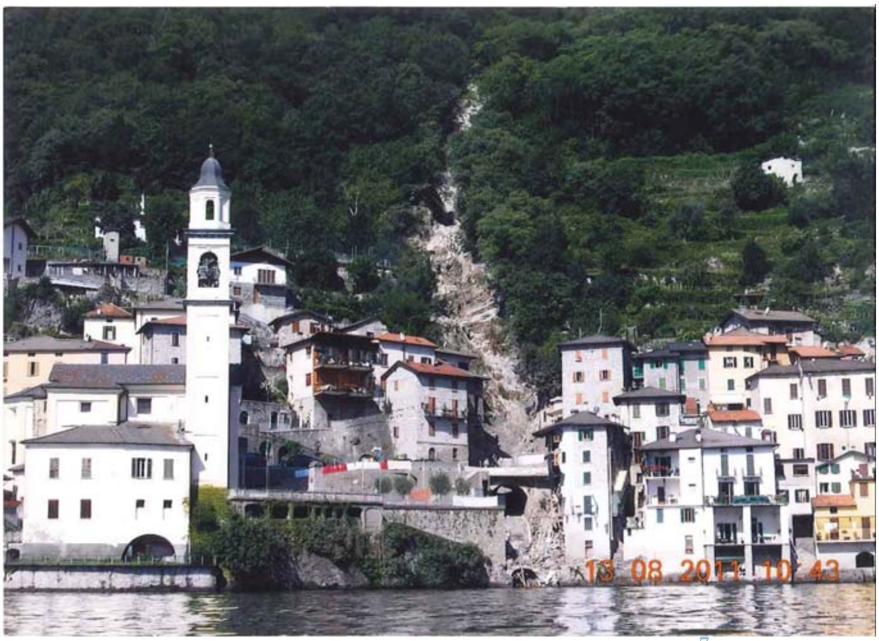


Figure 9.11: The debris flow in the town of Brienno[7]

August 31st 2011: a rock fall of over 2,500 m^3 at a height of approx. 2,900 metres on Monte Pelmo hit and killed two Alpine Rescue Team members of the Belluno Dolomites.

October 7th 2011: a debris flow from the northern portion of the Vadurso and Forcina drainage basins struck the village of Teglia, between the towns of Buccino and San Gregorio Magno (SA). About fifty homes were totally submerged by mud, debris and earth and the families evacuated.

The heavy, persistent and intense rainstorms triggered debris flows, which caused a number of deaths in the towns of Monterosso al Mare, Vernazza and Borghetto di Vara.

October 25th 2011: heavy, persistent and extremely intense rainfall fell on the Cinque Terre area, the Val di Vara (SP) and the Lunigiana (MS), with a maximum of 542 mm recorded throughout the event (lasting approx. 30 hours) by the ARPAL rain gauge located at Brugnato. The debris flows triggered by this intense rainfall caused one death at Monterosso al Mare, 3 at Vernazza and 4 at Borghetto di Vara. The A12 motorway was closed to traffic between Sestri Levante and Santo Stefano, due to a landslide that had submerged a passing lorry. The Aurelia main road was blocked at various points and train traffic was stopped in both directions between the towns of Levanto and Corniglia, due to a landslide with a front of approx. 2 km. The Cinque Terre towns, all characterized by basins with very short concentration times and steep slopes, which generally drop directly into the sea, sustained enormous damage (Figure 9.12 to 9.15). At Vernazza over 2 million cubic metres of earth and debris flowed down the valley submerging the town’s main street, beneath which runs the

[7] Source: (http://www.comune.brienno.co.it/)

Vernazzola stream, covered over and running beneath the street in an underground tunnel, with approx. 3-4 metres of material. 580 people were evacuated by boat from Vernazza, Monterosso and Levanto.

At Vernazza, the mud and debris reached the first floor of the buildings.

Figure 9.12: The center of Vernazza submerged by mud and debris[8]

The Vernazzola torrent broke its banks conveying a river of mud and debris towards the sea.

Figure 9.13: Houses submerged by debris along the Vernazzola torrent[9]

[8] Source: (http://www.protezionecivile.gov.it)

The events of 25 October 2011 caused considerable damage to the towns of Vernazza and Monterosso.

Figure 9.14: Damage to the parking area uphill from the town of Vernazza (SP)[10]

Figure 9.15: Damage to the paving of via Roma (at Monterosso al Mare - SP), beneath which runs the Pastanelli canal[11]

[9] Source: ISPRA
[10] Source: ISPRA
[11] *Ibidem*

The Civil Protection authorities of the autonomous region of Friuli-Venezia Giulia have carried out the helicopter-based aerial mapping and Lidar survey of the area of the province of La Spezia hit by the flood of 25 October, with an area of almost 200 km^2. The data analysis has made it possible to identify the landslides and highlight the areas affected by erosion and the accumulation of debris, by means of a differential comparison between the post-event Lidar survey and the surveys carried out in the previous years. About 300 landslides were identified in the area of Vernazza alone, and more than 170 at Monterosso. The resulting landslide density is 25 landslides per km^2 at Vernazza and 16 per km^2 at Monterosso al Mare. Over 1,000 landslides have been recorded in 100 square kilometres, amounting to about half the area affected by the event.

About 300 landslides have been surveyed in the area of Vernazza and over 170 at Monterosso.

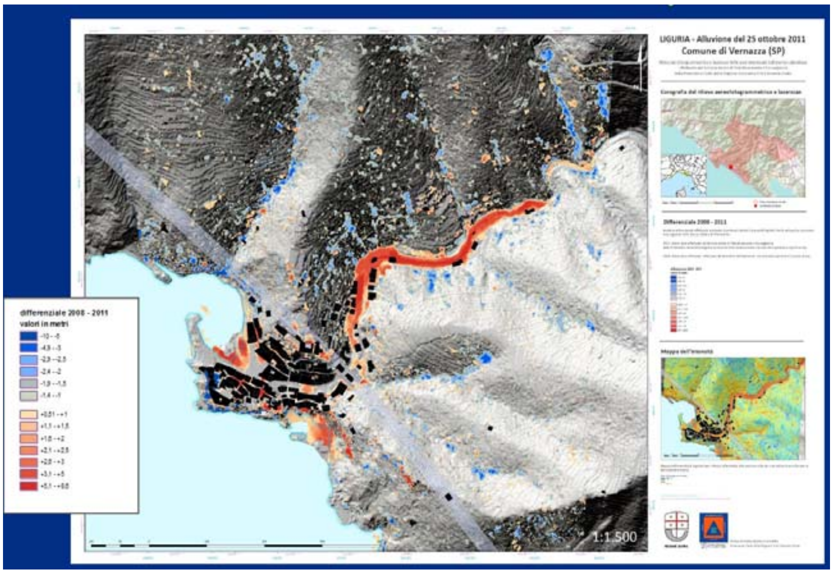


Figure 9.16: Map of the areas affected by erosion and the accumulation of debris in the municipality of Vernazza[12]

November 22nd 2011: intense and persistent rainfall affected the Tyrrhenian coastline of the province of Messina and the region of Calabria, with an hourly rainfall in the region of 60-100 mm and cumulative values of around 150 mm. During the night, at Scarcelli near Saponara (ME), a debris flow hit several houses causing three deaths.

The causes

Italy's vulnerability to hydrogeological hazard depends on the weather, water drainage and slope management and human activities.

Italy is decidedly vulnerable to certain natural events, when they exceed a threshold of intensity. In particular, a hydrogeological hazard can be triggered by the weather and drainage conditions in certain areas, also featuring a hilly or mountainous terrain with unstable soil and rock formations, which can be worsened by environmentally unfriendly human activities. Natural events are continuously changing the existing balance, through either *structural* – also called predisposing – causes, such as the lie of the land and the general geology of a certain area, or *occasional* – also called triggering – causes, such as the climate or human-based activities, which lead to situations of environmental

[12] Source: (http://www.protezionecivile.fvg.it)

instability and, eventually, disruption.
The natural environment is dynamic and changeable and cannot be pigeonholed into simple models. The physical mechanisms that regulate the triggering and evolution of critical "hydrogeological events" are extremely complex and very non-linear. The connection between rainfall and landslides or flooding is influenced, in fact, by numerous factors that can determine different outcomes from place to place, even in the presence of apparently similar circumstances.

Short and heavy rainfall and prolonged rainfall are the most important factors that can trigger slope instability, causing fast and shallow landslides or deeper landslides or mudflows, respectively.

Anthropic factors are becoming increasingly important among the causes of landslides.

Among the causes for hydrogeological disruption, human causes are becoming increasingly significant, due to environmentally unfriendly activities scarcely attentive to the delicate balance between geology, landforms and surface water drainage. The constant need for housing entails widespread urbanization, often invading the spaces that are necessary for natural processes and which, therefore, require special protection works, which are not always as effective as expected, aimed at restricting the evolution of the environment according to its specific natural dynamics.

For example, the abandonment of forest activities in hilly and mountainous areas, widespread wildfires and excessive urbanization and soil sealing in valley floor areas prevent rainwater from being absorbed into the ground and increase surface runoff. This leads to larger volumes of water being concentrated, even in the case of average rainfall. The fact that roads are not always built with adequate drains and gullies, the excavations, overloading and undersizing and the inadequacy of the water management works, and the failure to carry out routine and extraordinary land maintenance works are all important and, unfortunately, recurring causes of environmental disruption. In hilly and flat areas, the spreading of often intensive mono-cultivations in agriculture, entailing the flattening of uneven ground and the removal of trees, bushes and ditches, has increased soil erosion and surface runoff over the years, also increasing the amount of solid matter carried into rivers.

In hilly and flat areas, the spreading of often intensive mono-cultivations in agriculture, entailing the flattening of uneven ground and the removal of vegetation has increased soil erosion and surface runoff.

To increase the amount of cropland in flat areas, the course of rivers can be changed, straightened out to remove their natural meanders, destroying the alluvial vegetation and woodland, the purpose of which is to slow down floodwater and delay flooding.

Straightening out river meanders, in fact, leads to the overall shortening of the watercourse and the consequent speeding up of the water and its erosion capacity.

The use of former alluvial woodland for building, whether housing, infrastructure or industrial plants, reduces the cross-section of the watercourse, thus reducing its natural flood drainage capacity. On top of this, the uncontrolled dredging of sand and gravel from rivers, to be used as construction materials, has further lowered the minor bed of rivers causing the banks to become unstable, uncovering bridge pier foundations and reducing the supply of sediment to the coast.

The use of former alluvial woodland for building, whether housing, infrastructure or industrial plants and the uncontrolled dredging of sand and gravel from rivers has severe repercussions on the coastal systems,

The numerous artificial barrages built along watercourses can reduce damage by flooding downstream, but they also reduce the amount of sediment conveyed to sea, altering the natural balance of the coastal systems and inverting the beach widening trend that was the norm until several decades ago.

because the watercourses convey less and less sediment.

Buildings, by interfering with the natural life of the coastline, can trigger its erosion.

Figure 9.17: The effects of sea erosion on a sandy settled coastline (Capo d'Orlando – ME)[13]

Many coastal infrastructures, most of which have been designed regardless of the alterations produced by natural dynamics, cause important and gradual changes to the morphology of the coast.
In the case of a sandy coastline, alterations in the distribution of the sediments can significantly and rapidly change the previous outline, with huge ecological and socio-economic consequences; in cliffed coastlines, the interaction between the natural outline and human works can trigger erosion and thus upset cliff stability.
The correlation between increased hydrogeological hazard and climate change is the subect of questions that can hardly be answered according to a deterministic approach.
The regulations governing the preparation of future planning tools specifically refer to the assessment, in the different scenarios, of the effects of climate change, without however setting out any uniform assessment criteria.
Recent studies estimate that the factors underlying hydrogeological hazard in the last few years are primarily related to the increased vulnerability of land, due to the occupation of at-hazard areas with infrastructures and buildings.
Many recent disasters have been caused by heavy and persistent, albeit not exceptional, weather-related events: the current increase in surface water drainage-related hazards in flat-lying areas – meaning the likelihood that a flood will occur, in connection with a certain high water discharge – is directly related to the increased number and value of the elements exposed to the flooding.
In mountain environments (and especially in the Alps), new forms of disruption have appeared in recent years: events originating from the mobilization of masses of debris, rendered unstable as a result of the

Many recent disasters have been caused by heavy and persistent, albeit not exceptional, weather-related event..

New forms of disruption have

[13] Source: ISPRA

thawing of permafrost soils, are gradually increasing.

occurred in recent years in mountain environments, especially the Alps.

The consequences are an increased frequency and extension of gravitational slope deformations (debris flows and rock falls) and a diverse spatial distribution of these events, at lower heights than used to be the case historically.

New extremely hazardous situations, resulting from global warming, are related to the formation of small lakes inside the glaciers, which can break through the natural ice barriers and pose a very serious hazard further down the Alpine valleys.

The solutions

Land use management should become one of the cornerstones of environmental policies, in order to ensure suitable quality of life for people, aiming at achieving the "sustainable development", which is currently at the basis of domestic and community policies.

Within the field of land use management, soil protection issues are becoming increasingly important, a fact that is proved by the recent environmental disasters that have struck Italy.

Therefore, effective urban planning, taking natural hazards into due account (from the effects of seismic shaking to those triggered by intense weather events), must increasingly become a key component of policy and administrative decisions.

The mitigation of surface water drainage and landslide hazard conditions can be achieved through attentive land use management, combined with adequate forecasting and prevention.

The mitigation of surface water drainage and landslide hazard conditions can be achieved through attentive land use management, combined with adequate forecasting and prevention, which should become routine instead of being limited to the post-emergency phase.

Scenarios – i.e. projected disastrous events or situations – are expressed in terms of probability.

With regard to gravitational deformations, forecasting includes a fact-finding phase, aimed at surveying, collecting and updating information on landslides, monitoring gravitational movements, through ground and satellite telemeasurement networks, identifying landslide-prone areas and simulating event scenarios.

With regard to flooding, forecasts should include hydrological (rainfall modelling based on return periods and rainfall-runoff models) and hydraulic (analysis of how the flood wave evolves in the watercourse on the basis of hydrometric levels).

If the flood wave is larger than the watercourse's maximum drainage capacity, the watercourse will inevitably break its banks and flood any areas at hazard.

Flooding-prone areas are identified and bordered based on hydraulic models, which set out different scenarios based on the likelihood of a certain event occurring (return period).

More likely – and therefore more statistically frequent – scenarios are associated with greater hazard conditions, and vice versa.

Knowledge of flooding dynamics is a prerequisite for selecting and dimensioning effective prevention measures, capable of mitigating and minimizing the hazard level of an event or the vulnerability of any assets exposed to it.

Prevention includes the set of actions and activities aimed at

Prevention, in fact, means the set of actions and activities aimed at minimizing damage, consisting in any structural and/or non-structural measures that can significantly reduce the destructive power of a disastrous event. Structural prevention measures include the geological and hydraulic engineering works implemented in the very frequent cases in which the introduction of stringent land use and building restrictions is of little or no use, because the area concerned has already been more or less heavily urbanized. These measures obviously entail huge investments, the size of which is generally proportional to the hazard level. Unfortunately, due to the scarcity of funds for large-scale engineering works, it is often the case that temporary quick-fix solutions are put into place, to address an imminent and more dangerous hazard, because it is not possible to carry out thorough long-term solutions because of their cost, of the complexity of the conditions at the root of the hazard and, more and more frequently, due to the actual lack of space for the engineering works.

reducing the likelihood of occurrence of potentially destructive events and limiting damage.

Figure 9.18: Structural engineering measures (rockfall prevention screens) for mitigating hydrogeological hazards at Fontanelice (BO)[14]

Structural prevention measures include the geological and hydraulic engineering works implemented in the very frequent cases in which the introduction of stringent land use and building restrictions is of little or no use, because the area concerned has already been more or less heavily urbanized.

[14] Source: ISPRA

For all these reasons, the role of non-structural measures has become of primary importance. They are effective because, by regulating land use in connection with regional planning, they can significantly reduce the number – and, indeed, the value – of any assets exposed to hazard, therefore limited the expected damage from a hazard event. Besides blocking the number of at-hazard situations in hazard-prone areas, by introducing restrictive land use and building regulations, they can also mitigate hazards by activating ad hoc policies (of an agricultural or forestry-related nature, for example) or practical actions (for example, the use of existing water reservoirs for flood control).

Non-structural measures can effectively reduce the amount of assets exposed to hazard.

Very useful tools for protection against natural disasters are emergency planning (normal, pre-alert, alert, pre-alarm, alarm, emergency), information and training, with respect to the various types of hazards and hazard management. Reducing hazards to zero, in fact, is wishful thinking; therefore, the only practicable course of action, where necessary, is to enhance hazard awareness among the general public, making it an active part of emergency management, by adopting a suitable behaviour for protecting one's safety.

Enhancing hazard awareness can play a key role in protecting public safety.

To date, soil protection policies, in Italy, are governed by Legislative Decree 152/06 laying down environmental regulations, as amended and supplemented, the aim of which is to protect and, if necessary, remediate the soil and subsoil, provide hydrological and geological management guidelines and lay down provisions for the safety upgrading of at-hazard situations. Regarding areas affected by serious hydrogeological deterioration, the reference legislation is Law 183/89 laying down "Rules for the reorganization and functional improvement of soil protection", and DL 180/98 (called the "Sarno Decree", converted into Law 267/98), enacted in 1998 after the Sarno disaster (Campania) and then supplemented with additional related legislation.

River basin planning (introduced in Italy by Law 183/89) is the main technical and regulatory tool for land management and soil protection policies. In particular, it is the land-use planning tool ranking above the regional, provincial and local levels, with specific reference to soil protection and water management.

River basin planning is the main technical and regulatory tool for land management and soil protection policies.

These regulations make it possible and, indeed, a duty, to develop and implement regional land and water management guidelines and plans focusing on the integrated management of river basins and on use planning, actions and regulations aimed at achieving soil conservation, protection and improvement.

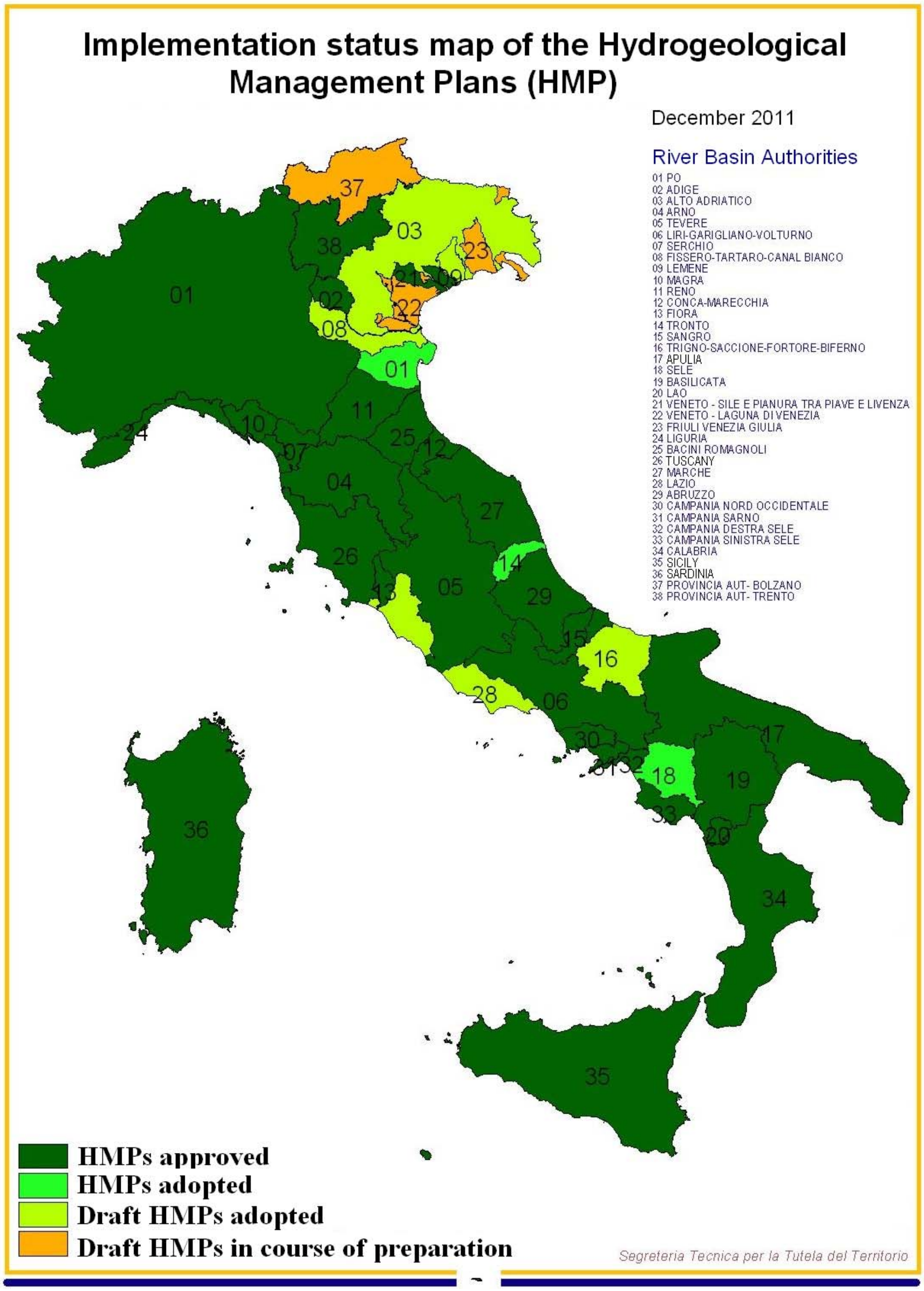
River basin plans comprise separate sectoral plans, including the Hydrogeological Management Plans (HMPs), which concern specific soil protection issues, hydrogeological hazard mitigation and public safety. The Hydrogeological Management Plan is a fact-finding, plannning and operational tool for preventing hydrogeological hazards.

Hydrogeological Management Plans are fact-finding, plannning and operational tools for the prevention of hydrogeological hazards.

Due to its very nature, HMPs are dynamic and constantly updated tools for integrating, at river basin level, the multiple protection instruments relating to the environment (geomorphological dynamics and weather and climate features) and regional planning (urbanization and land use). By providing for the development of ad hoc regulations aimed, inter alia, at preventing damage caused by hydrogeological disasters and overhauling hydrogeological restrictions, HMPs regulate the actions for the geomorphological and hydrogeological protection of land and river basins, in a certain region or area, by identifying the general guidelines and course of action for water management and geomorphological improvement.

The HMPs, which, to date, cover almost all the country, are developed based on guidelines established in central coordination standards (DPCM of September 29, 1998 laying down *"Guidelines and coordination principles for identifying the criteria relating to the obligations referred to in 'Article 1, paragraphs 1 and 2, of Decree Law 180/98"*), issued for the purpose of pursuing hazard mitigation objectives through the nationwide application of standard criteria and procedures.

To date, HMPs have been put into place covering almost the entire country, based at times on different methods, with a view to best adapting to the specific physiographical characteristics of the various basins, for defining detailed and accurate scenarios and bounding the hazard-prone areas.



To date, HMPs have been approved covering almost the entire country.

Figure 9.19: Implementation status map of the Hydrogeological Management Plans (2011)[15]

The effectiveness of the models applied and the forecasts set out in the HMPs has been confirmed, many times, ex post, by the reports relating to the occurrence of natural disasters. With regard to geomorphological criticalities, besides the different methods of assessment of potentially unstable areas, which makes it hard to effectively bound them, based on proneness to deterioration, there are also differences in respect of hazard determination, because of the use of different type analyses, as a result of which, at times, the results achieved cannot be directly compared.

HMPs mostly provide for the use of positional indexes to determine specific

An interesting fact, nevertheless, is the use of procedures providing for positional indexes to determine specific hazards, by compiling tables featuring the type and intensity of the hazard, the classes of assets at

[15] Source: MATTM-Segreteria Tecnica per la Tutela del Territorio

hazard and their vulnerability. The resulting assessment, however, still features a prevalence of the quality aspects.

hazards, featuring the type and intensity of the hazard.

Regarding the water drainage hazard, examples of defective uniformity are the different hydrological (probability analyses, distributed parameters, etc.) and hydraulic (mono- and bi-dimensional) models used by the single River Basin Authorities to forecast flood discharges, identified among the various patterns known in the literature, or specifically developed for the basin, or even resulting from the combination of two or more models.

However, it should be noted that the “best” model does not exist; each model is selected based on the characteristics of the basin in question.

Moreover, the HMPs often feature (at times significant) differences in the return periods used to outline flood scenarios and the criteria used to define the hydraulic hazard levels.

In short, we can acknowledge the effectiveness of the HMPs, with respect to its fact-finding aspects, including the identification, bounding and classification of hazard-prone and at-hazard areas, in relation to the seriousness of the expected event and the value of the assets exposed to it.

Based on a significant preliminary survey, we can then build structural and non-structural action plans for mitigating the hazard, at the same time structuring and applying rules and guidelines for regulating land use, aimed at preventing urbanization from increasing the hazard in hazard-prone areas.

This should be integrated with the Civil Protection plans, for dealing with both emergencies (nationwide, regional and local civil protection system) and prevention (enhancement of hazard awareness and emergency behaviour among the general public).

Moving on to the further river basin management activities, and their recent developments, implementing Directive 2000/60/EC, and awaiting the establishment of the River Basin District Authorities, provided for in Legislative Decree 152/06, the national River Basin Authorities have received the task of coordinating the drafting of the water Management Plans within the river basin districts into which the country has been divided.

These plans are essentially qualitative water management plans, but it is obvious that the future developments in the activities relating to the river basin districts will naturally lead to the comparison and standardization of the aspects strictly related to geomorphological and hydraulic hazards.

In view of the mitigation of hydrogeological hazard, structural works have been planned and financed, nationwide, in the areas most prone to the hazard identified by the HMPs.

These are urgent projects located in areas where higher land vulnerability combines with increased hazard levels for the local population, property and the environmental heritage (high R3 and very high R4 hazard areas).

A further hydrogeological hazard mitigation tool is the planning and financing of actions for the construction of structural engineering works

In this regard, the Ministry of the Environment financed, between 1999 and 2009, 3,460 urgent projects for mitigating geological and hydraulic hazard totalling more than 2.8 billion euros, pursuant to DL 180/98, and subsequent related legislation.

Since 2010, following the conclusion of Programme Agreements (PA) between the Ministry of the Environment and the regional authorities, urgent and priority action plans have been defined, in partnership with the River Basin Authorities, the Civil Protection Department and the ISPRA, for mitigating hydrogeological hazard.

in at-hazard areas.

At Community level, hazard assessment and management policies refer to Direttiva 2007/60/CE of 23 October 2007.

The so-called "Flood Directive" aims at minimizing the damaging effects of floods, which are becoming more and more frequent as a result of climate change, by implementing common transborder protection measures against flooding.

The so-called "Flood Directive" aims at the minimizing the damaging effects of floods, by implementing common transborder protection measures against flooding

The directive provides for a multiple-pronged approach, which includes a preliminary assessment of the flood hazard, flood hazard mapping and the preparation of flood hazard management plans in flood threatened areas implementing prevention and protection actions.

In order to comply with the European directive, the River Basin Authorities make use, first and foremost, of the information collected and set out in the HMPs, as tools for defining the flood hazard and hazard scenarios; the next steps are to integrate the HMPs and the hazard management plans, the objectives and contents of which should conform to the guidelines set out in the directive.

As highlighted above, the dissemination of information on environmental deterioration (triggering landslides and flooding) to the central and local government authorities and the general public is very important for hazard prevention purposes.

The dissemination of information on environmental deterioration to the central and local government authorities and the general public is very important for hazard prevention purposes.

Public information, in fact, heightens awareness of the hazards affecting a certain area and of the behaviour that needs to be put into place before, during and after the event.

Therefore, the ISPRA has developed an online consulting service of the IFFI Project maps (www.sinanet.isprambiente.it/progettoiffi) and the relevant database, for finding information on landslides and viewing documents, pictures and videos (Figure 9.20).

Another activity by the ISPRA, which it has been conducting since 2000, is monitoring the actions financed under DL 180/98, as amended and supplemented, the relevant data of which is filed with the ReNDiS, which is the acronym of *Repertorio Nazionale degli interventi per la Difesa del Suolo*, i.e. the National Repertory of Soil Protection Projects.

The aim of the ReNDiS is to provide a standard, and systematically updated, picture of the soil protection works carried out and resources employed, which is available to all the local and central government entities and authorities responsible for planning and implementing the projects.

The ReNDiS, therefore, can be viewed as a knowledge enhancement tool, potentially capable of improving the coordination of and, therefore, optimising spending for soil protection.

By publishing the relevant data (Figure 9.21), the Repertory aims at meeting the "transparency" needs of Government, in the field of soil protection.

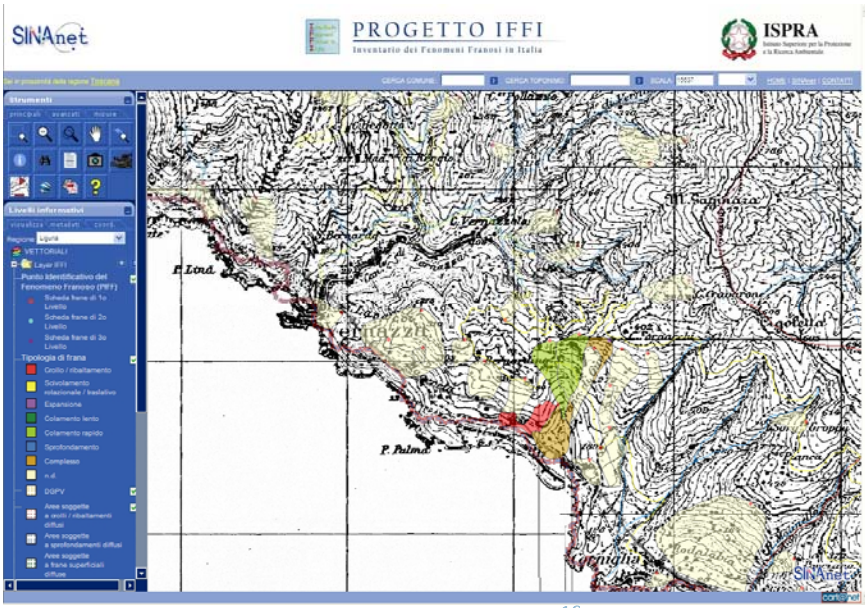


Figure 9.20: WebGIS of the IFFI Project[16]

The ISPRA has developed an online consulting service of the IFFI Project maps and of the monitoring of the actions financed under the so-called "Sarno Decree" (ReNDiS).

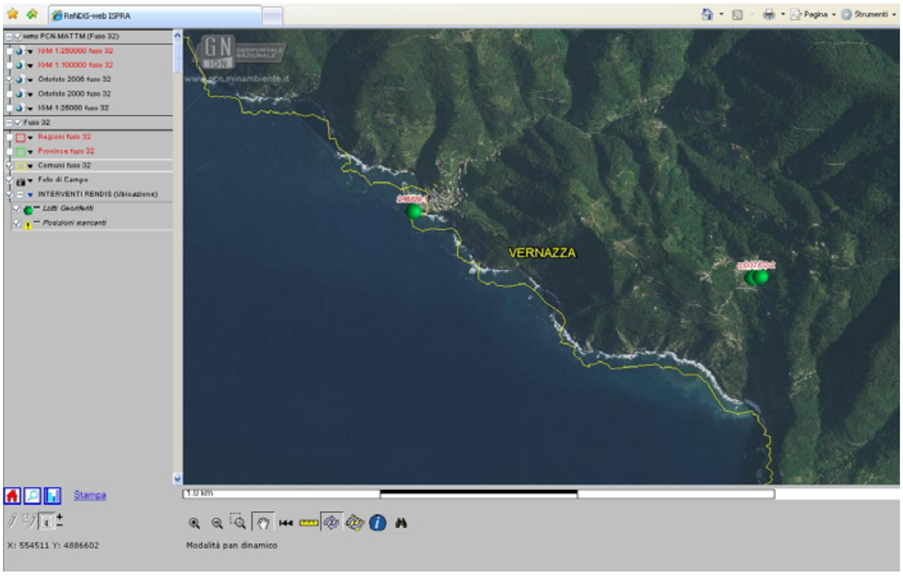


Figure 9.21: Web page of the National Repertory of Soil Protection Projects[17]

[16] Source: ISPRA
[17] *Ibidem*

ANTHROPOGENIC HAZARD

Introduction

Anthropogenic - or man-made - hazard means the (direct or indirect) hazards to human life and the environment due to potentially hazardous human activities. This rather broad definition includes all (small, medium and large, processing and manufacturing) industrial plants), but above all those industrial plants that make use of hazardous substances and are likely to increase the hazard of a major accident (aka MAH plants).

In the 1980s, the European Community focused for the first time on plants posing major accident hazards, enacting a specific Directive 82/501/EEC (also known as the "Seveso Directive"), with a view to preventing, or at least reducing, the impact of any major accidents, and to better protect the public and the environment as a whole. The directive was implemented in Italy by DPR 175/1988.

The aim of the Seveso Directive is to minimize the hazard of any major accidents occurring.

The Seveso Directive has since been amended twice, by Directives 96/82/EC (Seveso II) and 2003/105/EC, transposed into Italian law by Legislative Decree 334/99 (*Implementing Directive 96/82/EC on the control of major-accident hazards involving dangerous substances*) and Legislative Decree 238/05 (*Implementing Directive 2003/105/EC amending Directive 96/82/EC on the control of major-accident hazards involving dangerous substances*).

Legislative Decree 334/99 sets out provisions aimed at preventing major accidents involving the presence of dangerous substances and/or limiting their consequences for human beings and the environment, applies to plants possessing potentially dangerous substances (for use in the production cycle or simply stored there), in quantities that exceed certain thresholds referred to in the Seveso Directive.

The typical feature of a plant likely to increase the hazard of a major accident (MAH) is the presence of large quantities of toxic substances.

The typical feature of an plant likely to increase the hazard of a major accident (MAH) is, therefore, the presence of large quantities of certain substances, because the use and/or possession of large quantities of substances which, by their nature, are classified as toxic and/or flammable and/or explosive and/or supporters of combustion and/or hazardous for the environment, can lead to the potential uncontrollable development of incidents posing a serious (immediate or deferred) danger to both human beings (inside or outside the plant) and the surrounding environment, due to:

- fire;
- explosion;
- emissions into the air and/or leakage into the ground of toxic substances for human beings and/or the environment.

In order to reduce the likelihood of the occurrence of accidents, the management of such plants must comply with specific requirements, including the upgrading to improve their safety, and the preparation of ad hoc technical and information documents, with high fines and even criminal consequences for the failure to comply. At the same time, the plants are also subject to specific controls and inspections by the competent public authorities.

Since it is practically impossible to entirely remove a hazard and, therefore, the potential occurrence of an accident, regardless of the type of industrial activity, the purpose of the Seveso Directive is to identify the potentially hazardous industrial plants and lay down measures thanks to which major accidents can be either prevented or their effects mitigated, so that the consequences will not be particularly serious.

The Seveso Directive has contributed to improving the safety and reliability of industrial plants classified as MAH.

The Seveso Directive, thanks to the compliance formalities required from the management of the plant and the supervisory authorities, has undoubtedly contributed to improving the safety and reliability of industrial plants classified as posing a "major accident hazard".

Nevertheless, in recent years a string of major accidents has occurred, in industrial plants in general and in those classified according to the Seveso regulations, as shown in Figure 9.22, showing the notices sent by the Member States to the European Commission following each the occurrence of a major accident.

The MARS (Major Accident Reporting System) system was created by the European Commission to collecte the data (provided by the Member States) on so-called "major" accidents and to form an information/exchange training system for the States, on the various aspected related to the historical experience of major accidents accrued by each one.

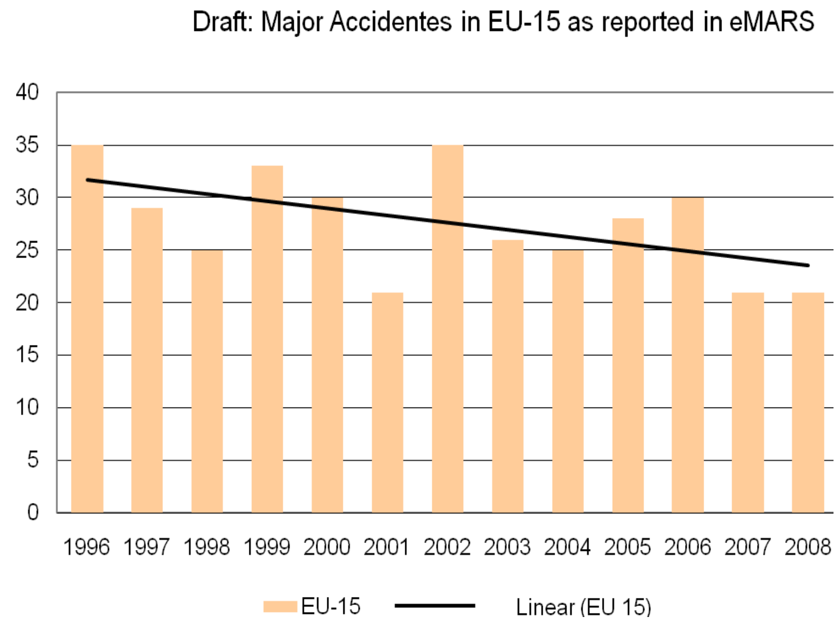


Figure 9.22: Major accidents in EU-15 as reported in e-MARS[1]

The data, filed in the e-MARS (*Major Accident Reporting System*) database kept by the EU, although showing a significant reduction of major accidents (by approx. 20%), after the entry into force of the provisions introduced by the various directives, has nevertheless convinced the European Commission to draft a new directive, the text of which is currently being discussed and which will probably be enacted within the end of 2013, and enter into force, after having been transposed into national law by the Member States, by 1 June 2015.

[1] Source: EC-JRC

The situation

Information on plants posing a major accident hazard, as provided by the management to the competent authorities (which include the MATTM (i.e. the Ministry of the Environment), pursuant to the specific obligations set out in Legislative Decree 334/99, which provides for fines and criminal sanctions in the case of failed declaration or misrepresentation), is collected by the ISPRA, in agreement with the MATTM, through the updating of the National Inventory of activities likely to increase the hazard of a major accident (so-called "MAH plants"), pursuant to Legislative Decree 334/99 (art. 15, paragraph 4).

The ISPRA, in agreement with the MATTM, collects information on the plants posing the hazard of a major accident provided by the management to the competent authorities.

The data thus collected is validated also by means of cross-references with the information in possession of the regional authorities and the competent regional Environmental Agencies.

Thanks to the information contained in the above mentioned Inventory, it is possible to build a general picture of the pressures exercised, in Italy, by the plants posing a major accident hazard.

Knowledge of the distribution of MAH plants can highlight areas in which there is a higher than usual concentration.

Knowledge of the distribution of plants posing the hazard of a major accident (at regional, provincial and local level) can highlight areas in which there is a higher than usual concentration of such plants and, therefore, enable the introduction of appropriate controls and precautionary measures, to ensure that any accidents occurring in any one of the plants do not spread wildly to the others (domino effect), with even greater consequences for both the surrounding communities and the environment.

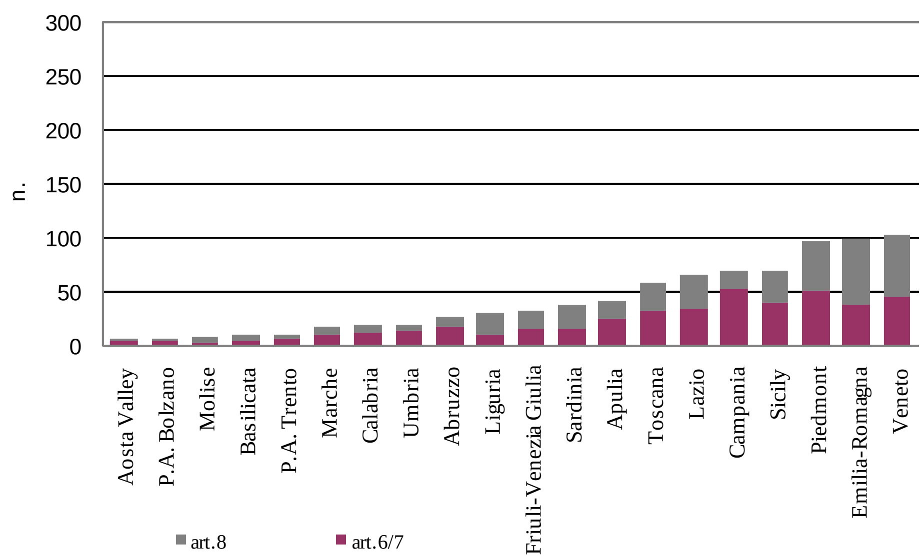
Therefore, in order to obtain more punctual results, thanks to the georeferencing work by the ISPRA, in partnership with the MATTM, about all the boundaries of the MAH plants, it is possible, given a certain distance established based on need, to visualize all the groups of MAH plants, regardless of the municipal, provincial or regional boundaries.

Moreover, MAH plants are grouped into categories according to the relevant legal provisions.

Each category features specific formalities and requirements the plant must comply with (based on articles 6, 7 and 8 of Legislative Decree 334/99, as amended by Legislative Decree 238/05).

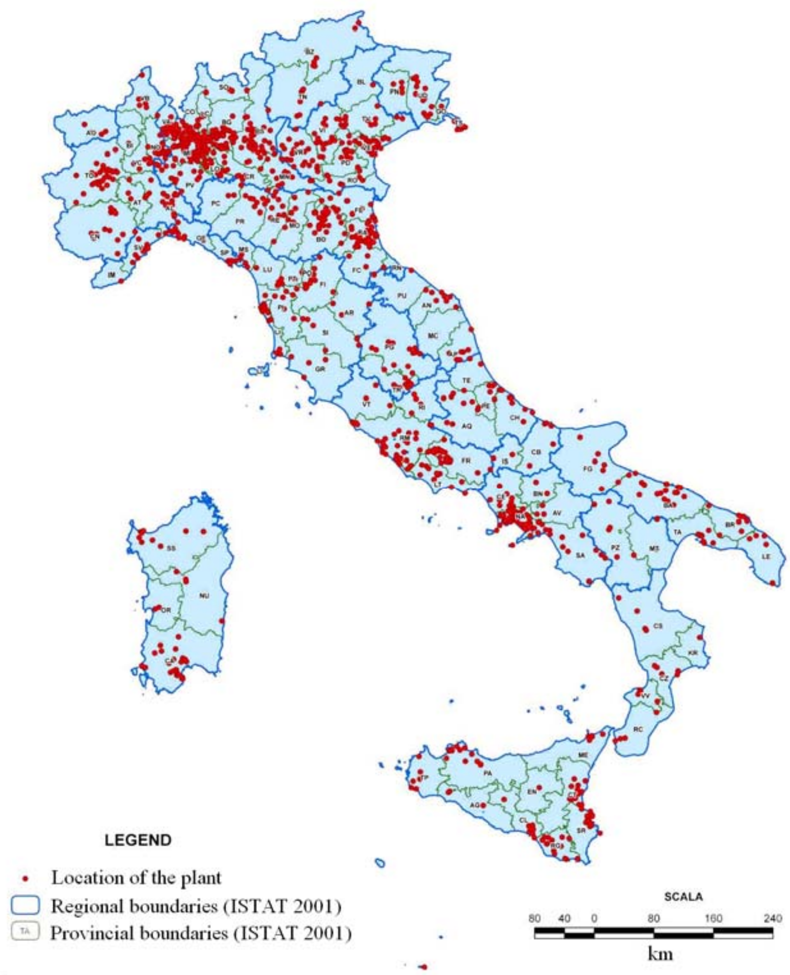
Plants subject to article 8, for example, are required to notify the competent authorities (including the MATTM), prepare a safety report and introduce a dedicated safety management system for the plant; plants subject to articles 6/7 have the same obligations as article 8, but are not required to prepare a safety report.

In Italy, in January 2012, there was a total of 566 plants posing the hazard of a major accident within the meaning of article 8, and 565 plants within the meaning of articles 6/7, as a result of which, the total number of plants posing the hazard of a major accident was 1,131 (Figure 9.23 – 9.25).



Over one fourth of MAH plants is located in Lombardy.

Figure 9.23: Regional breakdown of MAH plants[2]



The regions featuring the highest concentration of MAH plants are: Lombardy, Veneto, Emilia-Romagna, Piedmont and Sicily.

Figure 9.24: Nationwide distribution of plants, pursuant to articles 6,7 and 8 of Legislative Decree 334/99, as amended[3]

[2] Source: MATTM data processed by the ISPRA (2011)
[3] Source: MATTM data processed by the ISPRA (2010)

Based on an analysis of the types of plants, we can also draw further considerations on the map of major accident hazards in Italy. The activity of an plant, in fact, provides information on the type of substances normally stored there, or the type of process. This information can be used to assess, albeit in a qualitative and partial way, the potential hazards associated with the plant in a certain area. LPG and explosives deposits, like distilleries and the plants for the production and/or storage of technical gases, are characterised, for example, by a predominant hazard of fire and/or explosion, the principal effects of which, in the event of an accident, are irradiation and overpressures, to various degrees, and, therefore, structural damage to the plants and buildings and physical injuries to human beings. Chemical plants, refineries and deposits of toxic substances and plant protection products, besides the fire and/or explosion hazards mentioned above, also feature the incidental release into the environment of toxic substances, also at a distance, and therefore the possibility of immediate and/or deferred harmful consequences, for both man and the environment.

Information on the activities and type of substances normally present in a plant enables an assessment of the potential hazard associated to it.

Plants posing the hazard of a major accident are located in almost all the Italian provinces.

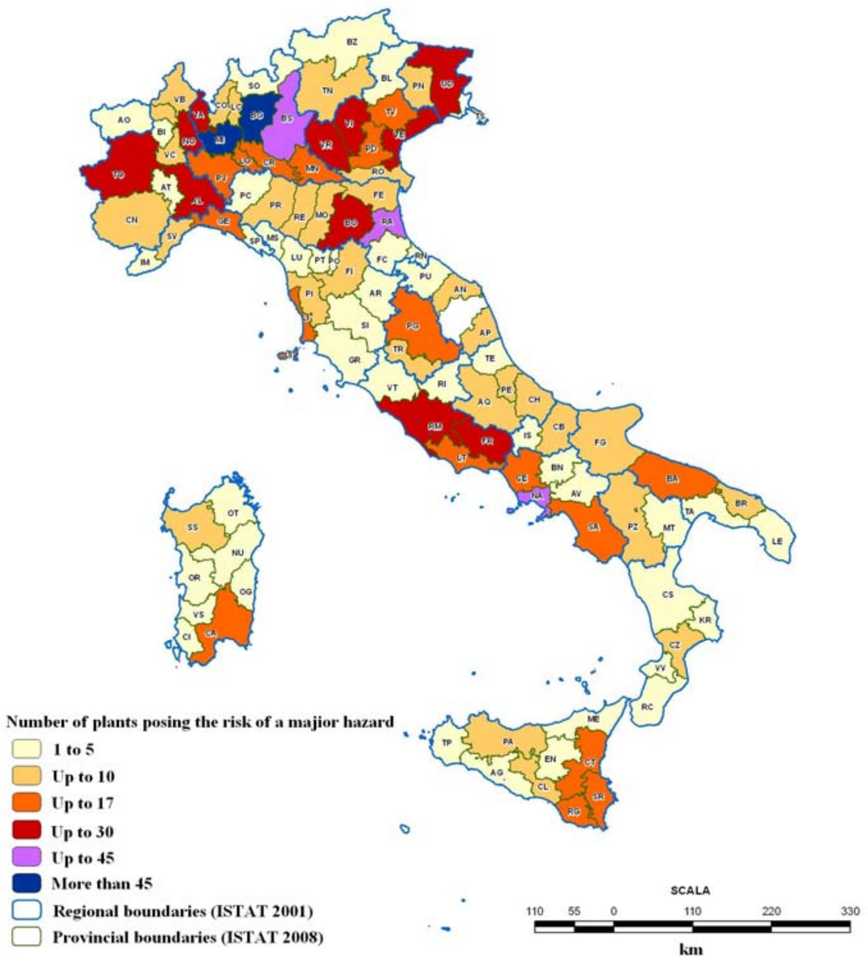


Figure 9.25: Provincial distribution of plants posing the risk of a major hazard[4]

[4] Source: MATTM data processed by the ISPRA (2010)

A complete and effective assessment of the potential hazards presupposes the consideration, by the supervisory entities, of possible accident scenarios and the plant and management measures put into place, by the management, for preventing accidents and mitigating their effects, besides the role played, in case of an accident, by the residual hazard management measures implemented by the competent Authorities (external emergency planning, information to the public, urban planning).
This information, together with the possible accident scenarios and potential damage, associated with the vulnerability of the surrounding area, can be used to build a hazard map for regional planning purposes, informing the public and managing emergencies. Figure 9.26 provides shows the most widespread industrial activities in the plants posing the hazard of a major accident.

Chemical and and/or petrochemical plants and LPG deposits together account for over 51% of all plants.

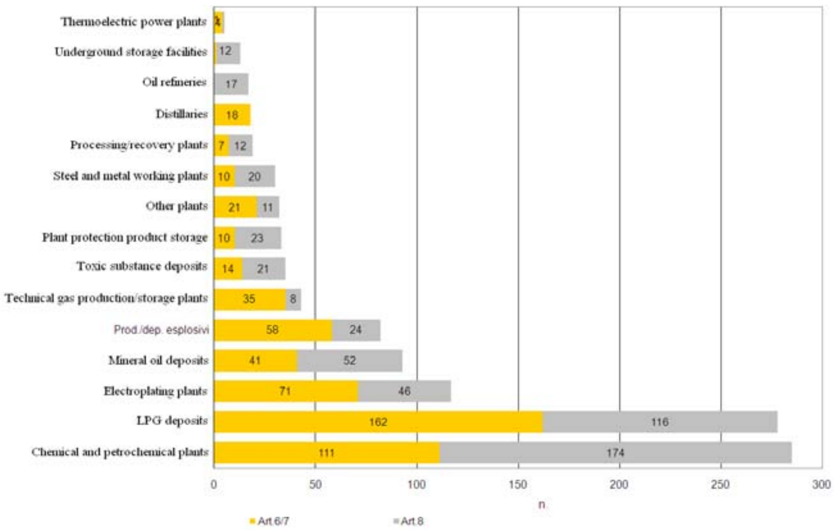


Figure 9.26: Nationwide distribution of MAH plants by type of activity (12/2011)[5]

The causes

The pressure by plants posing the hazard of a major accident in Italy is comparable to that of the other large European industrial countries, even though there are undoubtedlty certain specificities descending from the history and the development of industry in Italy and the decisions made in the past, regarding energy supplies, for instance. Suffice it to mention the concentration of oil refineries in Sicily and Lombardy, the presence of huge petrochemical complexes built after World War II in the Po Valley (Ravenna, Ferrara), the Venice Lagoon (Marghera) and, from the 1960s and 1970s, in the South of the country (Brindisi, Priolo, Gela, Porto Torres, etc.). An Italian peculiarity, in the European context of MAH plants, is the large-scale development of the network of LPG deposits, the function of which is to supply the areas of the country that are not covered by the methane gas supply network.
Another national peculiarity is the presence of industrial districts

Italy features an extensive network of LPG deposits and industrial districts grouping together small and medium enterprises producing similar

[5] Source: MATTM data processed by the ISPRA (2010)

(Marghera) and, from the 1960s and 1970s, in the South of the country (Brindisi, Priolo, Gela, Porto Torres, etc.). An Italian peculiarity, in the European context of MAH plants, is the large-scale development of the network of LPG deposits, the function of which is to supply the areas of the country that are not covered by the methane gas supply network.

Italy features an extensive network of LPG deposits and industrial districts grouping together small and medium enterprises producing similar products or sharing the same supply chain.

Another national peculiarity is the presence of industrial districts featuring a large concentration of small and medium enterprises producing similar products or sharing the same supply chain, such as, for example, the chemical and pharmaceutical enterprises in certain areas of Lombardy (which region hosts no less than 25% of all MAH plants) and in the area of Latina, or the electroplating enterprises in Veneto, Piedmont and Lombardy. These activities often operate in congested areas, in the proximity of urbanized (or densely-populated) areas, characterized by the presence of highly sensitive centers in the case of accidents.

The solutions

The European and domestic legal framework relating to major accident hazards is now defined and mature, having become the subject of three directives, duly transposed into domestic law (although the framework will be further overhauled). The measures implemented in Italy are in line with those adopted in the other EU countries: this confirms a substantial alignment to the European standards, albeit with margins for improvement to:

- streamline and speed up the safety report assessment procedures and increase inspections;
- enhance the awareness of the local authorities about industrial hazards and therefore increase regional control and public information activities;
- improve the quality of the activities related to external emergency planning in the event of an accident.

The above mentioned improvements may be achieved subject to:

- sufficent resources being allocated to the government entities and technical nodies involved, also through the introduction, pursuant to the Seveso provisions, of a fee system payable by the plants posing the hazard of major accidents, in respect of the controls by the public authorities;
- the gradual decentralization, at regional level, of controls, consistently with the “Bassanini” Law, subject to the prior assessment of the any local competencies and/or guarantees of the increase, especially in the southern regions, preparation and maintaining of monitoring procedures by the MATTM;
- the punctual and prompt definition, at state level, of detailed technical criteria and reference guidelines for the local authorities and technical bodies locally responsible for making the inspections.

Of fundamental importance, in this respect, is the upgrading of the Environmental Agency System, which, due to its role, skills and experience, can provide a huge contribution, in partnership with others, to the solution of the highlighted problems.

In order to harmonize the inspection activities nationwide, the ISPRA-Environmental Agency System has set out criteria and guidelines for inspections to plants posing the hazard of a major accident.

We should also stress the efforts and commitment, by the ISPRA-Environmental Agency System, within the framework of the 2010-2012 Programme, of the interagency activities, in view of the definition of the “*Technical and operational criteria and guidelines for conducting inspections at plants posing the hazard of a major accident*” (ISPRA, ARPA-APPA, Manuali e Linee guida 70/2011).

GLOSSARY

Anthropization:
The set of actions carried out by human beings for the purpose of adapting the environment to their needs and interests, consisting of buildings, communications routes, infrastructures, etc..

Damage:
The consequences – in terms of human lives, material damage, economic loss – produced as a result of a disastrous incident.

Hydrogeological deterioration:
A condition typical of areas where natural or anthropic processes, relating to the dynamics of water bodies, the soil or slopes, can produce a hazard or hazard for the area concerned.

Capable fault:
An active fault that can displace the ground surface, generally associated to major earthquakes in the short term, or, occasionally moving slowly and continuously (creep).

Geomorphology:
A discipline of Earth Sciences that studies the form of the Earth's crust and the phenomena that can modify it.

Georeferencing:
The technique used to associate a digital datum with a pair of coordinates that can fix its position on the Earth's surface.

Danger:
Any event that can cause potentially adverse and undesired effects to both communities and/or the environment. It is related to the inherent features and capability of a substance or a situation to cause damage.

Hazard:
The likelihood of a potentially destructive event occurring, with a certain intensity, in a given period of time and place.

Hazard:
The expected number of deaths, casualties or homeless persons per year and/or the expected amount of damage to or loss of property (e.g. Buildings) and/or economic activities, due to an adverse and dangerous event.

Vulnerability:
The propensity an object or an element (persons, buildings, infrastructure, economic activities) has to be damaged, in connection with a disastrous event.

CHAPTER 10

THE SOIL AND LAND

Introduction

The soil supplies the necessary elements to support human societies, which too often consider it as a container of human production waste or a resource to exploit with a scarce awareness of the effects deriving from the loss of its functions.

In scientific community, a term such as "soil" can take on many different meanings, depending on the context.
Pedologists, geologists, agronomists, engineers, architects, urbanists, political economists and also men of letters, everyone has his own definition of soil, ranging from "mother earth" to "native soil". Law-makers too are not of help in clarifying the term, in fact, they give an all-embracing definition of soil (soil: territory, land, subsoil, inhabited areas and infrastructural works), and, with the term "soil protection", essentially meaning the protection of an area from geological and water-related risks[1], they contribute to underlining the clash with the general meaning of the word at European level.
In the following pages, the term soil will be used to mean the thin porous and biologically active medium representing the "top layer of the Earth's crust, formed by mineral particles, organic matter, water, air and living organisms. It is the interface between earth, air and water and hosts most of the biosphere"[2] and which is "...capable of supporting plant life, is characterized by typical flora and wildlife and a specific water cycle. It is divided into horizons each with its own physical, chemical and biological characteristics"[3]. Along with air and water, soil is then essential for the existence of all living species on the Earth and performs a number of functions that place it at the centre of the environmental balances. Despite all this, it is too often perceived only as a support to agricultural production and a physical base on which human activities can be developed.
It plays a key role in the protection of groundwater against pollution, in controlling the amount of atmospheric CO_2, in regulating surface water flows, with a direct impact on flooding and landslides, in preserving biodiversity, in the nutritional cycles, etc..
Plant biomass depends on the state of health of the soil, with obvious effects on the entire food web.
Soil as an extraordinarily differentiated biological laboratory, may be considered as a complex living body, under constant evolution and, for some aspects, still not well known, which supplies human beings with the necessary elements for their survival. The soil is also a fragile and non-renewable resource often treated like a waste dump or relentlessly exploited, with absolutely no awareness as to the consequences that the loss of its functions may have. Improper

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[1] Legislative Decree No. 152/06, Art. 54. Soil protection: the set of actions and activities that can be referred to the protection of land, rivers, canals and conduits, lakes, lagoons, the coastal strip, groundwaters, as well as the territory related to them, with the aim of reducing hydrogeological risks, stabilizing the geological upheaval phenomena, optimizing water use and management, valorizing the related environmental and landscape features

[2] Commission of the European Communities (2006) – Thematic Strategy for Soil Protection. COM(2006)231 final (Thematic Strategy for Soil Protection. COM (2006) 231 final)

[3] Soil Conservation Society of America (1986)

agricultural practices, high urbanization, economic activities and infrastructures in located areas, land use changes in use and the local effects of global climate changes can cause serious deterioration. These processes limit or totally inhibit its functions and often can be highlighted only when they are irreversible or at such an advanced stage that recovery is extremely difficult and economically inconvenient.
Soil as a resource must be therefore protected and used properly, in relation to its intrinsic properties, so that it may continue to carry out its irreplaceable and efficient function on Earth.

The Italian situation

Knowledge about land use is is good, but still rather uneven with regard to the soil.

The knowledge of all the processes and phenomena taking place in the soil and on land is strategically important for sustainable regional development and planning policies, aimed at combining the needs and demands of communities (social and economic factors), also in terms of security, with the cautious and respectful management of the natural assets and related resources (environmental factors). Although the available information concerning the use and knowledge of land, even if subject to improvement, enables us to trace a uniform picture of the Italian situation, knowledge of the soil is more uneven.
Information on Italian soils has a rather long history, but it is only from the '90s that many Italian regions started to collect data and produce maps and databases.
Despite the large amount of data on the soil, even though not uniformly distributed, the information, also due to the lack of coordination at central level, shows a certain level of uneveness that, in many cases, is a limit to the attainment of organic national syntheses.
Attempts have been made to improve this situation through the harmonization of the regional information. The reported data must be then considered, to a large extent, as elaborate approximations, at a national level, on the way of progressive enrichment.

Organic carbon carries out an essential positive function on many soil properties.

Organic carbon (OC – *Organic Carbon*) accounts for about 60% of the soil organic matter present in the soils and performs an essential positive function on many soil properties: it favours the aggregation and stability of soil particles, the effect of which is the reduction of erosion, compaction, cracking, and the formation of surface crusts; it perfectly bonds with many substances, thus developing soil fertility and its absorbing capacity; it improves microbial activity and makes nutritional elements such as nitrogen and phosphorous available for plants.
The knowledge of the OC content in Italian soils is important to determine its state. For example, with regard to cropland, in relation to the nature of soils and the Italian climate areas, a level of OC equal to 1.2% (equal to about 2% of organic matter) in most of the pedoclimatic contexts is able to guarantee the maintenance of the main properties of the soil, such as the supply of nutritional elements for plants, the formation of organic and mineral

In Italian farming soils, an OC level

aggregates, water retention capacity as well as many other important functions for the life of microorganisms and plants. Moreover, considering that, even if the soil-plant carbon sink is smaller than ocean and fossil one, it is indeed more important and directly subject to human actions, the amount of OC stored in Italian soils represents the starting point to determine the role it has in calculating the absorption of GHGs.

equal to 1.2% is deemed as sufficient to guarantee the maintenance of the fundamental properties of the soil.[4]

Figure 10.1.a shows the organic carbon percentage in the surface horizon of soils in Europe. The map was developed by JRC/IES, using the data supplied by the *European Soil Database* together with other related databases on climate, land use and topography.

Most of the soils of cultivated plains and hills presents concentrations of organic carbon ranging between 1% and 2%, typical of arable crop cultivation systems; whereas for the hill and mountain soils, more frequently, carbon concentration ranges between 2% and 5% (locally between 5% and 10%). The different levels of carbon balance between the central and northern European environments and the Mediterranean regions is linked to the different climate conditions: in the former the conservation of carbon in the soil is due to a slower decaying of the organic matter and its consequent accumulation in the soil, whereas in the latter, the transformation of the organic matter is faster because they are favoured by higher temperatures and therefore, the carbon level traceable in the soil is definitely lower.

Figure 10.1b, instead, shows the amount of organic carbon stored in Italian soils in the first 30 cm, according to the regional data currently available and harmonized in connection with the SIAS project (Development of Environmental Indicators on Soil). This project, coordinated by the ISPRA e ARPAV, includes the participation of the Regional Pedological Services, the research centres of CRA (ABP e RPS) and JRC-IES, and is aimed at creating harmonized maps of several soil indicators, on the basis of a common and shared format, in agreement with the specifications of the INSPIRE Directive. The project is based on the revision and harmonization of the data contained in the regional database. The use of existing data, however, generated some malfunctions that, despite a common procedure, point out the difficulties in managing data produced by different bodies/laboratories/persons at different times.

This situation therefore requires a further revision of the basic data. As shown by Figure 10.1b, in Italy, the soils of cultivated plains and hills are mostly included in the 25-50 t/ha and 50-75 t/ha classes, whereas the soils of hilly and mountain areas, with prevailing natural vegetable systems, are especially included in the 75-100 and 100-125 t/ha classes.

A further study on the OC stock in the Italian cultivated soils, carried out within the *CarboItaly* project, by using data collected through the SIAS initiative, has outlined that the amount of organic carbon present in the Italian cultivated soils varies significantly

[4] Council for Research and Experimentation in Agriculture – Research Centre for agrobiology and pedology and Research Centre for the development of relations between plant and soil

among the different climatic areas and the different soil landscapes, ranging from 41,9±15,9 t/ha of vineyards, and 53,1±17,3 of arable crop fields, and 63,3±27,9 t/ha of rice-fields, with a slight decreas moving from the most temperate regions to the Mediterranean regions.

On the basis of the mean value calculated for each uniform area and the surfaces resulting from the ISTAT 2000 Census, the organic carbon totally stored in Italian soils amounts to 490,0±121,7 million tons. Considering the cultivated soils, the estimated national average amount is equal to 52,1±17,4 t/ha, similar to the one reported for other European Countries (50-60 t/ha).

The elaboration made on the basis of available data at a European level shows Italian soils in the arable crop cultivated plain and hill areas, organic carbon levels mainly ranging between 1 and 2%. It is interesting to know also the amount of organic carbon stored in the soil.

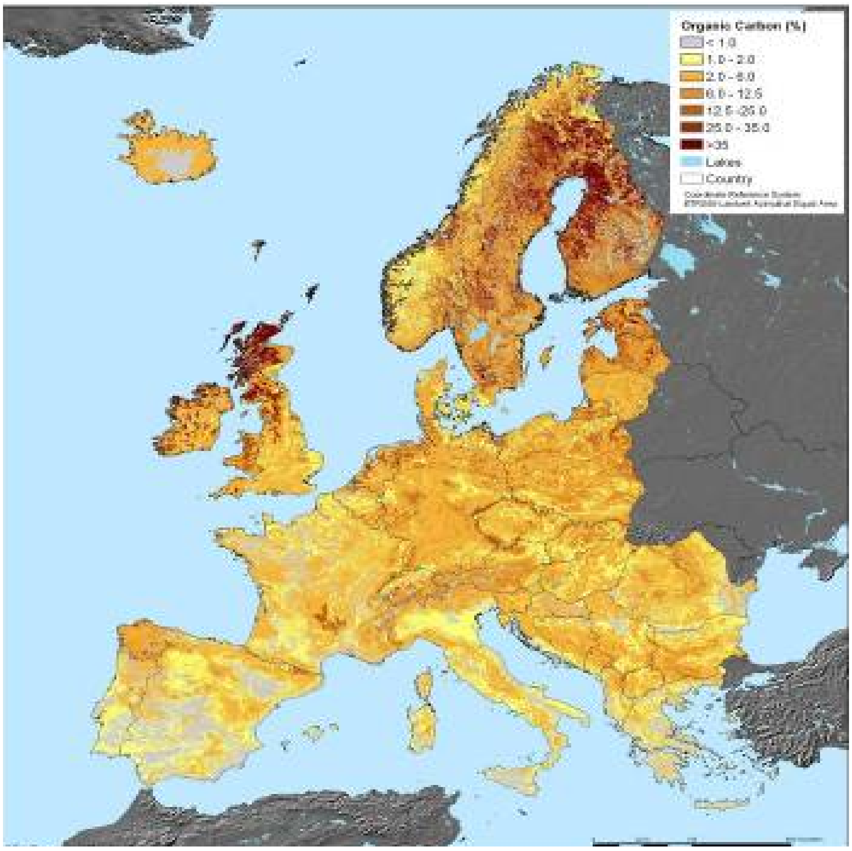
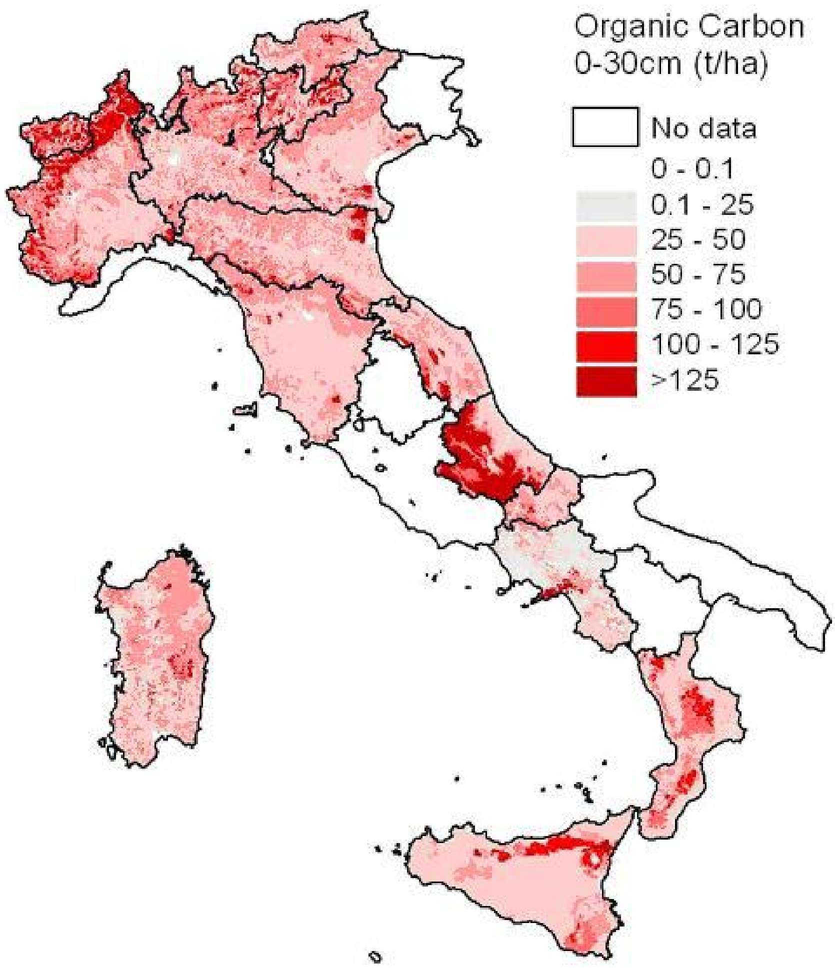


Figure 10.1a: Percentage of organic carbon content (OC) in the surface horizons of European soils[5]

[5] Source: JRC-IES



The preliminary results of the SIAS project have allowed the elaboration of a more detailed cartography obtained through the harmonization of information owned by the Regional Services for the Soil, according to a common and share exchange format.

Figure 10.1b: OC content in tons per hectare in the surface horizons of Italian soils (2011)[6]

Soil plays a fundamental protective function of the environment, by mitigating the polluting effects.

Soil plays a fundamental protective function of the environment by acting like a filter and a barrier that allows to mitigate the polluting effects. Concerning the latter, in agreement with what was proposed by Williamson (1973)[7], a clarification is necessary: a contaminant is "everything added to the environment causing a deviation from the average geochemical composition". The pollutant, in order to be considered as such, must be a contaminant responsible for causing harmful effects to the environment, meant, in a broad sense, as a union of both natural and anthropic parts. Legislative Decree No. 128/2010 defines pollution as "the direct or indirect introduction, through human activity, of substances, vibrations, heat or noise, or more generally physical or chemical agents, into the air, water or soil, that could damage human health or the environment quality, cause the deterioration of material goods, or damages or disturbances to recreational values of the environment or its other legitimate uses".

[6] Source: ISPRA, ARPAV and Regional Services for the Soil (SIAS Project)

[7] Williamson S. J. (1973), *Fundamentals of Air Pollution*. Addison-Wesley, Reading, 472 pp.

Therefore, in case of the voluntary or accidental introduction of hazardous substances into the soil, whenever they exceed the concentrations deemed potentially harmful, it can be defined as soil pollution and not contamination.

However, the terms soil contamination, contaminated sites and remediation of contaminated sites, are now commonly used to indicate pollution and the remediation of soils, also in national (Legislative Decree No. 152/06) and international rules and regulations, and will therefore be used in this chapter.

Soil contamination can determine an alteration of the features of the soil, such as to impair not only its protective functions, but its production and ecological functions as well.

The protective, productive and ecological functions of soil can be impaired because of its contamination.

The impacts of soil contamination also concern the surface and underground waters, the atmosphere and the food web, with increasing – and at times serious – risks for human health.

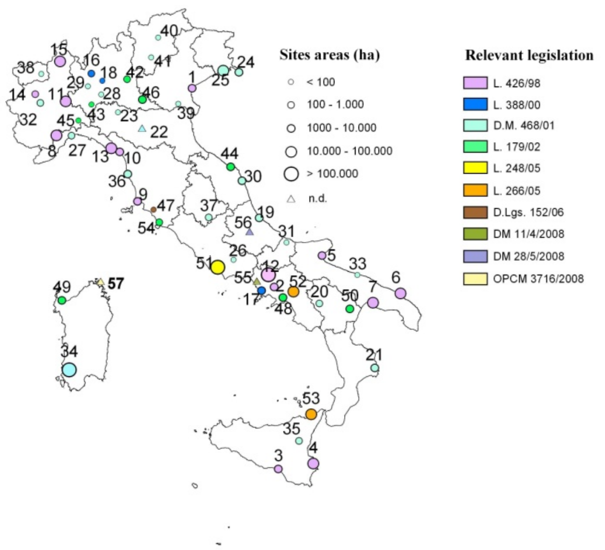
The economic consequences are linked especially to the huge financial commitments needed for the remediation and environmental recovery of the soil, but also to the loss of value of contaminated areas, to the need for measures on environmental factors, which are indirectly affected by the impacts of soil contamination (particularly underground waters) and the possible refusal, by consumers, of produce grown on polluted soils. An impact evaluation (SEC(2006)1165) related to the Thematic Strategy for Soil Protection (COM (2006) 231), carried out by the European Commission, the annual cost of soil contamination ranges between 2.4 and 17.3 billion euros.

Soil contamination can be located or diffuse. Localized soil contamination correspond to point areas, near known contamination sources (contaminated sites). Instead, diffuse contamination is attributed to the presence of contaminating substances whose origin cannot be identified, or due to the presence of multiple sources, e.g. farming, vehicle traffic, natural processes of contaminant transportation and spreading.

Soil contamination can be located or concerns vast areas (diffuse contamination).

With regard to contaminated sites, 57 contaminated Sites of National Interest (SIN, Figure 10.2) are now present nationwide, defined, through specific statutory provisions, on the basis of the site features, quantity and level of the polluting substances, the importance of health and ecological risks, as well as the prejudice to cultural and environmental goods. For these sites, the remediation procedure is made under the administrative responsibility of the Ministry for Environment, territory and sea, which, for the preliminary inquiry of the project documents, draw on the services of the ISPRA, ARPA/APPA and the Italian National Health Institute.

The contaminated sites of National Interest are 57. For these sites, the Ministry for the Environment, territory and sea is in charge of the administrative management of the remediation procedures.



The Sites of National Interest are concentrated in the areas subject to high anthropic impact (active or disused industrial areas, harbor areas, landfills, mines/quarries, etc.).

Figure 10.2: Localisation, dimension and reference legislation of the Sites of National Interest (2012)[8]

Some Sites of National Interest are particularly extensive (e.g.: Domizio Flegreo and Agro Aversano Coast, Sulcis-Iglesiente-Guspinese) and/or characterized by historical contamination levels of soils and groundwaters, such as to make the remediation operations extremely hard to execute in medium-short times (e.g.: Porto Marghera), from the technical, economic and environmental viewpoint.

For this reason, some of the sites are included in the group of so-called "megasites". Besides the Sites of National Interest ("SIN") then there are different thousands of contaminated, or potentially contaminated sites, of regional competence that, pursuant to the applicable regulations, should be included in specific "Regional Registers of sites to be remediated".

There are over 15,000 potentially polluted sites. More than 4,000 of them have been found to be contaminated. Almost 3,000 sites have been remediated.

A particular aspect is represented by the brownfield sites, abandoned and inactive or under-used sites that, in the past, hosted production activities, generally industrial or commercial activities, and for which remediation is hindered by an actual or potential situation of long-standing pollution. These sites are often located inside the urban territory and, therefore, have high economic potential. In Italy, the regions with the highest number of brownfield sites are the Northern regions, specifically Lombardy, Piedmont and Veneto, due to the intense industrial development of the past decades.

On the other hand, the southern and central regions are characterized by a small number of large industrial areas.

With regard to contamination, a uniform nationwide overview is still lacking, but problems linked to this phenomenon are present in almost all the Italian regions. High concentrations of heavy metals in soils are present close to road infrastructures (Pb), in wine-growing (Cu) and agricultural areas.

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[8] Source: ISPRA

With regard to pollution from nutrients, the available data report a Nitrogen surplus, along with phosphorous, in all the Italian regions, with a progressively decreasing trend. The highest values are registered in intensive agricultural areas, in particular in some regions of the Po valley. Also the farming use of sewage sludge, although it has positive consequences such as the supply of partially stabilized organic substances and nutritional macro-elements, especially present in organic form and, therefore, characterized by a slow release, it may imply problems of soil pollution.

Cases of spread contamination are present in almost all the regions, but a homogeneous national picture is still lacking.

In fact, sludge contains heavy metals that can accumulate in the soil, even if some of them (such as copper and zinc) are micro-elements which, in small doses, are useful to the vegetable cycle.

On the basis of the official data sent by MATTM to the EC, the use of sewage sludge in farming has increased by 49% in the 1998-2009 period, stabilizing at 289,620 t of dry substance (tss). In 2009, the highest use was made in Lombardy (38%), Apulia (32%) and Emilia-Romagna (18%) which together account for 88% of the national total. According to Government data, the emission of polluting substances seems limited and, in the 1998-2009 period, it never exceeded the limit values set out in the national and European legislations.

Soil erosion by water has a high environmental and economic relevance, i.e. the removal of its top layer, which is rich in organic matter, by means of surface runoff. Damage caused by erosion is generally classified as obvious damage in the place where it occurs (on-site damage), leading to the loss of soil, fertility, biodiversity, etc. and damage taking place in areas far from those in which the erosion occurs (off-site damages), resulting in floods, damages to infrastructures, pollution of surface areas, due to the transportation of pollutants through the surface runoff, etc..

Water erosion determines a loss of soil, fertility and biodiversity.

Limiting this damage often requires correction measures which, especially for valuable cropland, can be economically expensive or, however, when the "tolerable erosion factor" (T factor) exceeds the permitted value. The tolerable erosion factor (T factor), in tons per hectare per year, indicates the amount of soil that can be lost, while maintaining a good production level. Therefore, it must be generally lower than the soil formation speed (pedogenesis). The estimate concerning the loss of soil is based on models that can be either empirical (e.g. USLE – *Universal Soil Loss Equation*) or physically based (e.g. PESERA – *Pan European Soil Erosion Risk Assessment*). The information in Figure 10.3a, based on the PESERA model, tends to overestimate the erosion risk in flat agricultural areas, thus underestimating it in hilly and mountain areas. These estimates, based models at European scale, are affected by the approximations of the data used and the experimental stations for the direct measurement of the phenomenon, capable of validating the results obtained, are still few.

The processed data shows an erosion risk exceeding the tolerability level for about 30% of Italian soils.

However, a more compliant frameworkpicture with the current situation, based as it is on data available at the local level, is being built, as part of the above mentioned SIAS project for the harmonization of regional information (Figure 10.3b).

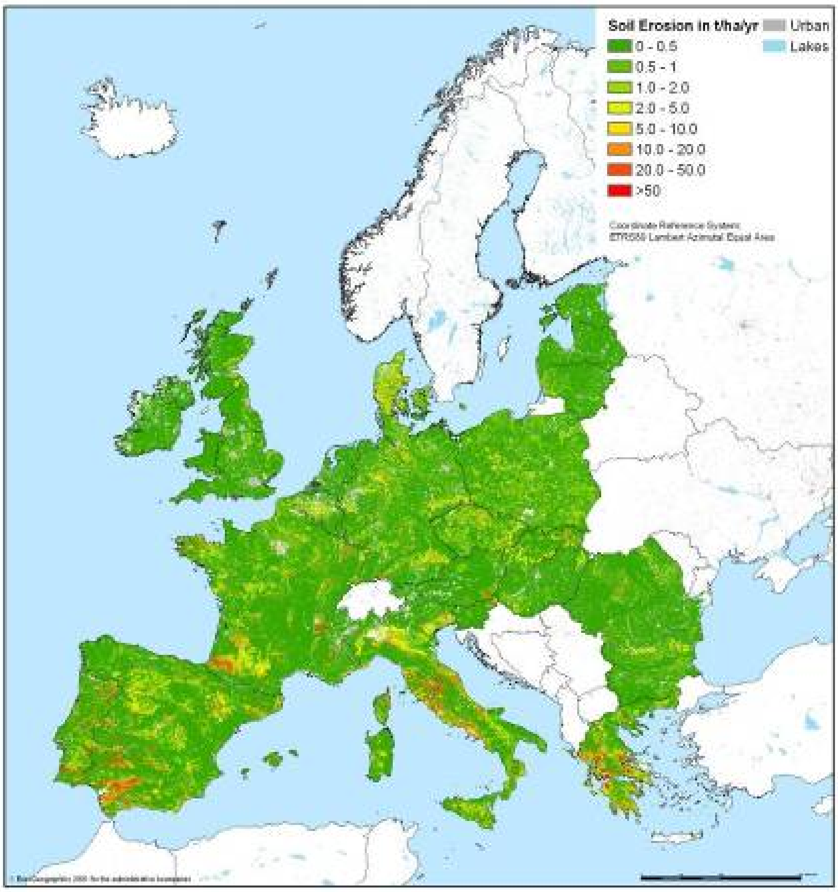
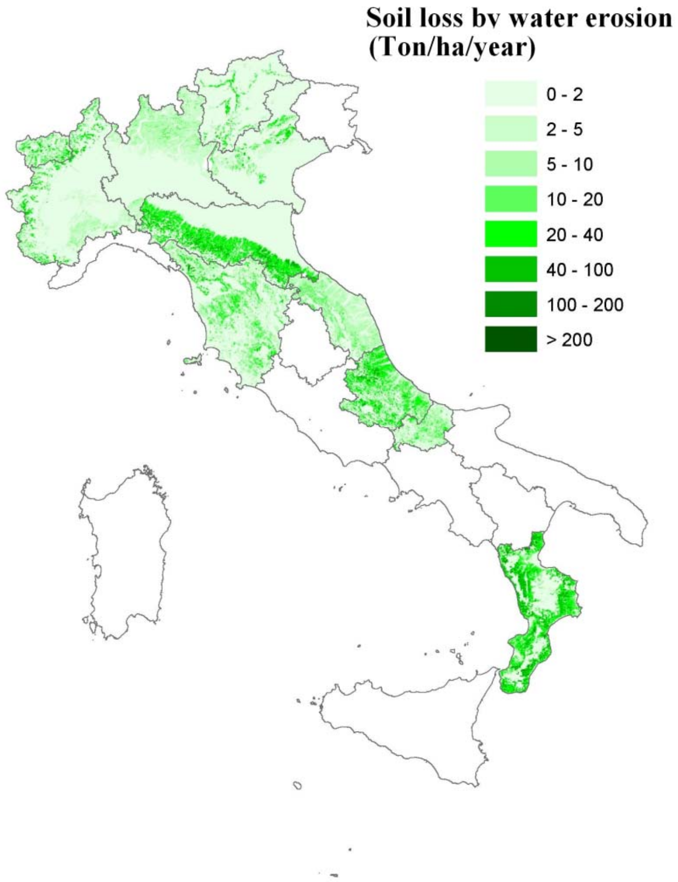


Figure 10.3.a: Actual erosion risk assessment according to the PESERA model (2004)[9]

Loss of soil by water erosioni s generally assessed through the use of models. Although these estimates give an interesting general information at a European level, they suffer from the simplifications made in the definition of environmental parameters and, in some cases, they can give results which differ substantially from the regional processed data.

9 Source: JRC - IES



SIAS Project: harmonization of data relating to the water erosion of soils based on data supplied by the Regional Soil Services, using a common and shared format according to the INSPIRE Directive.

Figure 10.3b: Actual soil loss by water erosion according to the SIAS project (2011)[10]

Soil Salinization is particularly widespread in coastal areas. Salinization is the accumulation, due to natural and anthropic causes, of salt in the soil that may reach such a level so as to compromise the vegetable and production activity of crops and determine strongly negative effects for soil biodiversity and its resistance to erosion. The phenomenon is considered one of the main factors leading to desertification and, in Europe (EU27), according to the JRC-IES estimates, 1 to 3 million hectares are concerned by this phenomenon. In Italy there are still no detailed maps showing the features and breakdown of saline soils.
According to the results of a survey they can be found primarily in the lower Po valley, in long stretches of the Tyrrhenian and Adriatic coasts, in the coasts of Apulia, Basilicata and Sardinia and in large areas of Sicily (Figure 10.4).

*Soil salinization consists in the accumulation of salt in the soil so as to compromise its vital functions, and is considered one of the main factors of desertification.
It is estimated that in Europe (EU27) 1 to 3 million hectares are concerned by this phenomenon.*

[10] Source: the ISPRA, ARPAV and Regional Services for the Soil (SIAS Project)

In Italy, saline soils are mainly distributed in the lower Po valley, in long parts of the Tyrrhenian and Adriatic coasts, on the coasts of Puglia, Basilicata and Sardinia and in vast areas of Sicily.

Figure 10.4: Distribution of salt-affected soil in Italy (red areas)[11]

In Veneto the phenomenon has been investigated in an area at about 25 km from the coast, choosing 480 profiles of soil described and sampled in connection with the regional soil maps (Figure 10.5). The values of electric conductivity, based on laboratory tests, with a water/land ratio of 1:2, have been measured at different depths: upper horizon (0-50 cm), lower horizon (50-100 cm) and subsoil (exceeding 100 cm). The data analysis pointed out that salinity, when present, is higher in the deepest horizons compared to the surface ones and that the highest values can be found in soils with a high content of organic matter (in particular in the remediated marsh areas of Adige and Po).

[11] Source: C. Dazzi, (2007), La salinizzazione. In: *Il suolo, la radice della vita*. APAT

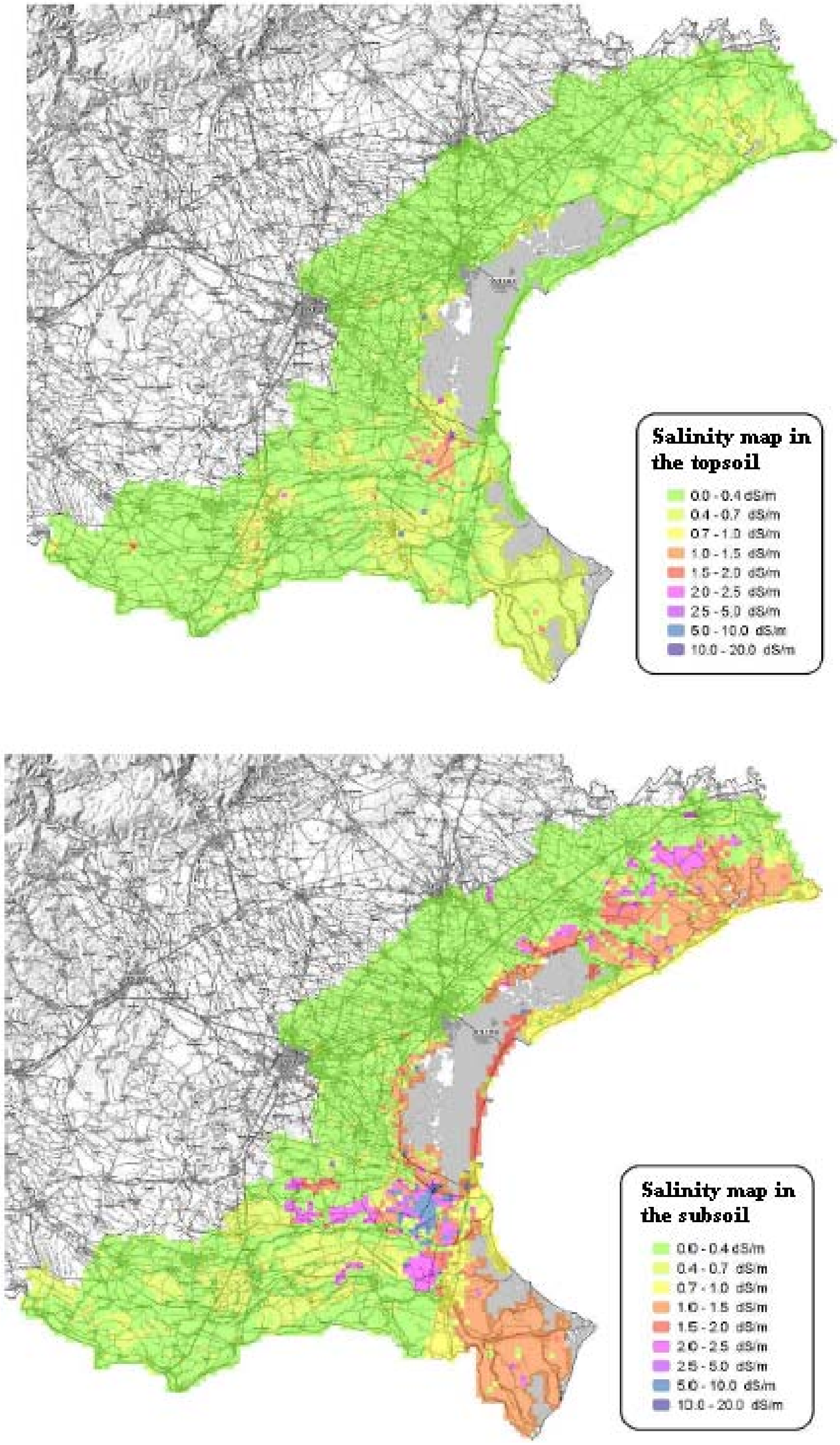


Figure 10.5: Map of the salinity of soils in surface horizons (0-50 cm, on top) and in the substratum (100-150 cm, below) of the venetian coastal area[12]

In Veneto, salinity is higher in the lower horizons compared to the upper ones. Higher values can be found in soils with a high content of organic substances (in particular in the remediated marsh areas of Adige and Po).

The areas concerned by intensive farming can be subject to increasing soil compaction. Soil compaction, mainly due to the use of farming machines, can be defined as the compression of soil particles in a smaller volume, as a result of the reduction of the spaces between the particles themselves. Normally it occurs when significant changes

Compaction takes place following soil particle compression, with reduced spaces between the particles and pore

[12] Source: ARPAV, 2008

occur in the structural properties of the soil and its behaviour, such as its thermal and water regime, the balance and features of the liquid and gas phases making it up. Besides the surface layer, a compacted layer frequently forms at the working depth (plough sole). Besides a lower yield, the result is the drastic reduction of water infiltration with a consequent increase of surface runoff.

continuiy.

Frequent water stagnation in flat areas, after heavy and concentrated rains, and the slip surfaces of landslides next to compacted layers along the soil profile highlight that the problem is common in Italian agricultural areas, both plain and hilly. However quantitative data are very few and limited to several analysed areas. The only available national map is the one relating to the natural sensitivity of soils to compaction, which can be taken from the European paper of the JRC-IES, which, however, does not give information on the actual extent of the phenomenon (Figure 10.6). At a continental level, compaction is generally considered an important concomitant cause of the great North-European floods of the past years, but studies on the actual incidence of the phenomenon in the amplification of the river floods in Italy are still few.

Soil compaction is considered an important factor in the great floods that have affected different European Countries in the past years.

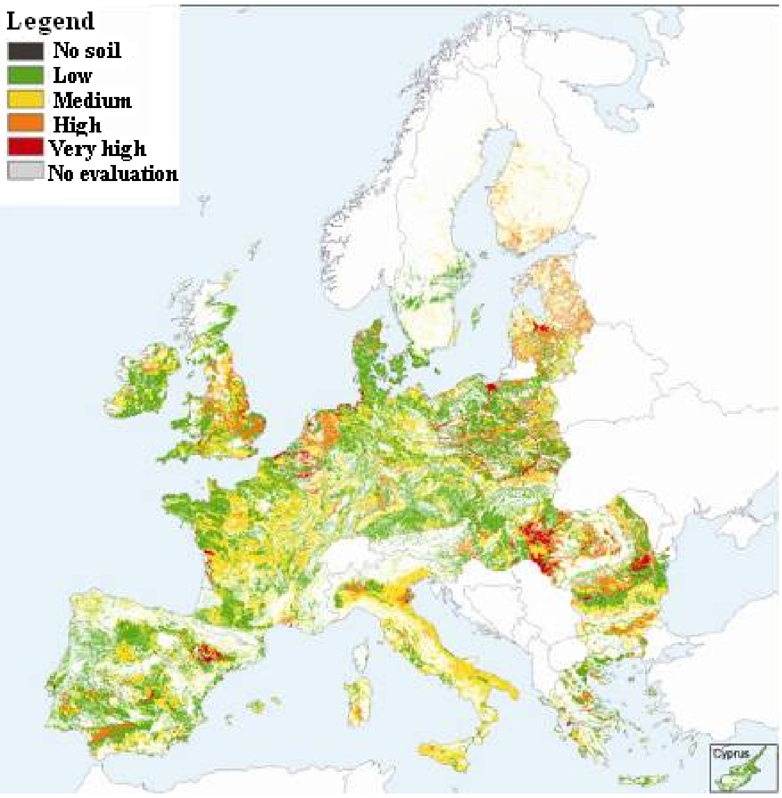


Figure 10.6: European soil compaction susceptibility (2007)[13]

Most Italian soils have a medium-high susceptibility to compaction. However, more detailed studies are required to asses the actual extent of the problem and its influence on the recent floods that have occurred in Italy.

In relation to the land use, the comparison of the *Corine Land Cover* 1990, 2000 and 2006 data (with the limit of a minimum map unit of 25 hectares, which does not allow the appreciation of the obvious development of the scattered urban areas and the minor road network) enabled the identification of a trend that further outlines, at national level, a general increase in urban areas, mainly to the detriment of

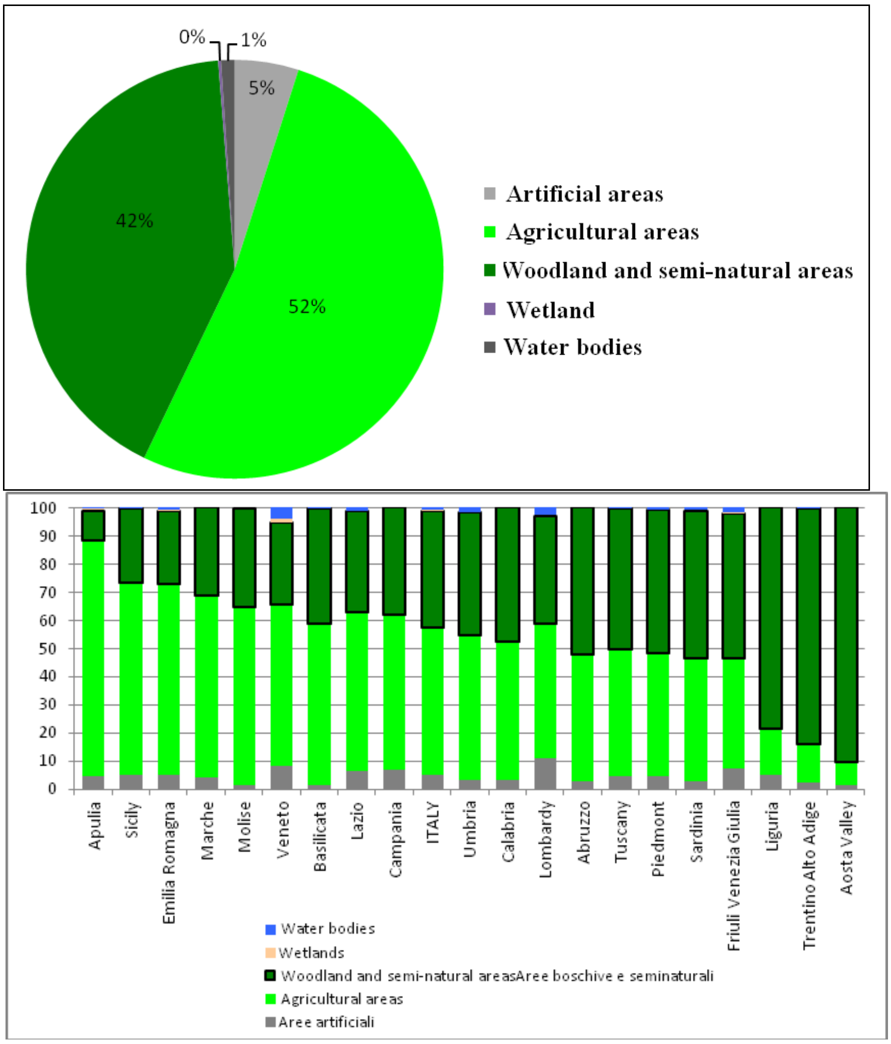
[13] Source: JRC -IES

agricultural areas and, to a smaller extent, to woodland and semi-natural areas.
In Italy, as in the rest of Europe, the base of cultivated lands contracts due to the opposite processes of rural abandonment and urbanization, with a progressive tendency to farming specialization and the decrease of the surface area occupied by traditional promiscuous systems.

Therefore, in the 1990-2006 period, there was a progressive decrease in agricultural areas (143,000 hectares lost between 1990 and 2000, 40,000 between 2000 and 2006), with the remediation of woodland or semi-natural soils.

Between 1990 and 2000, 143,000 hectares of agricultural areas were lost; then a further 40,000 hectares between 2000 and 2006.

The increase of artificial areas, especially in some Italian regions and, in particular, to the detriment of highly fertile farmland, is assuming worrying dimensions because it entails the irreversible loss of the resource and the environmental functions related to it.
In 2006, the regions featuring the highest percentage of artificial areas (> 6%) were: Lombardy, Veneto, Friuli-Venezia Giulia, Campania and Lazio, while the less urbanized regions were (< 2%) Molise, Basilicata and Aosta Valley.



More than half of the country is made up of agricultural areas, but in 1990-2006, 183,000 hectares of farmland was lost.

Figure 10.7: Percentage of the land use for CLC first-level classes at national and regional level (2006)[14]

The progressive loss of soil biodiversity is related to the above mentioned phenomena.

The soil is a very complex habitat for the very high number of organisms, mainly concentrated in the top layers.

In the complex tridimensional matrix of the soil these organisms interact forming a close-knit food network, giving rise to a complex system of biologic activities.

[14] Source: ISPRA

They actively contribute to many critical functions for the ecosystem such as: soil formation and water and nutrients retention capacity; the decomposition of the organic matter and consequently the availability of the elements contained; nitrogen fixation and carbon sink;
the suppression or induction of plant parasites and diseases; the remediation, through biological processes (bioremediation) of contaminated and degraded soils (through contaminant detoxing processes and the restoration of the properties and the physical, chemical and biological processes).

The organisms living in the soil play un irreplaceable environmental role but only a very small percentage of the species is known.

Despite their importance, only a very small percentage of organisms that live in the soil has been identified and classified, to date, and with regard to the most known species, much basic information is still missing (taxonomy, status, breakdown, dynamics). For its varied geological, climatic, morphological and vegetation features, Italy is the European Country with the highest biodiversity of soils. An edaphic biodiversity is associated to this diversification which, according to the censuses conducted (Table 10.1), reaches values ranging from two to ten times that of other European countries. At present, lacking a specific monitoring network, the precise distribution cannot be known and the extent of the populations cannot be quantified.

In Italy, a higher number of invertebrate species than in other European countries has been recorded in the topsoil.

In order to make up for this deficiency, also in relation to the requests coming from the EC, ISPRA created a working group for the planning of this network. However, in the first place, it can be stated that, in Italy, the areas subject to a loss of soil biodiversity mainly correspond to the areas concerned also by the other above mentioned threats, whereas recent investigations have shown that inside the protected areas there is a huge number of edaphic organisms.

Table 10.1: Number of Italian arthropods families and species highlighting classes more related to soil[15]

Class	Families	Species
Arachnida	351	4,618
Symphyla	2	19
Pauropoda	3	43
Chilopoda	11	155
Diplopoda	28	473
Protura	6	31
Diplura	5	76
Collembola	18	419
Insecta	623	36,853

[15] Source: MATTM, 2006. *Check-list* della Fauna d’Italia, edited by F. Stoch

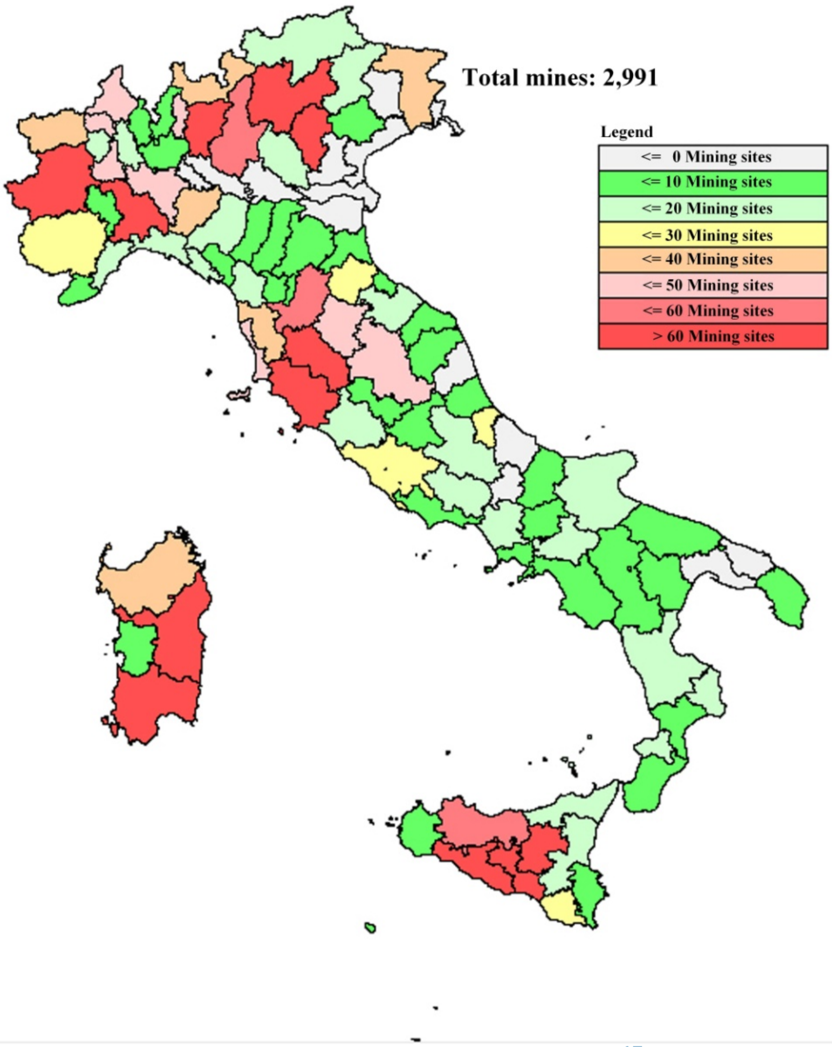
In agreement with the Thematic Strategy for Soil Protection (COM(2006) 231), the final stage of the processes of soil degradation is represented by desertification. In the collective imagination, this term is wrongly associated to the expansion process of sand deserts (properly defined as desertization) taking place in various parts of the planet, from Africa to China. On the other hand, desertification, means "the degradation of lands in dry, semi-dry and sub-humid dry areas for various causes, including climate change and human activities"[16].

The loss of soil functionality concerns large areas of Italy too. About 10% of the country shows high degree of environmental vulnerability and 49,2% shows medium degree. The most critical areas are concentrated in the southern regions, in particular Sicily (42.9% of its area), Molise (24.4%), Basilicata (24.2%).

Extraction activities determine temporary impacts and permanent changes to the environment.

Serious environmental problems can be determined, also when regulated by the law, by raw materials extraction activities (mines and quarries) and by the extraction of energy resources (gas, oil, steam), which represent an important part of the national economy. Besides the temporary impacts (noise, dust, pollution, etc.), these activities also produce deep and irreversible impacts to the landscape, an irreparable loss of soil, the possible pollution groundwater and a series of problems relating to the intended use of abandoned areas.

[16] UNCCD - *United Nations Convention to Combat Desertification, Art. 1a (1994)*



In the period between 1870 and 2006 a total of 2,991 mines were active. A peak was reached in 1950 which registered 1,247 activ mineral sites.Only 194 are now operating.

Figure 10.8: Estimated mining sites nationwide[17]

In Italy, mining is a residual activity mainly linked to the extraction of marlstone, ceramic minerals and other minerals for industrial-use. In the period between 1870-2006, 2,991 mines were active in 88 provinces out of 103 (Figure 10.8). Mining increased until the middle of last century, after which it dropped to the present levels. The progressive drop of mining activities, especially of metal ores, which contains high concentrations of pollutants, has surely mitigated the overall pressure exercised by mines on the environment. However, the ecological, health, static and structural problems relating to the hundreds of abandoned mining sites and related dumps and washing plants, which, have not yet been remedied, remain unsolved.

Mining activities has dropped considerably compared to the last century, however, the problems concerning abandoned sites have not yet been solved.

With regard to quarries, on the basis of the data collected by the competent regional offices, about 5,800 are operating in the country, of which more than 60% for the extraction of alluvial materials and limestone. The regions with the highest number of quarries are: Lombardy, Veneto, Piedmont (where extraction of alluvial materials is particularly developed), Apulia (with absolute predominance of limestone extraction), Sicily and Sardinia, Tuscany (with the highest

Active quarries are scattered nationwide; the situation concerning discontinued or illegal sites has not yet been surveyed.

[17] Source: ISPRA – Census of disused mining sites

number of metamorphic rock quarries due to the extraction settlements of the Apuan sector (marble) and the autonomous Provinces of Trento and Bolzano (Figure 10.9). At present, the situation of the thousands of discontinued or illegal quarries, which may cause serious environmental problems related to their intended use, has not been surveyed.

The regions with the highest number of active quarries are Veneto, Lombardia and Piemonte in the North, Sicily and Puglia in Southern Italy. The provinces of Vicenza, Verona, Brescia, Cuneo and Bolzano have more than 150 active quarries.

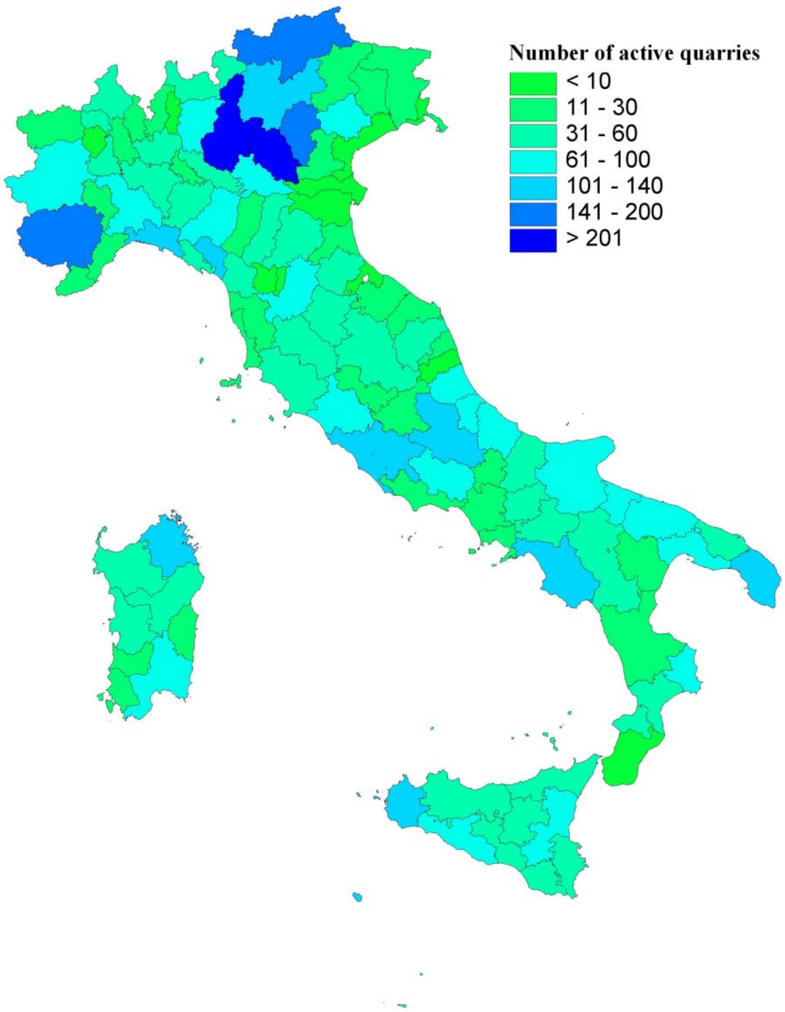


Figure 10.9: Active quarries in Italy (2011)[18]

With regard to extraction activities of energy resources, the most important fields are located in Basilicata (which produces 75% of oil and 12% of natural gas), Sicily (10% oil and 4% gas) and offshore in the Adriatic, where the maximum production of natural gas is recorded (52% in zone A, 14% in zone B and 10% in zone D, corresponding to the high, medium and low Adriatic). The recoverable reserves are estimated in about $187*10^6$ t of oil and $103*10^9$ Sm^3 of natural gas, with a significant increase compared to the previous estimates. In 2010, gas production was substantially stable (+0,4%), whereas oil production increased by 13%, against the trend compared to the previous year (Figure 10.10). Despite the large geothermal potential of Italy, only two areas are currently being

The highest production of oil is in Basilicata, whereas natural gas mainly comes from the high Adriatic. The production of geothermal steam has developed only in Tuscany.

[18] Source: ISPRA

exploited, both in Southern Tuscany (Larderello-Travale/Radicondoli and Monte Amiata). However, energy production from geothermal source is constantly increasing.

The production of natural gas has been decreasing since 1994, due to the decline of the old fields which have not been replaced by any new findings. In 2010, the production of oil increased by 13%.

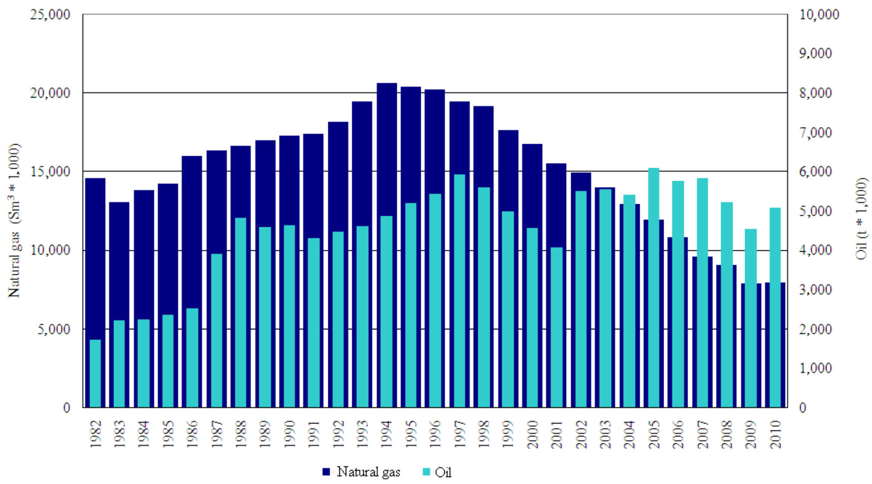


Figure 10.10: National production of crude oil and natural gas[19]

Important informations relating to the subsoil and groundwaters are supplied by the database of excavations, wells, borings and geophysical surveys made for deep water research, exceeding 30 meters from ground level, managed by the ISPRA in implementation of Law No. 464/84.

The database pursuant to Law No. 464/84 has improved knowledge of the geological and hydrogeological structure of the country.

The data highlights a strong incidence of the use of water for irrigation (about 50%), primarily in the flat areas (0-20°). A certain uneveness is reflected in the database, with respect to the different degree of compliance to the law, even though, following an information campaign promoted by the ISPRA, in the last few years, (except for 2010) there has been an increase in the flow of information and, therefore, a better statistical relevance of the geographical breakdown of the data.

Soil and subsoil, besides carrying out fundamental functions to humans (from fertility to geo-resources), also represent a main cultural heritage asset and, for this reason, the law-makers have also taken the protection of geological assets into account. The so-called "Urbani" Code (Legislative Decree No. 42/2004), in fact, lists among the categories worthy of protection any "sites with singular geological features", also known as geosites. These are the geological – geomorphological assets that, due to their rarity, scientific value and natural beauty, are considered, to all intents and purposes, as geological monuments to protect and valorize. Geosites are the main elements of the geological assets and give an important contribution for the understanding of the geological history of a region. Often, these are places characterized by an exceptional importance for their landscape and their significant cultural, didactic and recreational appeal. In some cases, these features are viewed as opportunities for sustainable local development, for example through the promotion of geotourism.

In Italy, to date, more than 3,000 geosites have been counted and recorded.

[19] Source: Ministry for Economic Development data processed by the ISPRA

Italy, thanks to its geological and geomorphological features, has a large number of geological assets. The survey of geosites, which is necessary because knowledge is the basis for all environmental protection activities, has been carried out by the ISPRA, since 2002, in partnership with the regional and local authorities, and provides for the collection of reports from research Institutions, Universities, freelance professionals and students, after their formal and substantial control, before their inclusion in the "Geosites" geodatabase.

The target is to set up:

- a national center for collecting data and metadata on sites of geological interest;
- an information and coordination pole for the knowledge, valorisation and protection of the geological assets;
- a regional planning instrument for government.

Since June 2011, a new application enables the consultation of the "Geosites" geodatabase on the ISPRA website[20], which at present includes more than 3,000 sites. Consultation is free and text-based and geographic searches can be made; the latter allowing the identification of the geosites on a map with access to each descriptive file.

The registered geosites differ among regions also on the basis of the progress of the census.

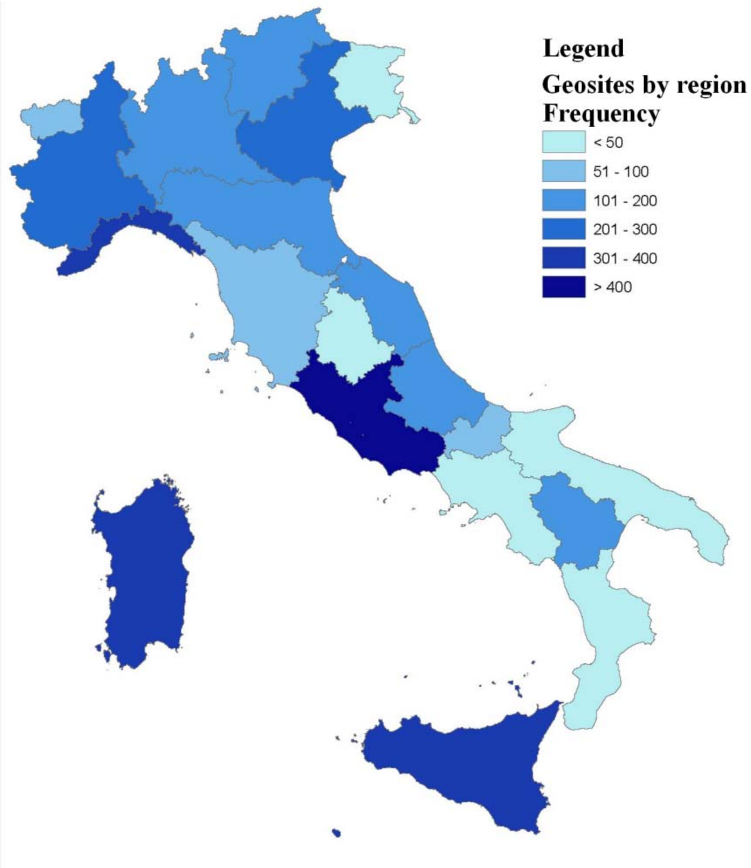


Figure 10.11: Distribution of geosites registered by the ISPRA (data at 30 September 2011)[21]

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[20] http://sgi2.isprambiente.it/geositiweb

[21] Source: ISPRA

The main causes of soil degradation

The various problems related to the physical and biological degradation processes affecting the soils in most anthropized areas (e.g. erosion, compaction, loss of organic substances, etc.), are mainly due to the huge transformations that occurred in Italy during last century.

The irregular expansion of urban centers, industrial development, the proliferation of infrastructures, the extraction of raw materials and the modernization of agriculture (focusing on maximum productivity) exercised a huge, sometimes inevitable, pressure on soil.

A large part of the land was then sacrificed, often incautiously, to the society's development needs, but the present knowledge on the effects of environmental and soil exploitation mean that the competent authorities can no longer postpone the adoption of suitable policies for the sustainable management of land and soil.

A common problem of all the industrialized countries is represented by the local or diffuse pollution of soil and groundwater.

Local contamination is due to the presence of oil refining industries, chemical and steel industries and some waste disposal activities (including asbestos.)

The local contamination (contaminated sites) is originated by anthropic activities (industrial plants, mines, landfills, etc.) which can determine local contamination phenomena of the soil, due to spills, leaks from plants/tanks, incorrect waste management, etc..

In Italy, the activities mainly involved in specific contamination phenomena are the oil refining industries, chemical, steel and extraction industries and some waste disposal activities, including the presence of asbestos structures, especially those in bad state of preservation.

On the other hand, diffuse contamination can be linked to atmospheric depositions and intensive farming, or to anthropic activities spread on the territory and/or prolonged in time, such as to make the identification of a univocal source difficult (Figure 10.12).

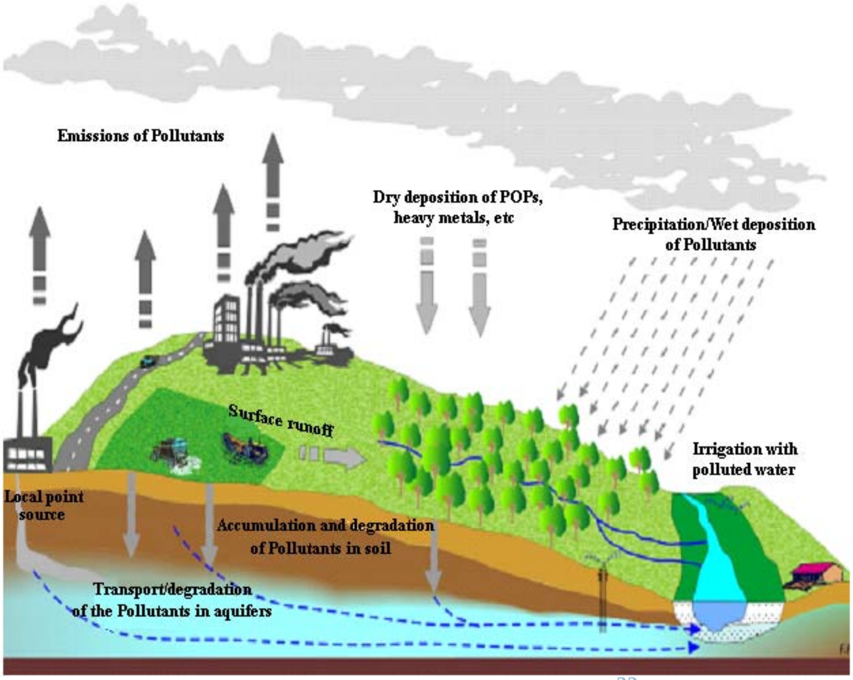

Figure 10.12: Diffuse contamination diagram[22]

Diffuse contamination is due to industrial, civil or agricultural sources. When soil loses its protective function, the polluting substances also contaminate rivers and groundwater and enter the food web

Industrial and vehicle emissions in the atmosphere determine the release in the soil of acidifying contaminants (SO_x, NO_x, NH_3), heavy metals (Pb, Hg, Cd, As, Cr, Cu, Ni, Se, Zn) and organic compounds (linear-chain hydrocarbons, PAHs, dioxins, furans, etc.). Intensive farming that makes abundant use of plant protection products, chemical fertilizers, livestock manure and sewage sludge can determine a surplus of nutrition elements (N, P, K), an accumulation of heavy metals and the spreading of bioacid substances. In particular, the excess of nutritional elements, such as nitrates, are very water-soluble and difficult to be kept in the soil, can determine serious pollution of undergroundwaters and eutrophication of water ecosystems. The recent communication of the European Commission[23] has pointed out a general trend toward the decrease in the amount of nitrates, due to the measures undertaken in compliance with the laws in force but also the existence of certain critical situations in vast areas of Northern Italy. This situation led Piedmont, Lombardy, Veneto and Emilia-Romagna to apply to the Commission for derogation from the nitrate limit values, aimed at the introduction of less restrictive limit values for livestock breeding effluents in more vulnerable agricultural areas. This exemption[24] allows the enterprises located in the areas of the Po-Venetian basin to increase from 170 to 250 kg per hectare/year the limit fixed by the Directive on Nitrates for

Industrial and civil activities release in the atmosphere acidifying substances, heavy metals and organic compounds. Agricultural practices determine excessive nutritional elements, accumulations of heavy metals and the spreading of bioacid substances.

Nitrates are decreasing all over Europe, but the situation is still critical.

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[22] Source: ISPRA

[23] *Report from the Commission to the Council and the European Parliament on implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources based on Member State reports for the period 2004-2007.* SEC(2010)118

[24] Decision of execution by the Commission rendered on November 3, 2011, granting a derogation requested by Italy with regard to the regions of Emilia-Romagna, Lombardia, Piemonte and Veneto in compliance with Directive 91/676/EEC of the Council relating to the protection of waters from the pollution caused by nitrates coming from farming sources (2011/721/EU)

the agronomic use of nitrogen of livestock breeding origin in Nitrate Vulnerable Zones (NVZs). The derogation started on 1 January 2012 and will end on 31 December 2015, and provides for a series of binding obligations, which essentially modify the manure spreading activities.

The Ministry of Agricultural, food and forestry policies ("MiPAAF"), within the National Rural Network Programme will finance the ISPRA for the implementation of a programme that, on a supra-regional scale, improves the definition level of nitrate sources in surface and groundwater, in pursuing the EU targets aimed at protecting waters from the pollution caused by nitrates from agricultural sources (Directive No. 91/676/EEC).

This project, carried out by ISPRA in partnership with the Regional Agencies for Environmental Protection ("ARPA") of the regions of Piedmont, Lombardy, Emilia-Romagna, Veneto and Friuli-Venezia Giulia, will be focused on the application of isotopic investigations as a support in identifying and estimating the contribution that can lead to the presence of high values of nitrates in underground and surface waters.

The spreading of sewage sludge should be accompanied by an accurate study of the soil features.

Sometimes, the use of sewage sludge too, which contains, along with nutrients and organic carbon, significant amounts of dangerous substances for human beings, can raise concerns if it is not properly managed and controlled. In particular, the spreading of sludge must always be accompanied by a careful pedological characterization of the areas concerned that allows to determine the amounts of sludge that can be introduced in the soil without causing environmental problems.

Some soils naturally contain high amounts of contaminants.

In fact in specific geological contexts, naturally high values of certain contaminants can be identified in the soil (base value), which cannot be referred to any specific – past or present – source, in the area concerned[25]. A high concentration of heavy metals can come from the chemical features of rocks from which the soils originated and, in order to identify possible anthropic contamination, actions aimed at correctly defining the base natural content must therefore be necessarily undertaken.

In order to calculate the presence of heavy metals in the soils, the discrimination between the natural content (base value) and the one induced by anthropic activities is fundamental.

The data processed by APAT/CTN_TES (2005), based on a limited number of samples, taken however from most of the Italian regions, highlighted an accumulation of Zn, Cu, Pb and Cd in the first 30 cm of soil, proving that the contamination was of anthropic (industrial and residential) (Pb and Cd) and agricultural (Cu, Zn) origin.

Other elements (Ni, Cr and As) show higher concentrations in depth that may confirm, for the surveyed areas, a natural origin due to the geological composition of the parental material.

[25] APAT-ISS, Operative protocol for the determination of the base values of metals/metalloids in the soils of sites of national interest. June 2006

Excessive concentrations of pollutants have negative effects also on soil organisms, both directly, causing the emigration or death of the organisms and the most sensitive species, and indirectly, for the development of resistant and scarcely specialized organisms.

The consequence of pollution, intensive farming, erosion, compaction, salinization, organic matter decline and sealing is the loss of soil biodiversity and, therefore, the reduction of its vital functions.

For this reason, edaphic biodiversity is increasingly used in the monitoring programmes of soils and contaminated sites, as useful biological indicators capable of integrating the chemical and physical data obtained from the conventional pedological analyses.

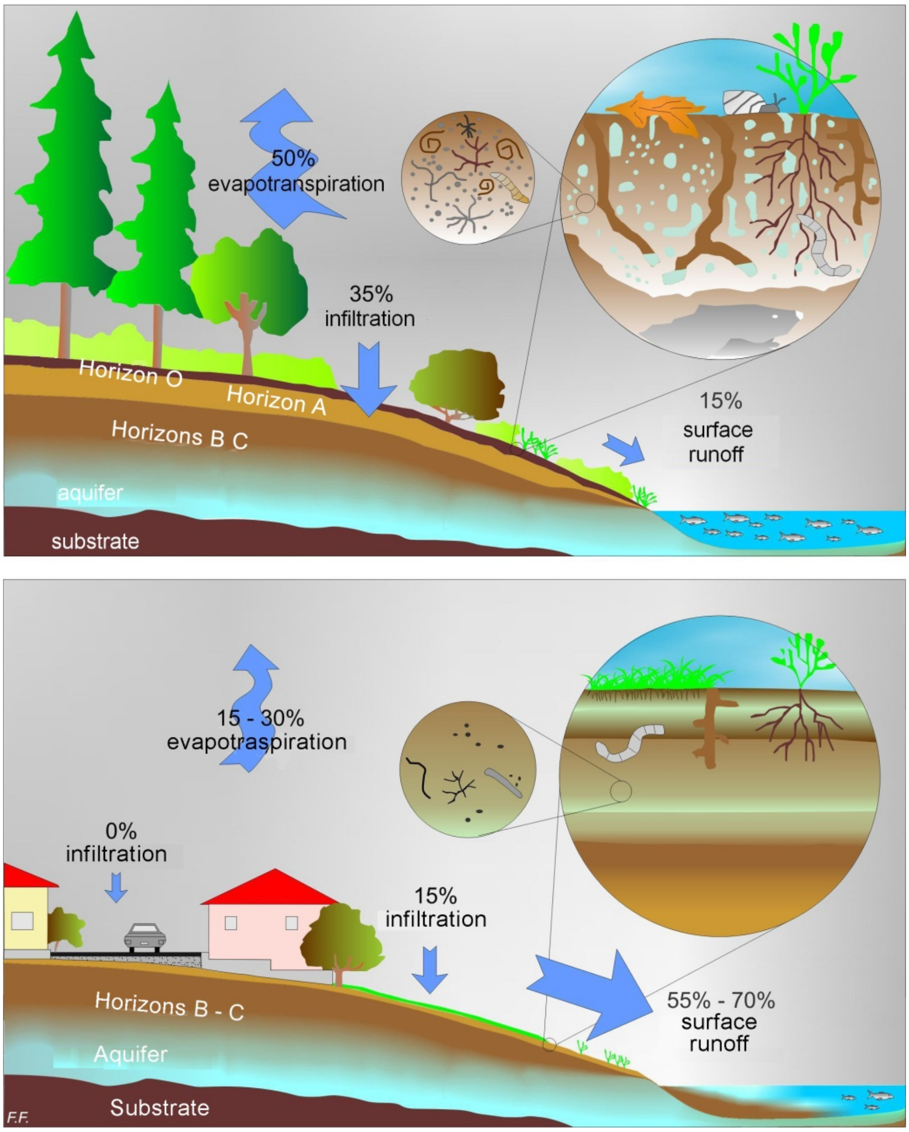
However, the reasons for the loss of soil biodiversity are not limited to the problem of the presence and persistence of pollutants; a strongly negative impact is also linked to intensive farming (deep and frequent cultivations), which often, with the formation of compacted surfaces, reduces the favourable habitat for edaphic organisms.

The reduction of porosity in the so-called “plough sole” limits the amount of oxygen spreading, thus causing alterations in the food web and, in particular, in the type and distribution of organisms.

Other factors limiting the presence of organisms are linked to the increase of salts or soil acidity changes, that can modify the structure of communities of micro-organisms.

Moreover, a serious loss of biodiversity occurs in all the transformations of land use that envisage soil sealing, due to the failed supply of organic matter, its removal by erosion or after fires or, in the worst case, the total removal of the top soil horizon richer in organic matter.

Finally, the accidental or deliberate introduction of allochthonous species often determines invasive population explosions, to the detriment of the autochthonous ones, which are more in balance with the environment.



Note:
The values shown in the picture are given by way of example only.
They vary, also considerably, according to several parameters (physical and chemical features of soil, topography, geology, duration and intensity of rainfall, etc.)

Figure 10.13: Indicative sketch of water movement on natural soil and an anthropized soil[26]

Soil under natural conditions, on the basis of its porosity, permeability and humidity, is able to hold a big amount of atmospheric rainwater, thus contributing to regulating the surface flow. On the other hand, in an anthropized environment, the presence of soil sealing, the reduction of vegetation, the removal of the topsoil layer rich in organic substances and increasing compaction entail a serious decline of soil functionality. The reduction of evapotranspiration and of the soil absorption capacity of waters determine an increase of surface runoff with increased erosion and transportation of large amounts of sediment in the natural channels.

The loss of organic substances is linked to the transformations of the soil use and intensive farming.

Organic matter decline (OM) is one of the most serious phenomena affecting soils. On the one hand, it takes place following the large-scale transformations of soil made by mankind (deforestation, the conversion of forests or permanent pastures into arable land, etc.), on the other, even though in a less impactful way, it is due to the adoption of intensive farming. A big anomaly of the agricultural systems in the last century was breaking the organic matter cycle, in which the agricultural biomasses represent an important step. In particular, the traditional practices to reintegrate the removals made by cultivation, especially with manure, have been abandoned for a long time, so that the input of organic carbon for ploughed soils is mainly entrusted to a more or less cautious management of cultural residues and the supply of other forms of organic non-livestock breeding matter. Moreover, the mineralization processes of organic

[26] Source: ISPRA

substances depends on the climate and type of soil, therefore in the Mediterranean area the concentration of OM in soils, on average, is lower than the average levels considered for the rest of Europe. Therefore, in the Italian context, specific attention must be given to OM conservation, to prevent alert values being reached that may imply a significant loss of fertility.

With regard to the capacity of soils to stock carbon, thus impeding the climate change and, in particular, the organic carbon dynamics of cultivated soils, at national level, recent studies[27] show that the SOC (*Soil Organic Carbon*) sink is approaching a balance, maintaining the annual average loss between 0.2 and 0.5 t/ha.

This loss can be attributed to the intensification of agricultural practices in soils that have been cultivated for thousands of years and could be diminished by using different mitigation options, such as reduced cultivation, better use of soil or the supply of fertilizers of livestock origin. In order to increase the amount of the SOC sink, a long-term domestic policy that promotes the introduction of low-impact agricultural practices is necessary, maybe with the help of measures to be implemented in the agriculture and forestry sectors, in order to to reach the targets fixed by the Kyoto protocol.

The use of agricultural practices focused only on productivity is at the basis of the increase of serious soil erosion and compaction.

impacts on soil from agriculture can be mitigated through the use of innovative agricultural practices, for reducing the impact on the telluric ecosystem and fostering the maintenance of the production capacity and fertility of soil. In this regard, the results of the SoCo (Sustainable Agriculture and Soil Conservation)[28] project of the European Commission, concerning specific agricultural systems (conservation agriculture and organic agriculture), have highlighted important positive effects after the application of these alternative farming practices, from an economic, social and, above all, environmental point of view.

Agricultural techniques such as no or reduced tillage, suitably combined cover crops or appropriate crop rotation, can reduce the soil degradation processes with unquestionable benefits (Table 10.2), such as for example:

- the reduction of water erosion and the consequent increase of the water infiltration capacity in the soil;
- the increase of organic and nitrogen in top soil matter that allows, at the same time, a reduction in the use of pesticides and herbicides, the protection of the underground layer from possible pollutants and, last but not least, the storage of harmful greenhouse gases;
- the increase of soil biomasses (a larger biological activity contributes to the formation of essentially vertical macropores that increase water infiltration and soil resistance to compaction).

However, the implementation of similar cultivation systems must inevitably take into account the considerable investments that farmers need to make in order to purchase specific equipment and machinery and adequately train their employees, and the waiting times necessary

[27] Chiti et al. 2011

[28] http://soco.jrc.ec.europa.eu/

for a conservative agricultural system to reach a balance (generally between 5 and 7 years). In this regard, some regions have introduced a new agro-environmental measure in the Rural Development Plan, envisaging a contribution to cover the costs for those farm enterprises that undertake to practice sod seeding or reduced tillage, with alternation for a period of at least 5 years.

Table 10.2: (Positive/negative) effects of agricultural practices on soil degradation and the related environmental issues[29]

Agricultural practices	Soil degradation processes				Related environmental issues			
	Water erosion	OM decline	Compaction	Salinization/ Sodification	Contamination	Decrease of biodiversity	Landslides and floods	Emissions of green house gases
No tillage (sod seeding) or reduced tillage of the soil	2	1	1		2	3		2
Cover crops	1	1	3		1	3		1
Crop rotation	1	1	1		1	1		4
Intercropping	1	1	1		1	1		
Subsoiling			4	4			3	
Contour farming	1							
Buffer	1	3	3		1	1		
Terraces	1	3					2	

Legend
1 = Positive effect (verified)
2 = Positive/negative (verified)
3 = Positive (estimated)
4 = Positive effect (limited or indirect)

The results of the SoCo project have also highlighted that there are no univocal solutions for reducing, if not abolishing, the effects of soil degradation due to the application of inappropriate agricultural practices. Conservative agriculture, called by some “blue agriculture” can be a solution, but also in this case, it is necessary to estimate its applicability in relation to the nature of the soils, the business structure and the related productions. Modern agriculture, also aimed at the preservation of the natural resources, cannot ignore the knowledge of the resources themselves and the “local reorganization” of agricultural management.

Italian coastal areas are particularly prone to salinization caused by drainage and the use of increasingly saline waters.

Italy, like other Mediterranean European countries, is particularly prone to salinization problems, linked to factors related to the formation and natural evolution of the soil on a particular parent material (primary salinization), or induced by man (secondary), or as a result of the concurrence of both effects.

In particular, the secondary salinization of soils caused by irrigation is a problem destined to worsen, not only due to the existing competition between urban areas, industries and rural areas for the use of water, the excessive exploitation of groundwater and the use

[29] Source: http://soco.jrc.ec.europa.eu/

in agriculture of less and less suitable waters (saline waters, civil and industrial wastewaters) but also because of the estimated effects of climate change, which by increasing dryness, shall determine reduced leaching and the consequent increase of salinization. Therefore, the areas characterized by a hot-dry climate, are particularly exposed, especially in coastal areas where excessive drainages for farming, civil or industrial use, cause the reduction of groundwater level and the possible infiltration of saline waters. Soil degradation process is therefore linked to different pressure factors of natural and anthropic origin; desertification is the result of this complex system of interactions, when degradation can seriously impair the sustainable production capacity of farming and forest ecosystems. Climatic factors that mostly characterize this process are: dryness, drought and rain erosivity; whereas the main anthropic causes are linked to social and economic activities: agriculture, livestock breeding, the management of water resources, forest fires, industry, urbanization, tourism, landfills, extraction activities.

The last phase of soil deterioration is represented by desertification

The degradation process of an area is linked to pressure factors of natural and anthropic origin.

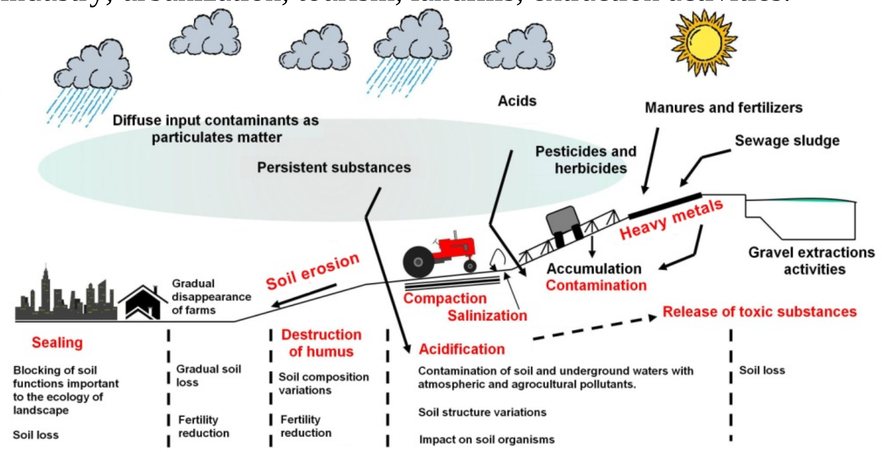


Figure 10.14: Diagram of the threats that can compromise soil functions. The last phase of degradation is represented by desertification[30]

[30] Source: JRC – IES

Aimed at soil conservation

The growing awareness in Europe, of the environmental relevance of soils and the need to counteract their progressive degradation and loss of function, the need to limit of desertification, to mitigate hydrogeological instability and reduce the human pressures on the environment, has led to a substantial review of the regulatory framework. The Sixth Environment Action Programme, the new Common Agricultural Policy (CAP; EU Regulations 1782/03, 1783/03 and 1698/05) and the proposal for soil conservation directive (COM (2006) 232) recognize the environmental function of soils and lay the foundations for the protection and conservation of this resourse.

The new Common Agricultural Policy has laid the foundations for soustainable agriculture.

In view of the problems caused by the application of the old CAP relating to surplus production, the huge growth of community investments and the show of significant environmental damage and the progressive decline in yields, the new "Agenda 2000" agricultural policy has resulted in a approach centered on environmental sustainability.

Based on the principles of Agenda 2000, the subsequent mid-term reform of the CAP (Fischler reform) has been the decisive turning to agriculture as much as possible, in balance with the environment and able to ensure productivity even in the future.

"Conditionality" submits Community support to the obligation to ensure proper soil management.

Of particular interest for soil conservation is the principle of "*conditionality*", according to which the bonuses to farmers receiving direct payments are made conditional on compliance with a series of requirements regarding the proper management of agricultural land (even in the absence of crop cultivation), namely: food security, environmental respect, worker safety, health and welfare of animals.

Each year the Ministry of Agricultural, Food and fhttp://vbox7.com/play:6e3dbd39restry Policies issues a decree containing list of rules to be observed

Support to agriculture is therefore subject to compliance with the Statutory Management Requirements (SMR) and to maintaining the land in Good Agricultural and Environmental Conditions (GAEC). Each year, the Ministry of Agricultural, Food and Forestry Policies issues a decree providing for the complete list of SMRs and GAECs to be met for the following year, although the single regions are entitled to issue implementing measures best suited to each region.

- In particular, SMRs are national and regional statutory provisions already in force, and resulting from relevant Community legislation (e.g. Directive 278/86/CEE "Sludge Directive" 91/676/EEC and "Nitrates Directive"), while the GAECs are established at national and regional level to ensure the implementation of the four priorities set by the EU:
- to protect soil from erosion;
- to maintain soil organic matter levels;
- to maintain soil structure;
- to ensure a minimum level of maintenance and avoid the degradation of habitats.

The rules for maintaining land in good agricultural and environmental conditions included in the DM regard: the retention of surface water in sloping land, stubble management, crop residues and rotation management, and the efficient maintenance of the drainage network for surface runoff, the protection of permanent pastures, the management of land withdrawn from production, the maintenance of olive groves, the retention of landscape features.

The National Strategic Plan for Rural Development provides the guidelines for the corresponding Regional Programmes (RDP).

In the PAC 2007-2013 rural development has been further strengthened by introducing new standards and increasing the available resources. The National Strategic Plan for Rural Development (NSP), developed by the MiPAAF, lays down the guidelines for the corresponding Regional Programmes (RDP) and provides for four priorities, with respect to Axis 2 (Improvement of the environment and the rural areas), aimed at strengthening conditionality:

- biodiversity conservation, preservation and the dissemination of agroforestry systems with high natural value ;
- the quali-quantitative protection of surface and subsurface water resources;
- the reduction of greenhouse gases;
- soil protection.

The fourth objective should be achieved through a series of measures aiming at mitigating water erosion, salinization, compaction, contamination, organic matter decline and biodiversity, land use and soil sealing. All the regions / autonomous provinces have drawn up their own RDP, suitably adapted to the local environments, the SNP.
Among the "measures" put into place and adopted by the Italian regions within Axis 2 of the RDP, many have a direct impact on improvement of some of the threats of degradation highlighted by the Thematic Strategy for Soil Protection, since they aim at reducing nutrient loading to relate it to crop needs, to help maintain or increase soil organic matter, reduce the intensity of soil processes, to decrease the use of plant protection products, to increase the degree of soil cover to combat erosion and the release of nutrients to promote crop diversification and the care of natural areas or grass or wooded strips. In particular, in measure 214 on "Agri-environmental payments”, many regions have provided support for cultural practices characterized by a strong focus on the conservation of soil properties, such as organic farming or integrated agriculture, or the creation and maintenance of hedgerows. Even measures not strictly addressing organic matter contain some obligations for enterprises relating to the spreading of manure on the land with a certrain periodicity. In particular, in the Po valley, where the presence of large farms concentrated in certain areas is a problem for the excessive nitrogen load, it is expected that farms without livestock should source the organic material with the intention, on one hand, to increase the level of soil organic matter, and on the other to better distribute livestock on the land.

The European

In September 2006, the European Commission adopted a Soil

Thematic Strategy (COM (2006) 231), the *Proposal for a Soil Framework Directive* (COM (2006) 232) and the *Impact Assessment* (SEC (2006) 1165) with the aim to protect the European soil.

Commission has developed a thematic strategy leading to the adoption of a proposal for a Framework Directive for Soil protection (COM (2006) 232).

These documents confirm the role of soil and define the environmental threats that can compromise its functions. Moreover, they also acknowledge the strong interrelationship between soil and the other environmental factors and needs, because of their extreme spatial variability, incorporating a strong local factor in security policies.

The States should identify the threats to "agriculture", the risk areas based on common elements, setting targets for reducing the risk to those areas and establishing programs of measures required to reach them.

Regarding contamination, recognized as one of "priority threats" to soil functions, the main elements contained in the Thematic Strategy are: definition of a common risk-based (i.e. based on risk assessments) "contaminated site" and "remediation", the systematic procedure for identifying contaminated sites and the establishment of national registers of contaminated sites, the introduction of the "reports on soil status", as a useful tool in the sale of sites affected by potentially polluting activities, the need for Member States to establish a "National Remediation Strategy" which includes targets (number of sites to be remediated), action priorities and a timetable for implementing them.

However, this proposal is still under discussion in the Council, as stated by the recent European Commission Communication COM (2011) 531, which emphasizes that "overall the Sixth EAP has contributed to including the environmental policy in a general framework for a period of ten years, during which environmental legislation has been consolidated and completed so as to cover all areas related to the environment with the exception of the soil."

The European regulatory gap is also reflected at the national level, where legislation on soil protection has intensively focused on resource conservation, protection of land from hydrogeological instability phenomena. The aspect of soil protection and water pollution has been excluded, characterized by various rules which provide, among other things, the involvement of different institutional sectors.

The remediation of contaminated sites through ad hoc processes, is regulated in Italy, first by MD 471/99, then by the Decree. 152/06 (Part IV, Title V) and the amending decree Lgs. D. 4 / 08.

The Leg. 152/06 regulates the process of remediation of contaminated sites, and introduces the concept of risk analysis.

Leg. D. 152/06, presents important new parts which describe a "potentially contaminated site as: *a site where one or more values of concentration of pollutants found in environmental concentrations are higher than the threshold concentration of risk values, awaiting actions for the characterization and analysis of site-specific environmental risks, able to determine whether or not the state of contamination based on the threshold concentration of risk (TCR).* Instead, it defines a contaminated site as*: a site in which the threshold concentration of risk (TCR) values, determined using the procedure of*

risk analysis in Annex 1 to Part IV of this decree on the basis of the results of the plan characterization, have been exceeded."
Within the decision-making process for the identification and management of contaminated sites, the difference between the threshold of toxicological concern (TCC) and the critical risk threshold (CRT) is relevant .

While exceeding the former requires the characterization and analysis of the risk, exceeding the latter determines the status of "contaminated site" and the consequent safety measures or remediation.
It is clear that the regulations have more recently introduced a policy of setting objectives for contaminated site remediation, risk-based and site-specific, thus updating the definition of contaminated site contained in the MD 471/99.

It should be noted that, among all the effects that could harm human health or the quality of the environment, cause deterioration of material assets, or impair or interfere with amenities or other legitimate uses, the rule focuses exclusively on the direct effects on human health. Indeed, the definition of contaminated site depends on the "*human health effects resulting from prolonged exposure to the action of substances present in environmental contamination"*

For SNI, the percentage of areas released and or remediated is still small

With respect to Sites of National Interest (SNI), since more than ten years from the first rule, the percentage of areas released and/or remediated is still weak and the progress of remediation activities is rather uneven nationwide. In general, a higher percentage of remediated and/or released lands within the SNI is less complex and in particular it detects increased speed of the processes in areas where settlements are provided with high economic value (redevelopment with urban-residential purposes, installation of new production facilities).

The introduction of the Lgs. D. 04/08 Art. 252-bis (*Sites of overriding public interest for industrial conversion*) which provides, through the involvement of the Ministry of Economic Development, public finance schemes and several features to speed up the procedures for the reuse of polluted areas by private entities, may lead to greater development of the remediation and restoration of contaminated sites for productive industrial objectives. Another effective tool in ensuring the coordination of actions between the various parties involved in the clean-up activities and implementation of administrative procedures are streamlined by Programme Agreements.

At regional government level, contaminated sites should be included in special "regional registers of sites requiring remediation".

MD 471/99 provides that the regions should be equipped with a system for collecting and updating data on contaminated sites through the creation of "regional registers of sites requiring remediation" and adopt the remediation plans.

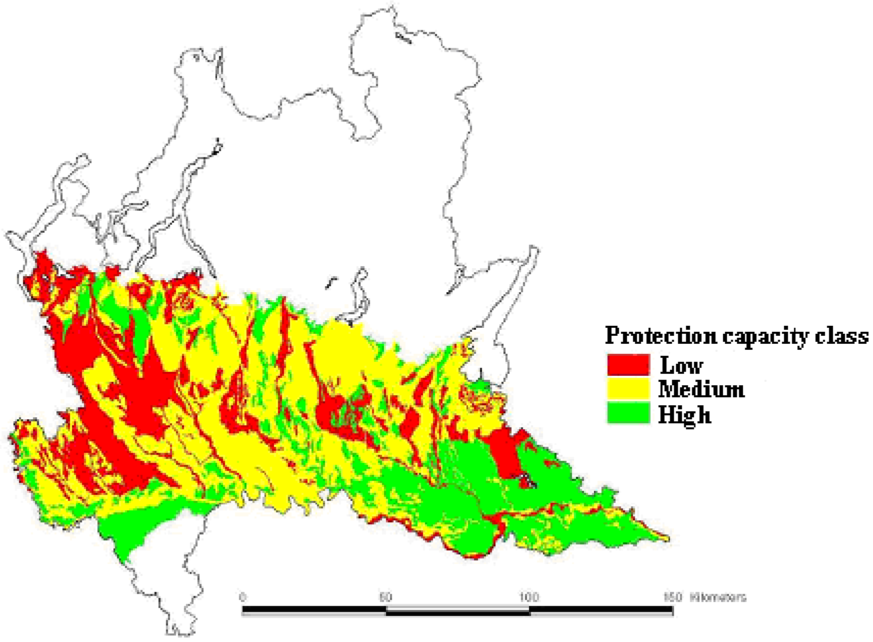
However, the implementation of the registers is lagging behind the timeframe set out in the decree and those that have been set up can be very inconsistent, due to the different criteria used to identify contaminated sites.

The preparation of the registers has been confirmed in Leg.D. 152/06, but the deep changes introduced in respect of the procedures for identifying the sites can cause serious difficulties.

Generally speaking, the criteria for the inclusion of contaminated sites within the regional registers often suffer from the lack of nationwide systematic and uniform investigation procedures for the identification of potentially contaminated areas, i.e. areas that host or have hosted potentially polluting activities.
Regarding *brownfields*, activities are under way to revitalize brownfield sites to make them an active part of urban areas.
Many areas have already been regenerated and are generally used for residential purposes, as public parks, retail areas and public common spaces, while the conversion of "megasites", especially those located in the southern regions, are still very much below potential.

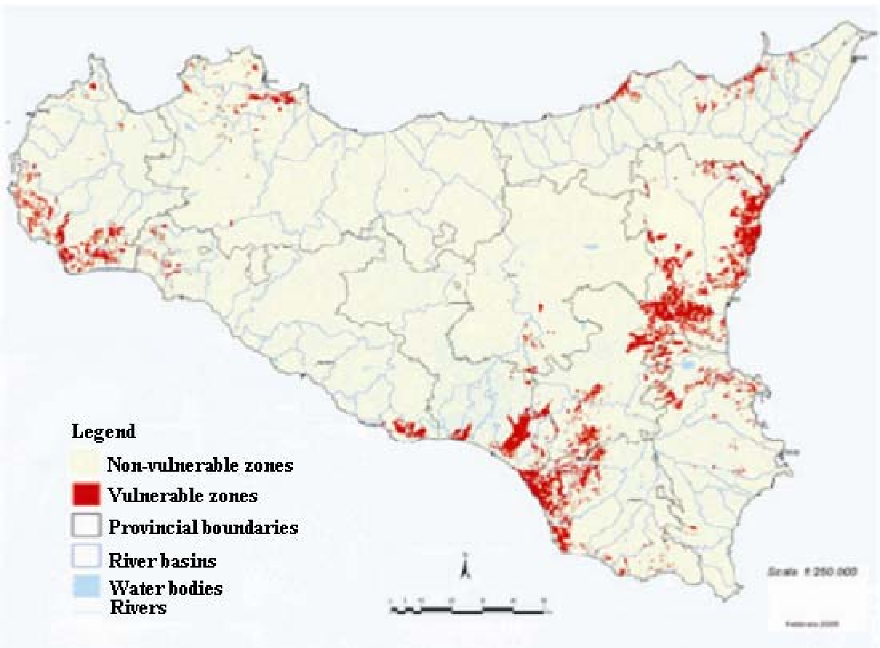
In the case of diffuse contamination, the most effective response is to take activities mitigate the pressures.

In the case of diffuse contamination, the most effective response is to implement preventive actions aimed at mitigating the pressures through: the improvement of controls of emissions into air and water, limiting the use and marketing of potentially contaminating substances, and the definition of quality criteria for products used in agriculture and the limitation of the quantities of fertilizers to use, on the basis of their composition.
The quality of sewage sludge, as a function of their possible use as agricultural land and their receptors, is defined by Directive 86 / 278/CEE, implemented by Legislative Decree 27 January 1992, n.99, which aims at regulating the use of sewage sludge in agriculture to prevent harmful effects on soil, vegetation, animals and humans, also aimed at encouraging its correct use.
The regional authorities have been delegated powers to issue permits for the collection, transportation, storage, preparation and use of sludge. Such rules shall also further limit the use of and regulate the conditions for spreading. They will also develop plans for the use of agricultural sludges.
The MD MiPAF 19/04/99 "Code of Good Agricultural Practice" provides instructions for the proper use of fertilizers, in order to avoid excess of nutrients, while D.Lgs. 152/06, section three, "rules on soil conservation and combating desertification, protecting water bodies against pollution and managing water resources", provides guidance on the mitigation of water pollution by nitrates and sets out procedures for the regional surveying of of Nitrate Vulnerable Zones (NVZ) and plant protection products (Annex 7).
The definition of NVZs is a complex process that results from the integration of the protective capacity of soils and their hydrogeological characteristics with loads of agricultural origin and water quality data (examples in Figures 10.15 and 10.16).
These areas have been identified, at different times, throughout the country, with the exception of Aosta Valley, Trento and Bolzano, which do not have this problems.
The estimated pressures on water bodies, at river basin scale, including local and widespread contamination, is also provided by Directive 2000/60/EC.



The map shows the potential capacity of the soil to retain the crop protection products within the limits of the thickness affected by the root systems of plants and for a time sufficient to allow degradation.

Figure 10.15: Map of the protection capacity of soils in the Lombard plain compared to the underground water (2005)[31]



In vulnerable areas a series of provisions need to be applied for the management of fertilizers and other agricultural practices, as well as measures described in the Code of Good Agricultural Practice.

Figure 10.16: Regional map of the nitrate vulnerable zones of agricultural origin (2005)[32]

The United Nations Convention to Combat Drought and/or Desertification is the international

Italian Law 170 of 4 June 1997 ratifies the UN Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification (UNCCD), adopted in Paris in 1994.

The Convention is an international legal tool that commits all signatory countries to cooperate in combating desertification, in order to mitigate the effects of drought in seriously affected countries, based

[31] Source: ERSAF (Regional Agency for Services to Agriculture and Forestry), Lombardy region

[32] Source: Region of Sicily

on an approach for improving the living conditions of local populations.

legal tool that commits all signatory countries to cooperate in combating desertification.

In order to fulfill the obligations of the Convention, which provides for "*the preparation of National Action Plans aiming at sustainable development with the objective of reducing losses of soil productivity caused by climatic changes and human activities* ", the Italian government adopted the National Action Programme (NAP) to Combat Drought and Desertification, with CIPE resolution no. 299/99, which highlights how the issue is viewed in Italy, in particular as regards the role of human activities, in combination with increasingly frequent extreme weather events.
At legislative level rules specifically targeting the problem in an indirect way have not yet been enacted, Legislative Decree 152/06, Section III, refers to the planning and implementation of enforcement actions assigned to the regions and River Basin Authorities.
The MATTM, moreover, in recent years, has allocated financial aid to several affected regions, which although limited, has nevertheless allowed the definition of action plans at local level.

Waste from extraction activities (quarries and mines) are regulated by Decree 117/2008, implementing Directive 2006/21/EC.

With regard to extraction activities, the national legislation refers in addition to the RD No. 1443 of 07.29.1927 (Discipline of research and cultivation of mines) and DPR 128/59 (Standards of police in mines and quarries), Law no. 23/12/2000 388 (includes a special plan for the remediation and environmental restoration of former mining and quarrying sites), Law 179 of 07/31/2002 (establishing an inventory of abandoned mine sites) and Legislative Decree 117/2008 implementing Directive 2006/21/EC (waste from extraction industries).
Leg. Decree 117/08 sets out the measures, procedures and actions necessary to prevent or minimize any adverse effects for the environment and any risks to human health, resulting from the management of waste from extraction industries (mining and quarrying).
It requires completion by the manager of the mining site of a waste management plan to be approved by the Competent Authority.
It also envisages the creation of a national inventory of shelter facilities for abandoned mining waste sites, to be updated annually, through the ISPRA.
The decree also affects the management of waste from the quarries which, for all the other aspects, are governed by regional laws following the transfer of certain powers after the entry into force of Presidential Decree no. 616 of 24/7/1977.

The planning of extraction activities shall be made based on regional (or provincial) plans (PRAE or PPAE), which, besides surveying any discontinued quarries, contains requirements on the identification and delimitation of areas (geographical areas affected by constraints), requirements, methods of cultivation, time of excavation and recovery plans to be followed in the design of individual interventions, in relation to different situations and morphological characteristics. However the situation is different at national level, however: the plans have been approved at different times and there are regions that have not yet adopted these planning instruments.

Planning is delegated to the regions through the Regional Plans and / or Provincial Mining Activities.

Following the introduction of the geological heritage protection rules in landscape planning (Lgs. D. 42/2004), some regions and provinces have carried out projects for surveying geological sites in the area and, in some cases, they have introduced measures in the regional and provincial Landscape Plans, representing the first steps towards their protection. Only Emilia-Romagna, Liguria and Apulia have a law for the protection and enhancement of the geological heritage.

Several regions have initiated projects for the identification of geological sites.

Careful and appropriate environmental policies and planning, also aiming at the prevention of disasters, can not do without an accurate identification and thorough understanding of the phenomena on a national scale.

A foundamental basis is the geological knowledge of the area, through geological and geothematic mapping (including the associated database) to a scale, which, by allowing a better definition of the most geologically vulnerable areas, makes it an effective tool for the definition of adequate planning and action policies, for land management purposes. Today the country is covered by the Official Geological Map, at a 1:100.000 scale, completed in 1970.

Geological mapping, at an appropriate scale, is a requisite for proper planning.

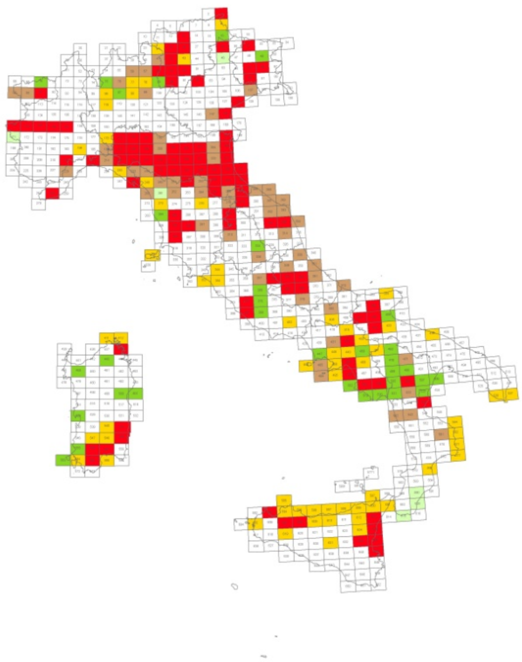
The new geological map at a scale of 1:50.000, more suited to application studies, is made by the ISPRA's Geological Survey of Italy, in partnership with the regions and autonomous provinces, institutes and university departments, and the National Research Council (CARG project - GeologicCARtography).

ISPRA – Geological Survey of Italy is the state cartographer's office.

The research facilities are responsible for ensuring the scientific support necessary for the resolution of the issues to be addressed, to ensure the quality of the geological maps, through the creation of new methodologies.

The Project, characterized by the use of national technical standards drawn specifically from the Geological Survey of Italy, with the collaboration of experts and by building a geological database, has produced a great deal of useful data for management and spatial planning and the production of detailed maps for practical applications.

The legal and financial framework set up between 1988 and 2004 has ensured the necessary resources enabling the production of 255 geological maps, 14 thematic maps, 6 geological maps of the Adriatic continental shelf, at a scale of 1:250.000, 1 morphobathymetric map of the Tyrrhenian basin, part of the CROP (CROsta Profonda- Deep crust) project and the updating of the catalog of geological formations (Figure 10.17).



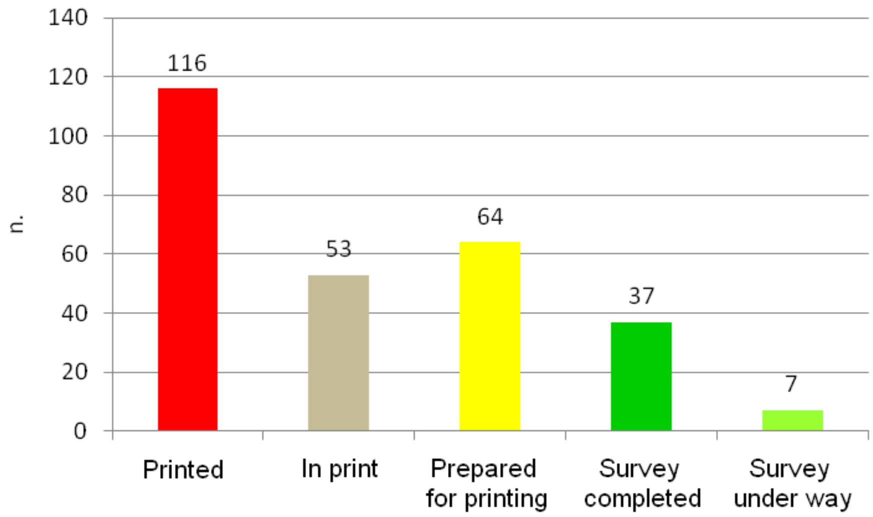


Figure 10.17: Status of CARG project - Geological Map of Italy – scale of 1:50,000 (as of 15 December 2011)[33]

[33] Source: ISPRA

The resources allocated to the CARG Project were not constant, with only two large fund assignments in 1989 and 1999. Since 1999, new provisions have been issued providing for the further funding of the project. In the view of the foregoing, there is the need for a new regulatory approach, with the necessary financial backing, to initiate a second phase of the project, so as to complete the mapping and digitalization of the whole country. It would also be necessary to produce geothematic maps, alongside the geological maps, providing extra information on morphological, geological, gravity, slope stability, as an essential means for collecting knowledge about and assessing the general risks and soil vulnerability.
It shall be based on the same scale used for the geological mapping.

GLOSSARY

Brownfield sites:
are abandoned or underused industrial or commercial facilities and sites, located in inner city or suburban areas, which already feature infrastructures (water, electricity, gas supply, sewerage, etc..), with nearby transport services, the regeneration and development of which, however, is hampered by environmental pollution.

Desertification:
land degradation in arid, semi-arid, sub-humid, dry and other areas subject to chemical pollution, salinization and depletion of the water table, as well as the inefficient management of the soils, resulting from various factors including climate change and human activities.

Desertization:
the expansion process of sandy wastelands.

Horizon:
in a vertical section of the soil, from the surface to the pedogenic substrate, it is normally possible to recognize a series of layers running parallel to the surface, which take the name of horizons and feature specific characteristics depending on pedogenic processes.
They are therefore also called genetic horizons and their designation is based on a qualitative assessment of the origin of the analyzed soil. The vertical succession of horizons constitutes the soil profile.

Pedology:
the science that deals with the study of soils.

Pedogenesis:
process of soil formation from mostly mineral debris originating from the disintegration of rocks (pedogenic substrate). It is achieved through processes of transformation, accumulation, loss and movement due to a set of pedogenic factors: climate, rock, morphology, living organisms and time.

Organic matter:
all the materials of organic – mostly vegetable – origin, from the

flora or by fertilization and accumulated mainly in the upper horizons of soil. The further transformation of these materials produces humus.

Territory:
an area of land considered with regard to its biology and geology and as shaped by past and present human activities. It also takes on a political and administrative meaning, with respect to the formulation of land use and regional/urban planning and development activities.

Surface runoff:
excess rainwater running off the topsoil due to insufficient penetration into the soil as a result of its saturation or excess rainfall. It is a fundamental part of the hydrological cycle and the main agent of soil erosion.

Nutrients:
any materials absorbed by plants and essential for their development. The main nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron and zinc from the soil, and carbon, hydrogen and oxygen from air and water.

SPECIAL FOCUS BOX

BOX 1: Land Use

The causes and consequences of land use

Urbanization and urban sprawl dynamics feature a strong acceleration in the consumption of forest and agricultural soils.

The construction of buildings, roads or other land uses generally involve the removal of soil or soil sealing, due to its compaction or permanent cover with waterproof materials, such as concrete, metal, glass, tar and plastic.

In these cases the change in the nature of the soil is such that these forms of processing can be considered virtually irreversible.

Soil consumption is, therefore, a phenomenon related to the anthropic use of suburban land, deprived of its agriculture or natural functions.

A process that involves the loss, through concrete covering and soil sealing, of a common asset, land, where its availability is increasingly limitated.

Land, and the landscape, are routinely covered by new residential areas, villas, holiday homes, hotels, industrial buildings, warehouses, and office buildings, stores, shops, streets, highways, parking lots, greenhouses, quarries, landfills.

The anthropic use of land, not always properly governed by spatial planning policy instruments and the effective management of natural assets, is becoming increasingly common, often causing the loss of agricultural areas with a high environmental and cultural value.

In sealed-land area, the production functions are inevitably impaired, as well as the ability to absorb CO2 or provide support and sustenance for the biotic components of the ecosystem, to ensure biodiversity and social enjoyment.

Soil sealing increases the fragmentation of the habitats, it can cause disruption of migratory corridors for wildlife and contributes to the urban climate becoming hotter and drier, due to diminished plant transpiration and evaporation and of the wider surfaces with a high coefficient of heat refraction.

Moreover, the soil is no longer able to retain a good part of the rainwater, and to help regulate runoff.

The leaching of soils due to surface runoff results in an increase of the solid load, in many cases with a high pollutant content, causing a strong impact on surface water quality and aquatic life.

The situation in Europe and Italy

Lacking effective policies to manage natural assets, the expansion of urban areas in Italy and Europe has often resulted in the loss of agricultural areas with a high environmental and cultural value.

A uniform picture of the situation in Europe is available based on the the database of *Corine Land Cover*, which however, has an insufficient resolution for making an accurate estimate of land use due to urbanization.

In fact, it does not consider the individual changes in land cover below five hectares, or due to linear infrastructure such as roads and railways, leading to an underestimation of soil consumption.

The analysis by the European Environment Agency (EEA) of the Corine data, contained in the report "*The European Environment - state and outlook* 2010", shows that changes in land cover between 2000 and 2006 concerned 1.3% of the surface area of the 36 surveyed countries (68,353 km2 of 5.42 million km2).

The annual rate of change decreased, compared to 1990-2000, but with substantial differences between the different countries.

The artificial soil cover has risen by 3.4% between 2000 and 2006. Although in the EU, urban areas cover only 4% of the area (5% in Italy), their dispersion implies that at least one quarter of the land is directly involved in an "urban" use. Furthermore, the peri-urban areas with low density increased, between 2000 and 2006, four times faster than the high-density compact urban areas, showing a growing tendency towards urban sprawl in Europe.

A recent report on soil sealing commissioned by the Directorate General for Environment of the European Commission (*The Soil Sealing Report*) has estimated land use in Europe at approximately 1,000 km2 per year between 1990 and 2000, and 920 km ^{2} per year in 2000-2006.

In practice, an overall increase of nearly 9% between 1990 and 2006, compared to an overall population growth of 5%.

In Italy, a statistical source from which it is possible to extract useful information for analyzing the impact on residential and productive land settlement, consists of the monthly survey on building permits, concerning which the ISTAT recently published the historical series of provincial data from 2000 to 2009.

In this period, the Italian local authorities issued, on average, building permits for 2.7 billion m3, equivalent to over 266 million m3 per year, of which slightly more than 83% for the construction of new buildings and the remaining for the extension of existing buildings.

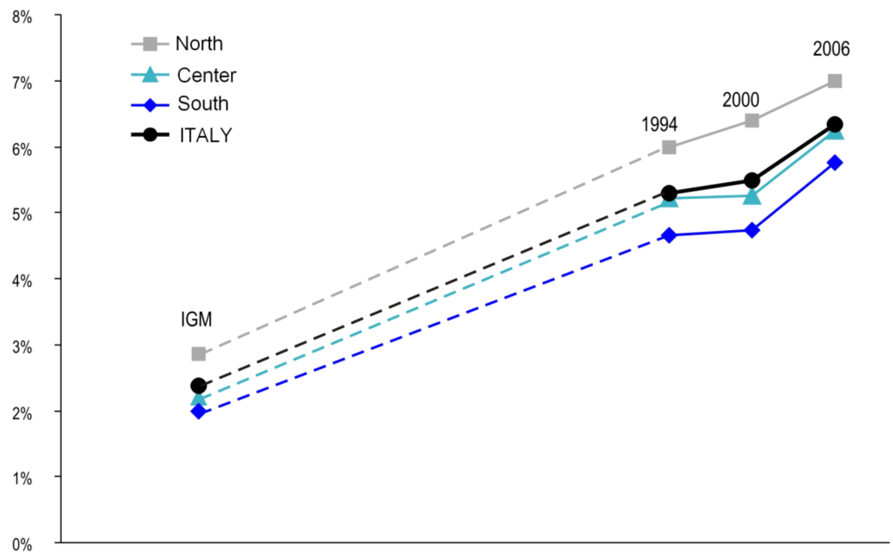
Housing, with an average of 109 million m3 per year, accounts for about 41% of this flow.

Therefore, most legal building applications (59%) concerns production activities and, in particular, trade and industry (101 million m3, accounting for 38% of demand), followed far behind by trade, tourism and agriculture. In the last three years, the average value of the authorized volumes amounted to 231 million m3 per year, 42% of which represented by housing.

Building permits, and the subsequent buildings, have determined a general increase in artificial areas, mainly at the expense of

agricultural areas and, to a lesser extent, of forests and semi-natural areas.
In particular, the *Corine Land Cover* data show a growth of artificial surfaces of approximately 80,000 hectares, in 1990-2000 (over 6%) and approximately 50,000 hectares in 2000-2006 (over 3%).
The increase in artificial areas has an uneven breakdown among the different regions.
Over 60% of the changes between 1990 and 2006 was concentrated in six regions (Piedmont, Lombardy, Veneto, Emilia-Romagna, Tuscany and Sardinia).
While the nationwide annual growth rate remained almost constant in this period, amounting to about 8,000 hectares per year, in regions such as Lombardia it rose from 500 hectares per year (1990-2000) to 1,000 hectares per year (2000-2006).
The region of Veneto featured a similar trend (from 600 to 1,300 hectares per year). Sardinia, by contrast, featured the annual urbanization rate change from 1,200 hectares per year between 1990 and 2000 to less than 300 (2000-2006).
Land use is not limited to the outskirts of urban areas but also spreads into the neighbouring agricultural, natural and semi-natural areas.
For this reason, and to ensure a nationally consistent framework of knowledge beyond the limits of accuracy of *Corine,* ISPRA, in partnership with the Environmental Agency network, has developed a system for the regular monitoring of land use, in order to quantify and assess progressive soil sealing and the loss of agricultural and natural soil.
The data shows high land consumption and the ongoing increase of soil sealing of Italy and in the major urban areas, mainly due to the expansion and construction of new infrastructures, with a general acceleration in the years after 2000.
At national level, land consumption has now exceeded one hundred acres per day and sealed-land areas now account for more than 6% of the entire country.
The highest values of *soil sealing* have been recorded in Lombardy, Veneto and Campania, in correspondence with higher concentrations in urban areas and along major roads.
The phenomenon has taken on alarming proportions in large sections of the plains, where to the effects of urbanization one must also add those resulting from intensive agriculture (soil compaction).
The diachronic analysis of the data shows a progressive increase of soil sealing in Italy in the fifties, a symptom of soil consumption that has remained rather constant over time.
Although the North of the country is the area with the highest percentage of soil sealing, the South has recorded the highest increase rates from 1956 onwards.
The level of soil sealing, nationwide, equal to 2.38% in 1956, amounted to 6.34% in 2006.
The first period (1956-1994) is linked to the urban growth after World War II, with a parallel population growth, at least until the 70s.
The next period (1994-2006) is characterized, however, by widespread urban development, typical of peri-urban and coastal

lowlands, with a growing trend in the 2000s.
Currently, relentless urban growth no longer matches the population growth, the two processes are totally disjoined and the value of per capita soil consumption tends to increase with continuity.



Legend:
IGM= Military Geographical Institute

Figure 1: Evolution of urbanized areas in Italy[34]

In major urban areas, soil sealing has already spread, in some cases, to more than half the municipal territory (more than 60% in cities such as Milan and Naples), with a growing trend, which, in Rome alone, features an increase of the sealed areas amounting to more than three hundred acres per year, in recent years.

[34] Source: ISPRA (the 1946-1960 data are drawn from the topographic maps made by the Military Geographical Institute)

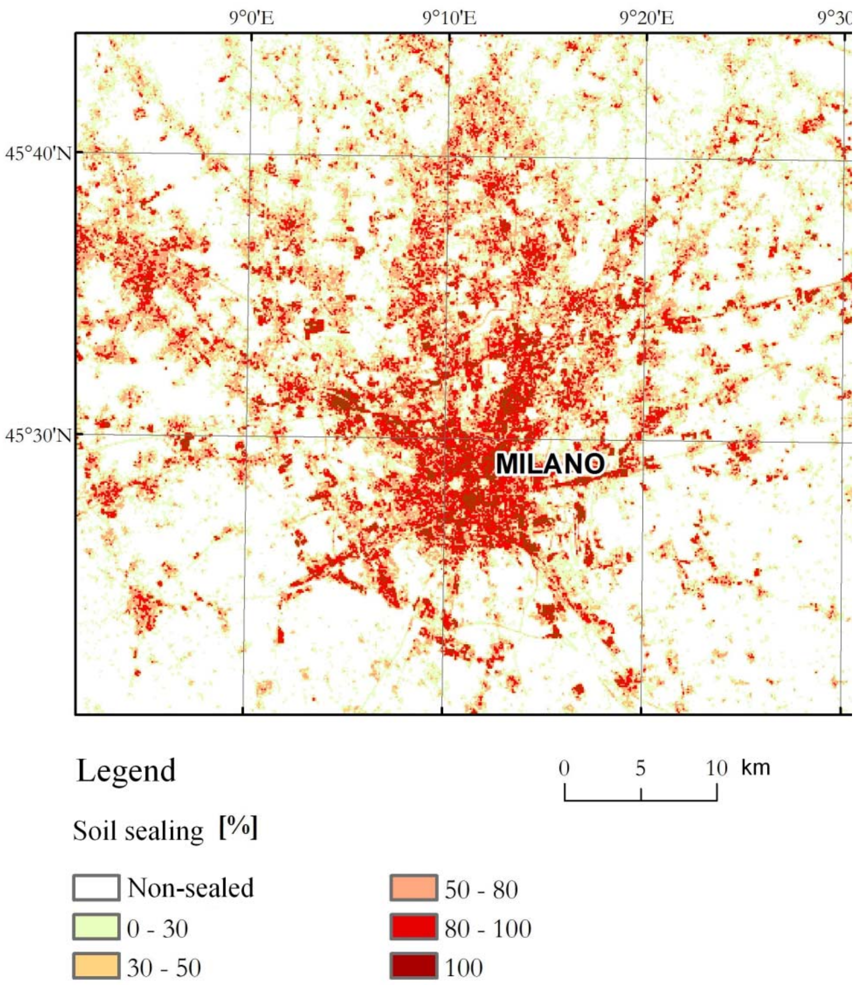


Figure 2: Soil sealing in Milan in 2009[35]

Policies for sustainable land management

The primary goal is to reduce the rate of conversion from agricultural and natural land to artificial loss of areas of high environmental and cultural value.

In agreement with achievements in other European countries, this would require the adoption, in Italy, through appropriate tools and levels of regional and local government, of effective measures that can help limit and reduce the consumption of soil.

Regional planning instruments should be integrated and follow a three-tiered approach, as indicated by the Directorate General for the Environment of the European Commission: limitation, mitigation and compensation.

First of all, the reuse of existing urban areas should be guaranteed and promoted, preventing the expansion and sprawling of the city with new housing, offices, commercial, and industrial developments and the resultant consumption and soil sealing of agricultural or natural land.

When *soil sealing* and the loss of land are expected and unavoidable,

[35] Source: EEA - *Degree of soil sealing* 2009

appropriate mitigation measures in the maintenance of soil functions and for reducing negative environmental effects should be identified, defined and implemented.

Finally, only in the case where the mitigation measures for unavoidable interventions are deemed sufficient, compensation actions may be taken into account.

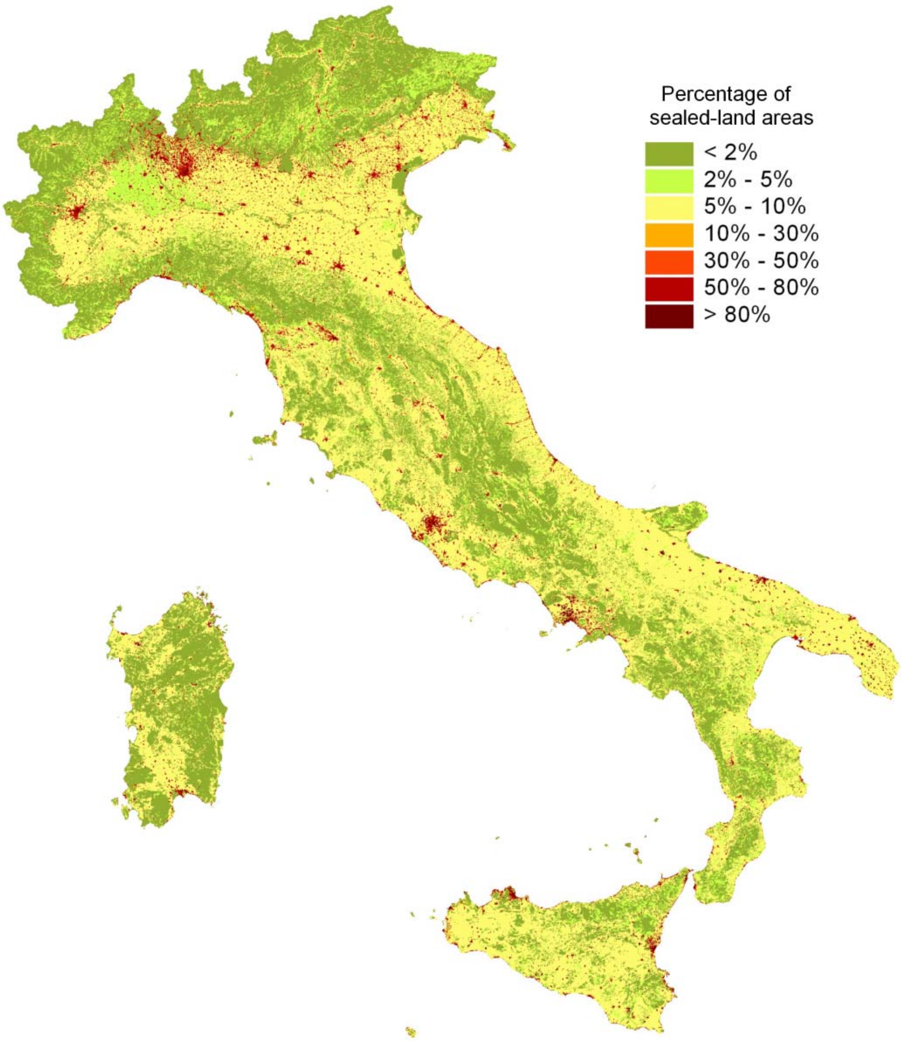


Figure 3: National map of soil sealing (2006)[36]

[36] Source: ISPRA

SPECIAL FOCUS BOX

BOX 2: Desertification

In European countries the processes of desertification are related to a series of natural (climate change, drought, etc..) and human-related causes (overexploitation of water resources, improper agricultural practices, urbanization pressures, etc..), which add on to natural factors (shallow and poorly structured soil, lack of vegetation cover, steep slopes, etc..), which interact in stressing environmental vulnerability, leading in many cases to the "functional sterility" of soils (*National Atlas of the areas at risk of desertification*, 2007).
In the Mediterranean Region, the maps produced by the European Environment Agency (EEA) and the ETC-LUSI (European Topic Centre Land Use and Spatial Information) consortium features the presence of several areas of high/very high sensitivity to desertification, where levels of deterioration can be reached such as to make the land unusable for agriculture, forestry and grazing (Figure 4).

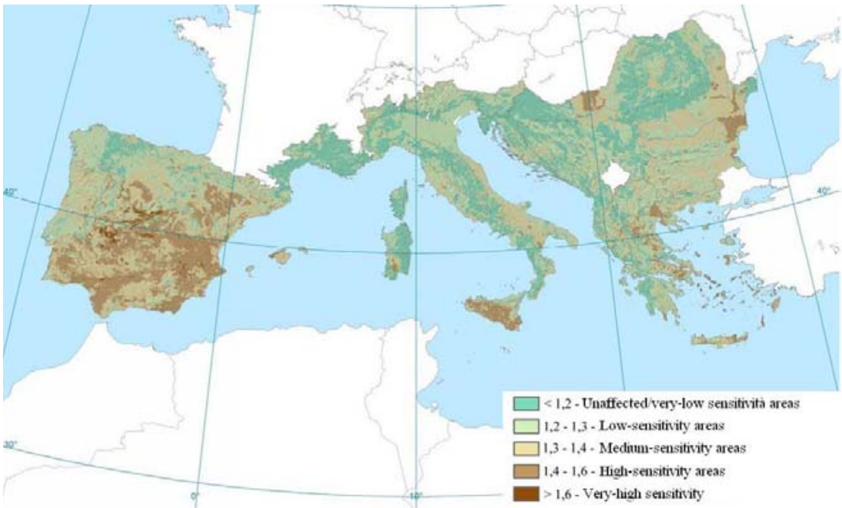


Figure 4: Sensitivity to desertification index map for Europe (2008)[37]

<u>Desertification in Italy</u>

In Italy, even through the situation is not as bad as in other areas of the Earth, desertification is becoming increasingly obvious in at least six regions (Sicily, Basilicata, Molise, Sardinia, Apulia and Calabria) and negative signs are coming from other central and northern regions.
The evaluation of the intensity and extent of desertification is a difficult task, due to the lack of a unique and integrated methodology at global and regional level.
The need to determine the "scientific" status of and trend in desertification has resulted in numerous projects and studies at international, national and regional level. Italy has invested in

[37] Source: Foundation of Applied Meteorology, AEA, ETC-LUSI

improving the knowledge and methodologies, producing results in several regions, mainly based on the method of the *Environmental Sensitive Areas* (ESA, C. Kosmas et al. 1999).

According to this method, vulnerability to land degradation and desertification is defined by the ESA index, calculated using the geometric mean of soil, climate, vegetation and land management quality indices.

The latest nationwide assessment (L. Perini, et al, 2008) estimates that 10% of the country is very vulnerable (ESAI> 1.5), 49.2% has a medium vulnerability (1.3 <ESAI <1 , 5) and 26% a lower or no vulnerability at all (ESAI <1.3).

The most vulnerable areas (ESAI> 1.5) are in Sicily (42.9% of its area), Molise (24.4%), Apulia (15.4%), Basilicata (24.2%) and Sardinia (19.1%). Six regions (Tuscany, Umbria, Marche, Abruzzo, Campania, Calabria) feature a percentage of highly vulnerable land of between 5% and 15%, while in all other areas the vulnerability is below 5%.

Other studies from the regions are associated with activities and projects sponsored by the National Committee for Combating Desertification since 2004, confirming the national framework for providing insights into and facts about the most vulnerable areas and highlighting situations of particular local relevance.

At international level, the *Millennium Ecosistem Assessment* (MA), using the concept of "ecosystem services" has rendered the definition of desertification adopted by the UNCCD more operational in nature.

The decline or improvement of various services provided by ecosystems is, in fact, the main symptom of degradation/desertification, or the success of remediation measures, especially for services related to subsistence farming, which directly threaten the livelihoods of the most vulnerable communities.

The FAO's *Land Degradation Assessment in Drylands* (LDAD) project, based on the concepts proposed by MA, has used the Gladis method to assess the status of and trends in desertification and land degradation.

Preliminary results are promising, although the low spatial resolution of the data used allows very limited use of the available results. Six indicators have been selected for: biomass, biodiversity, soil health, water availability, the economic and social situation.

By using bio-physical and socio-economic parameters, global maps and diagrams at the local and national levels were made, with the aim of providing an overview of the state of the ecosystem services and their evolutionary trend.

The six indicators are calculated from satellite data, results of simulation models and economic and social databases. The results of the Gladis project are still being improved and verificated, so they still cannot be used at the national and subnational levels.

Mitigation policies

In 1994, Italy signed the UN Convention to Combat Drought and Desertification in the country becoming a member, with the dual role of "donor" and "affected" country, included in Annex IV of the

Convention for northern Mediterranean countries.
The DPCM of 26 September 1997 gives the National Committee for Combating Desertification – NCCD in Italy the task of implementing the obligations of the Convention and, in particular, the preparation of the National Action Programme (NAP) in the context of the Mediterranean basin, according to the procedures, contents and participatory approach reported in articles. 9 and 10 of the Convention.
In 1999, the NCCD has developed the Guidelines of the NAP, subsequently approved by CIPE 229/99.
NAP is based on a system of actions at national and regional level, which gives the regions and River Basin Authorities the powers to develop and implement specific agricultural, forestry, civil and social measures, accompanied and supported by specific plans for information, training and education, in some areas identified as prioritary:

- Soil protection
- Sustainable management of water resources
- Reducing the impact of production activities
- Environmental balance.

The financial resources made available by MATTM (about 5 million euros between 2004 and 2008) have focused on actions at national and local levels. Firstly, for the improvement of knowledge and design skills, education, training and dissemination of information and some international activities.
Secondly, to focus on specific actions in separate plans (Figure 5):

- Local Action Plans (LAP), whose key actors were the local scientific and technical institutions. These LAPs were based on the identification of environmentally uniform areas and the establishment of guidelines based on the specific local issues.
- Pilot projects, for which the key actors were the local authorities, with the support of local scientific and technical institutions. These projects have provided a complete description of the environmental area, identifying the relevant problems, establishing specific operational projects, ensuring integration with existing plans and land management programs and defining guidelines for their reproducibility.

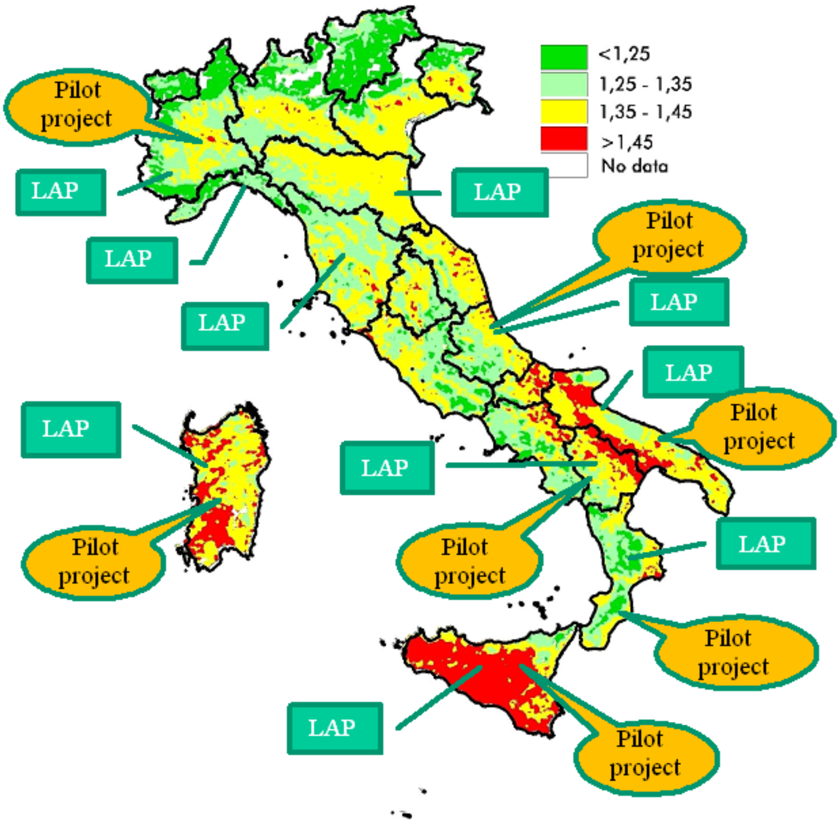


Figure 5: National Environmental vulnerability index (2008; data of 2000) with the activities to combat desertification[38]

The "Decade NCCD Strategy" (2008-2018) provides for the adjustment of the NAP and the evolution of environmental and land knowledge management tools, renewing the national regulatory framework and enhancing the analysis and economic instruments.

CHAPTER 11

USE OF RESOURCES AND MATERIAL FLOWS

Introduction

The use of material resources plays a crucial role in the generation of environmental pressures due to the demand for natural resources (*input*) and the transformation thereof(output).

Knowledge of the amount of resources used by a given socio-economic system – and, generally speaking, of those necessary for it to function – is very important for the purpose of understanding, at the macro (economy-wide) level, the interaction between this system and the natural environment. The use of material resources, in fact, plays a crucial role in the generation of environmental pressures, because it is both at the origin of the pressures directly deriving from primary activities (cultivation of agricultural biomass, extraction of timber from forests, extraction of minerals) and a prerequisite for pressures such as emissions to air and water, waste landfilled and dissipative flows, i.e for those pressures consisting in material outputs to the natural environment. Ultimately, any pressure on the natural environment and on human health presupposes the extraction and transformation of materials.

Knowing the quantities of resources used, along with their quality and origin, means knowing the potential of the system to generate pressures through the handling of materials. Only by putting under control this potential and by adopting qualitatively and quantitatively responsible production and consumption patterns – that respect the *absolute* limits placed by nature to the expansion of human activities – will we be able to achieve sustainability.

European Commission's headline indicator[1] to monitor the target of sustainable consumption and production is resource productivity. This target is one of the seven key challenges identified by the EU's Sustainable Development Strategy[2]. To measure resource productivity, the European Union has adopted the ratio of GDP to the Domestic material consumption (DMC). The variation in time of this ratio provides a clear indication of the decoupling of economic growth from the use of resources.

Figure 11.1 compares resource productivity in Italy and in several other European countries. The differences between the countries are due to the diverse industrial structures, the role played by the services sector and the level of construction activities, the scale and patterns of consumption and the different energy sources. The figure shows how, even in the short period taken into account, Italy, along with the UK and Spain,featured the highst growth in productivity , followed by France and Germany .

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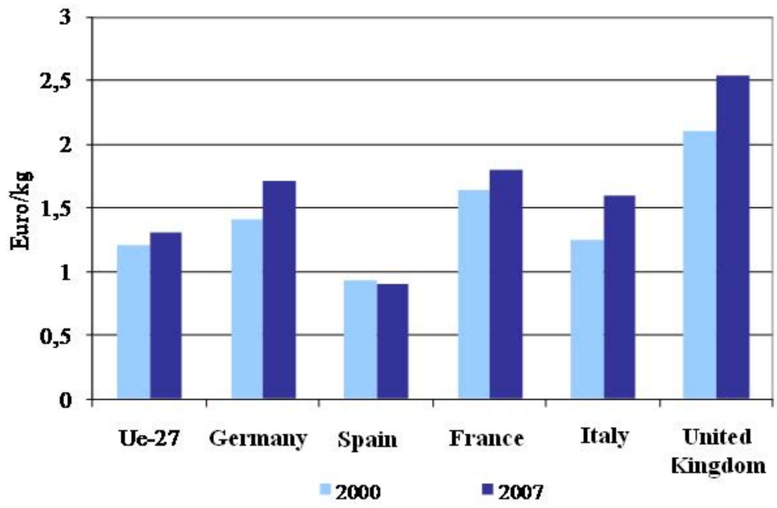
[1] *Sustainable development in the European Union*, 2011 monitoring report of the EU sustainable development strategy, Luxembourg 2011

[2] Council of the European Union, Review of the EU Sustainable Development Strategy (EU SDS) - *Renewed Strategy*, 10117/06. Brussels, 9 June 2006



Italy features one of the highest increase in resource productivity , compared to several other EU Member States and the EU average.

Figure 11.1: Resource productivity in the EU, in France, Germany, Italy, the UK and Spain (2000, 2009)[3]

Globally, the extraction of natural resources used by the economic system for transformation into products, reached almost 60 billion tons in 2007, up by 65% compared to 1980. These products, besides the direct use of the materials, require the further extraction - amounting to about 40 billion tons in 2007 – of unused materials, i.e. materials that originate from the environment, but do not physically enter the economic system as input for further processing or consumption and return to the environment as residuals immediately after removal/displacement from their natural site. The rate of growth of unused materials, in 1980-2007, was lower than that of directly used materials, due to both the improvements in the extraction and production processes and to the different composition of the extracted materials[4].

Globally, the growth rate of unused materials, in 1980-2007, was lower than that of the directly used materials, as a result of both the improvements in the extraction and production processes and the different composition of the extracted materials.

In the OECD countries, this data is accompanied by a relative decoupling of economic growth from efficiency in the use of the resources. Figure 11.2 compares the Italian resource labour and energy productivity, higlighting how the OECD trend is confirmed with respect to the use of natural resources.

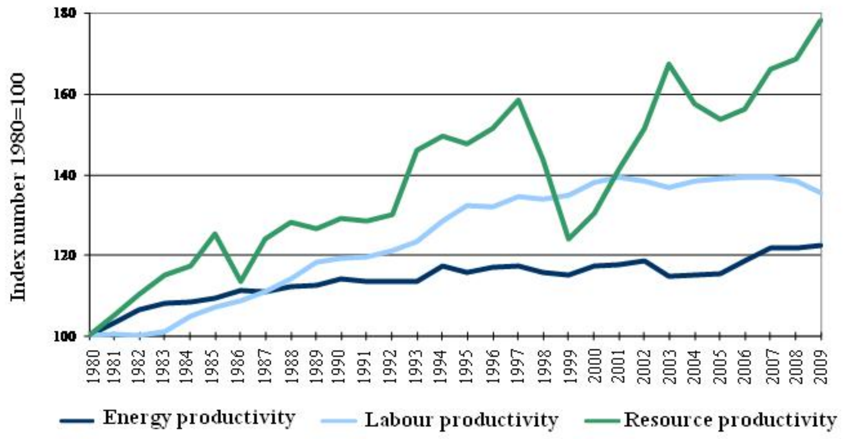
Resource, labour and energy productivity in Italy

In Italy, in 1980-2009, significant improvements occurred in the productivity of economic resources per unit of domestic material consumption (DMC) (+79%), despite the drop at the end of the 90s caused by the considerable growth of domestic extraction in 1998-1999. The increased efficiency of resource use is faster than that of both labour productivity (+36%) and energy productivity (+23%)[5].

[3] Source: Eurostat

[4] Oecd, 2011: *Resource Productivity in the G8 and the OECD*, Parigi http://www.oecd.org/dataoecd/18/20/47944428.pdf

[5] It should be observed how the European energy efficiency indicator hides the fundamental distinction between the roles and efficiencies of the energy supply systems and of the final energy use, likewise the indicator relating to the use of the resources, in which imported products are viewed as equal to the domestically extracted resources



In Italy, in 1980-2009, the productivity of economic resources increased by 78%. Increased efficiency of resource use is faster than both productivity of labour (+36%) and productivity of energy (+23%).

Figure 11.2: Resource, labour and energy productivity in Italy (1980-2009)[6]

The European indicator seem to show is that Italy is moving in the right direction, with regard to resource use …

…. although further investigation is required.

What these indicators seem to show is that Italy is moving in the right direction, in line with *the need to put a drastic increase of the efficiency with which natural resources are used among the primary goals of society, and to assign to this goal a very high priority level, even higher than that currently attached to the increase of labour productivity*[7]. However, it should be observed that the efficiency indicators shown in Figure 11.2 provide an excessively condensed representation of the environmental, socio-economic and energy dynamics. The conclusions regarding to the changes in the country's industrial structure that can be drawn from these indicators, must be based on a more in-depth and extensive analysis. In particular, the *resource efficiency* indicator adopted by the European Union is, on the one hand, very much aggregated and could, therefore, conceal critical trends in various resources; on the other hand, its interpretation must take into account the fact that it does not exhaustively represent the natural resource needs of an economic system. For these reasons, besides considering the resource productivity indicator, it is expedient on the one hand to disaggregate material consumption (i.e. the denominator of the resource productivity indicator) into its component parts and on the other hand to broaden the analysis to overall material requirements, therefore also including unused domestic extraction (UDE) and indirect material flows associated with international trade. A similar more exhaustive analysis helps understand how resource productivity has evolved in Italy over the years and the dynamics underlying domestic extraction, such as those of international trade and the final demand by Italians.

Disaggregation of material consumption: extraction and external trade by type of resource

[6] Source: Istat

[7] Femia A., *Changing the priorities: From labour productivity to resource productivity*, in Policy, Strategies and Instruments for a Sustainable Resource use, H. Lehmann, M. Angrick, A. Burger (eds), German Federal Environment Agency: Perspectives Factor X, Springer. 2012 (the Italian version is available online at: http://www.sbilanciamoci.org/benessere/femia_cambiare_priorita.pdf)

In 2009, domestic extraction used (DEU) in Italy amounted to 529 million tons. Despite dropping by 18% since 1991, this indicator features a cyclic performance and does not highlight any long-term trends (Figure 11.3). In 1991-2009, the composition of DEU remained constant: the principal extracted materials were non-metallic minerals and biomass (respectively, 75% and 22% of the total, on average, in the period); the extraction of fossil energy carriers and metal ores does not exceed 3%, on average, of the total for the period and almost entirely concerns fossil energy resources.

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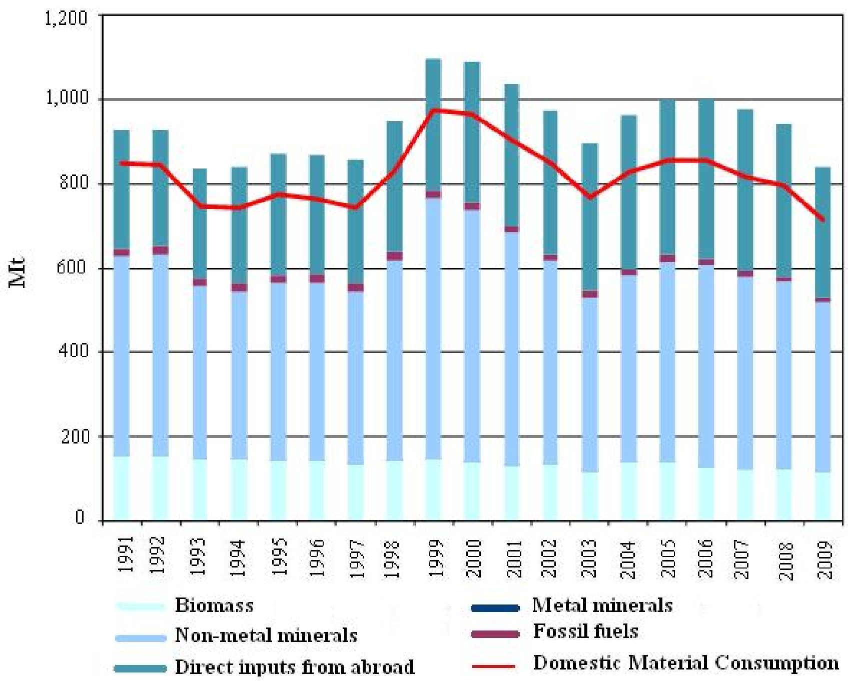


Figure 11.3: Domestic extraction, in Italy, by resource, external input and apparent consumption (1991-2009)[8]

This composition of the domestic extraction of natural resources in Italy highlights the importance of the construction industry – which uses most of the non-metallic minerals – and the lack of fossil energy resources and metal ores extraction. Figure 11.3 also allows considering the trend in the Italian physical trade balance, by looking at difference between the top of the bars - which represents the direct material input (DMI) - and the domestic material consumption (DMC) line.

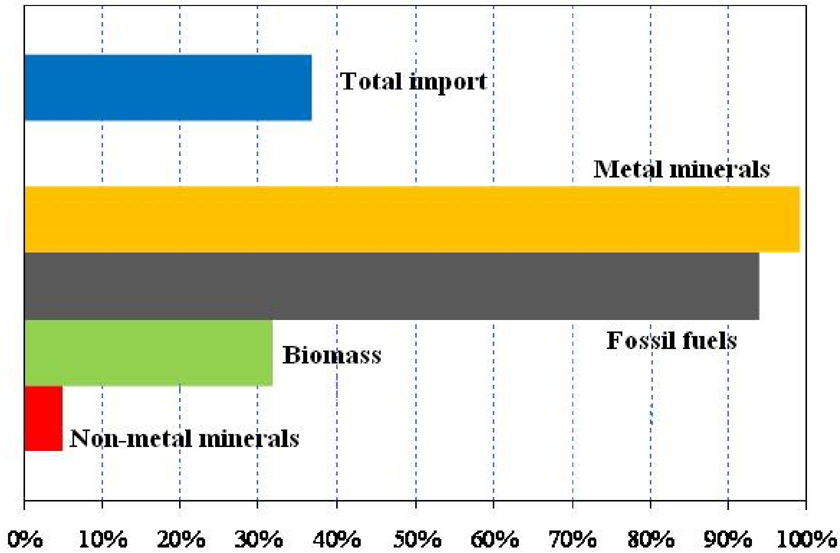
The relationship between DMC and DMI is very important: the balance between total weight of imports and total weight of exports provides a useful indicator of a country’s role in the international panorama of resource extraction, because it shows to what extent the material resources that enter a country’s socio-economic system are directly used within it or exported to other economies. The Italian economy’s foreign dependence on the raw materials it lacks makes Italy, like most European countries, a net importer of natural resources; Italy, in fact, imports almost all the metal ores and fuels it

Italy’s foreign dependence on the

[8] Source: Istat

needs for its socio-economic metabolism[9] (Figure 11.4). Total imports supply a significant proportion of the direct material input (DMI), which stood at approx. 30% until the beginning of the 2000s, surging to 37% in 2009. Imports are more sensitive to the economic cycle than domestic extraction; this is visible in the evolution of the percentage of imports, with respect to the total materials used: the figure for 2009, in particular, records the economic crisis we are facing, featuring a 5 percentage point drop year on year. This crisis, however, counterbalances only partially the long-term growing trend in external input's share on total use of materials.

raw materials it lacks makes it, like most European countries, a net importer of natural resources.



Italy imports almost all the metal and fuel it needs for its socio-economic metabolism.

Figure 11.4: Percentage of imports to total use of materials, overall and by material (2009)[10]

The percentage breakdown of imports by type is: 53% fossil energy carriers (in order of importance: crude oil, natural gas and coal), 14% metal ores (primarily iron), 11% biomass – which will be dealt with more extensively further on – and, in much smaller proportions, non-metallic minerals (5%). Then other imported products (15%) and fuel bunkered by resident units abroad (2%)[11].

As highlighted in Figures 11.3 and 11.4, we can conclude that Italy, although it does not have the more prized non-renewable natural resources, especially fossil fuels and metal ores, and must necessarily significantly depend on flows from abroad, has nevertheless failed to put into place any effective policies for reducing this dependence. We refer to energy and industrial policies for increasing the efficiency in the use of resources and their replacement – where possible – with domestically available resources. These are obviously very demanding and research-

Italy, although it does not have the more prized non-renewable natural resources, has nevertheless failed to put into place any effective policies for reducing the dependence from

[9] A socio-economic system, in fact, can be likened to an organism that uses and transforms materials and energy

[10] Source: Istat

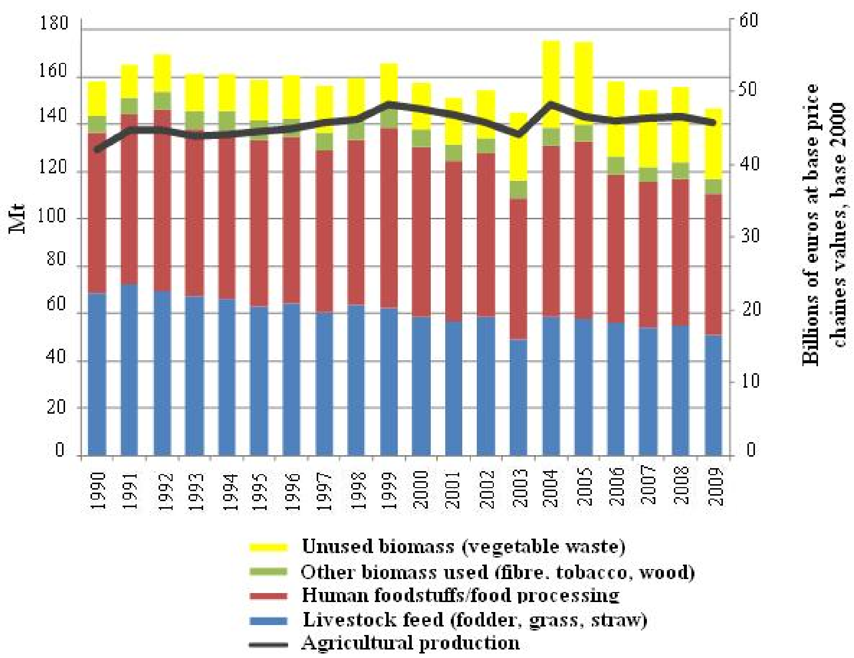
[11] As in domestic extraction, so in material flows from abroad the percentage breakdown of the components remained stable in 1991-2009; therefore, the values shown are the average values for the period

intensive policies, which only produce results in the long run, and to which great impulse has been given, internationally, in recent years[12].

With regard to renewable resources, unlike non-renewable resources, domestic extraction can be traded off with imports: biomasses, in fact, account for 22% of the domestic extraction used (DEU) and 14% of flows from abroad[13].

Agriculture's role in the socio-economic metabolism is to generate and make available biological materials for the economic system as a whole. Figure 11.5 shows the decreasing trend, with a strong cyclical component, of the quantities produced in Italy over the past twenty years, along with monetary value of the output of the branch, which features a similar cyclical performance, but with a slightly growing trend. In particular, all types of used biomass have decreased: significantly and regularly those associated with livestock breeding (-26%), in parallel with the reduction in the amount of animals, but also those of greater interest for the food processing industry, because suited to human consumption (-12%). The latter type of biomass primary consists of cereals, fruit and vegetables.

abroad. Energy and industrial policies could have been planned and enforced for increasing the efficient use of resources and their replacement with domestically available resources.



In the Italian agricultural system, the quantities produced over the last twenty years has dropped, with a strong cyclical component, while the output of the branch featuring a similar cyclical performance, recorded a slight upward trend. In particular, among the different types of biomass used, those associated with livestock breeding diminished (-26%)

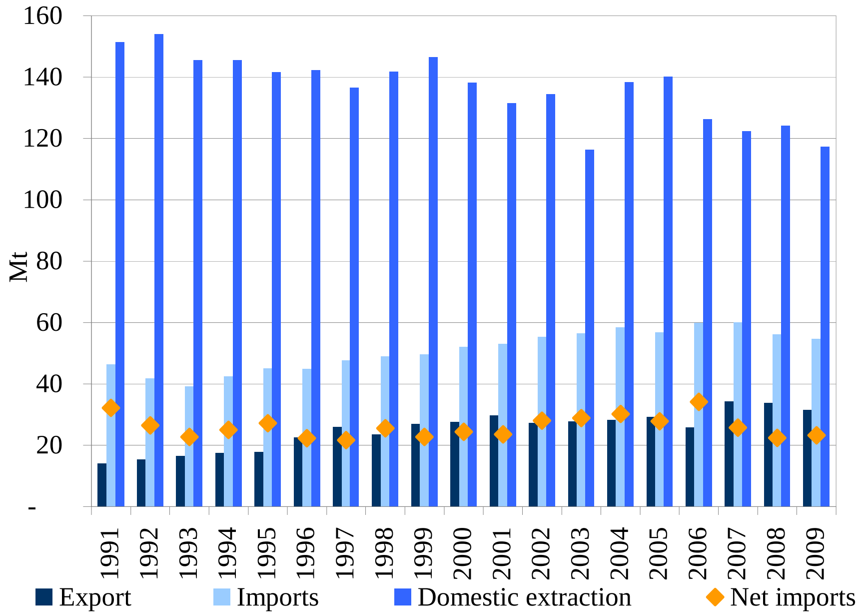
Figure 11.5: Biomass extracted from the Italian environment and economic value of the output of the Agriculture branch (1990-2009)[14]

[12] See the Communication from the Commission the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions *On the Progress of the Thematic Strategy on the Sustainable use of Natural Resources*, SEC(2011) 1068 final, Brussels, and the OECD *Recommendation of the Council on Resource Productivity*, C(2008)40, Paris

[13] Average value (1991-2009) for both indicators

[14] Source: Istat

Figure 11.5 shows the unused biomass not included in the DMC, as for example, all the crop and plant residues, which could be used for reducing the country's energy bill by using appropriate technologies. This is the only biomass component on the rise (+108%). There was a considerable increase between 2002 and 2004, primarily as a result of the increased cultivation of maize, which produces a great deal of residues.
In the rest of the socio-economic system, the used biomass is transformed into excrements, organic waste, air emissions and, to a very limited extent, into durable goods. To this potential for pollution generated in Italy, we must add that relating to the imports (Figure 11.6). The flows from abroad appear to be clearly rising (+7%), despite the ongoing fall due to the crisis, while domestic extraction is dropping: the replacement effect is evident. The portion of potential pollution transferred abroad, in connection with exports, is rising, in relative terms at least (+39%), being parallel to that of imports in absolute terms, which clearly indicates Italy's growing biomass transformation vocation over the last twenty years.



Biomass: flows from abroad are clearly rising (+18%), while domestic extraction is dropping, with an obvious replacement effect.

Figure 11.6: Foreign trade and domestic extraction of biomass[15]

Broadening the analysis to total resource requirement: Italy's material footprint

For a more complete assessment of the material flows associated with the domestic economy, we should also take into account, besides the above mentioned flows, the materials removed from the environment but not used, and those needed to produce the imported and exported goods, but not embodied in them (indirect flows). Unused materials are materials the removal of which is necessary for the performance of other activities; generally speaking, these consist of spoil and other waste products generated in connection with the extraction of minerals of economic value, spoil produced in

[15] Source: Istat

connection with excavations for buildings and infrastructure, and agricultural and forest unused biomass (the latter has already been seen in Figure 11.5). Indirect flows consist of the waste and emissions generated (from used as well as from unused materials) in the countries of origin of internationally traded goods.
An indicator that takes all these flows into account is Total Material Consumption (TMC) (Figure 11.7), which measures the total primary material requirement associated with domestic consumption activities and provides the country's "material footprint", i.e. the overall "cost" paid globally by nature, in terms of its resources, to satisfy the final domestic demand of a country. It excludes the flows related to the exported goods and services..

Italan economic growth has been accompanied by the constant growth of Total Material Consumption until the early 70s, after which it slowed down, until the 90s, reaching a shaky stability in the last decade.

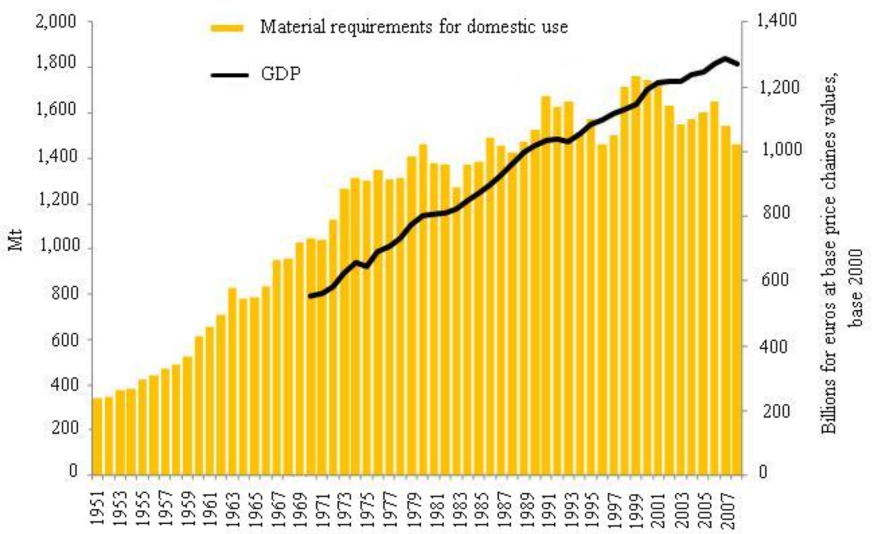


Figure 11.7: Total material consumption (1951-2008) and Gross Domestic Product (1970-2008) in Italy[16]

The Figure above shows how the Italian economic growth has been accompanied by the constant growth of TMC until the early 70s, after which it slowed down, until the 90s, reaching a shaky stability in the last decade. The performance of the two indicators shows the relative decoupling of the environmental variable from the economic one, because the requirement of material resources features a lower growth rate than that of the Gross Domestic Product.

Tra il 1970 e il 2008 si rileva un decoupling *relativo del fabbisogno di risorse materiali dal Prodotto Interno Lordo.*

The breakdown of the TMC into its two main components, used materials flows and induced flows, enables a more in-depth investigation of the indicator's overall performance (Figure 11.8).

[16] Source: Istat

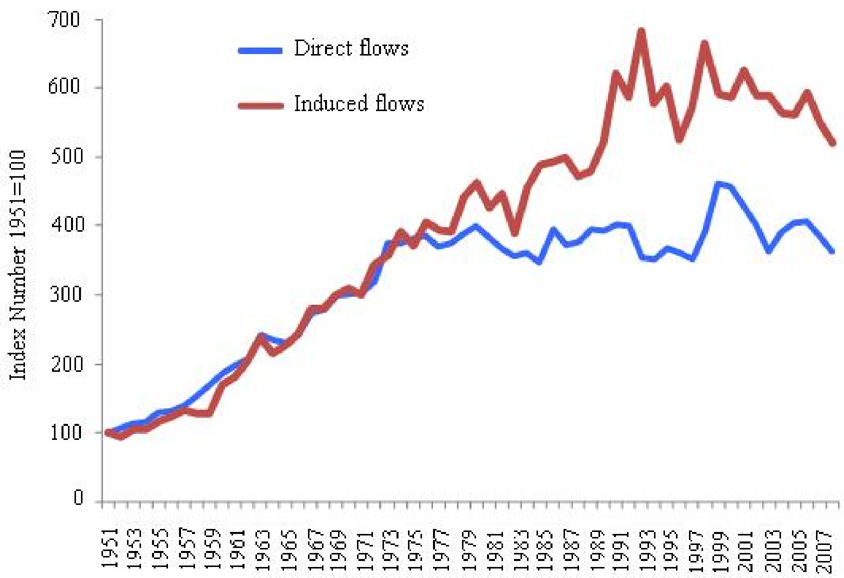


Figure 11.8: Breakdown of domestic material requirements. Italy (1951- 2008)[16]

Domestic material consumption indicates that the process of dematerialization of the visible part of the economy already began in the early 70s, during which the direct use of natural resources remained stable, despite the significant economic growth. However, the flows induced by this apparent consumption continued until the early 90s, determining the growing trend of the Total Material Consumption.

The first component, DMC, indicates that the process of dematerialization of the "visible" part of the economy began in the 70s, during which the direct use of natural resources is stable, despite the significant economic growth. However, the unused and upstream flows induced by this apparent consumption continued to increase until the early 90s, determining the growing trend of TMC. The principal driver of this increase is the indirect net flows related to international trade, which is the largest part of the "induced flows" component of TMC . Moreover, in the same period, DMC's largest share are net imports, which also feature a strong growth. Therefore, in order to satisfy domestic demand, an increasing use was made of both direct and indirect material inputs from abroad. This consisted in the replacement of domestic resources, in the case of biomass, and in the input of otherwise non-existent or non-extracted domestic resources for fossil fuels and metal ores. Thus, a part of the pressures on the environment was transferred abroad.

The analysis of the purely quantitative indicators does not allow drawing detailed conclusions, because the qualitative aspects are of fundamental importance. In TMC, e.g., there is no distinction between the used and unused parts of the natural resources extracted abroad (these aspects are currently being studied by the European statistical system). However, a very clear message emerges from the impressive growth of the extraction of materials necessary to sustain with a hypertrophic socio-economic metabolism.

GLOSSARY

Domestic Material Consumption (DMC):
The indicator Domestic Material Consumption measures the Domestic Extraction Used plus Imports (Direct Material Input)) minus Exports.

Resource productivity:
The indicator Resource productivity reflects the Gross Domestic Product (GDP) per unit of Domestic Material Consumption.

Labour productivity:
The indicator Labour productivity reflects the GDP per unit of hour worked.

Energy productivity:
The indicator Energy productivity reflects the GDP per unit of Gross Inland Energy Consumption.

Direct Material Input (DMI):
The indicator Direct Material Input measures the direct flows of materials that physically enter the economic system as an input , i.e. all materials which are of economic value and are used in production and consumption activities. DMI equals Domestic Extraction Used plus Imports.

Domestic Extraction Used (DEU):
The indicator Domestic Extraction Used measures the total inputs domesticaly extracted from the natural environment (biomass, metal ores, non-metallic minerals, fossil energy materials/carriers.

Unused flows:
Unused material flows refer to any material which is intentionally extracted from the environment but do not physically enter the economic system. They return to the environment as residuals immediately after removal/displacement from their natural site.

Induced flows:
Induced flows comprise the unused material flows from the domestic extraction of resources and the indirect net flows of international trade, i.e. the materials needed to produce the net imports. These flows complete the demand of materials expressed throughout the lifecycle of the goods.

Total Material Consumption (TMC):
The indicator Total Material Consumption measures the total material use associated with domestic production and consumption activities, including indirect flows imported (i.e. the material flows that are associated to imports, but that take place in other countries), minus exports and their associated indirect flows. Hence TMC provides information on the overall amount of natural resources extracted worldwide to satisfy the final domestic demand for goods

and services. TMC would also assess whether the dematerialization of final domestic demand – based on the direct flows of material used (Domestic Material Consumption) – entails a similar dematerialization of the entire production chain, or we are actually dealing with increasing flows taking place abroad to satisfy the domestic demand of consumer goods and investments. The latter hypothesis would entail the growth of the overall potential pressures exercised globally.

CHAPTER 12

THE WASTE CYCLE

Issues and regulations

All the strategic actions and regulations produced by the European Union set as a priority the sustainable use of resources, linking this to sustainable waste management.

The aim is to ensure that the consumption of renewable and non-renewable resources and the ensuing impact does not overcome the environment's load capacity and to obtain decoupling of the use of resources from economic growth via the significant improvement of the efficiency in their use, obtained by "dematerializing" the economy and by preventing waste.

Waste prevention actions are implemented mainly via "source reduction" means. This approach entails, on the one hand, the search for solutions that extend the life cycle of products so as to reduce the use of resources and engage in the use of cleaner manufacturing processes and, on the other, the capacity to channel consumer choice and demand towards products and services that generate less waste.

All of the European Union's strategic and regulatory acts set as primary objective the sustainable use of resources, linking it to the sustainable management of waste.

The Thematic Strategy on waste prevention and recycling, one of the seven thematic strategies of the 6th Environment Community Action Programme, lists a series of measures to be implemented in order to improve waste management, reinforcing the approach based on the fact that waste is no longer seen as a source of pollution but rather as an important resource that can be managed and used effectively.

The aims of the waste management policy, promoted by the Strategy, remain waste prevention and the promotion of reuse, recycling and recovery, although its new objective is to make the European Union become a "recycling society that not only avoids generating waste but also uses it as a resource".

Finally, Directive No. 2008/98/EC of 19 November 2008 lays down significant new measures aimed at reinforcing the principles of precaution and prevention in waste management, at maximising waste recycling/recovery and at ensuring that all management operations, beginning from collection, are performed to strict environmental standards. Moreover, the directive invites Member States to ensure complete traceability of hazardous waste, from production to final destination.

Knowledge of the waste system leads to the taking of well-grounded decisions and allows to supervise them, to provide information accessible by economic operators and by the general public regarding the environmental situation and relating trends.

It is therefore essential, also with a view to fulfilling the EU obligations, to possess an effective, continuous and accurate information base, capable of adapting to the reality it represents, and to its changes, and able to portray the institutional responses and the effects produced by the decisions and relevant corrective

In the waste sector, also in order to fulfil community obligations, the

actions.
Of even greater importance is ensuring the public, and all the organizations and structures operating in the social fabric, receive accurate information on the waste cycle.
Indeed, individuals play a leading role in the application of waste prevention and recycling policies. The routing of consumption towards products that pollute less during their entire life cycle (conception, manufacture, distribution, consumption and post-consumption) and that are also easier to reuse and recycle truly can boost prevention and recycling, leading to a more sustainable use of resources. Also noteworthy is the key role played by citizens in separate collection systems, the success of which is closely linked to correct information and their active involvement.
Most recently, the European Commission has reiterated the priorities in waste management by means of two Communications to the European Parliament, the Council, the European Economic and Social Committee and to the Committee of the Regions: the first dated 26 January 2011 "A resource-efficient Europe - Flagship initiative under the Europe 2020 Strategy" and the second dated 20 September 2011 "Roadmap to a resource efficient Europe". In a consumer-oriented civilisation, the waste management issue has increasingly grown over time, sometimes into an emergency requiring drastic measures.

availability of an effective, continuous and accurate information base capable of adapting to reality and its changes and capable of accounting for institutional responses and the effects produced by their ensuing decisions and corrective measures, is key.

In these communications, the sustainable use of waste is set in the more ample strategy of sustainable use of resources. This approach stems from the change in current growth and consumption models to define a coherent action plan that envisages diverse areas and sectors and is aimed at providing a stable prospective for transforming the economy.
The Commission's Communication "Roadmap to a resource efficient Europe" lists in detail the actions and time schedules required to arrive concretely at an efficient use of resources. It starts from an analysis of the current situation that appears to be truly alarming: today, in the EU, each citizen consumes an average annual amount of 16 tons of material, 6 of which are wasted (half of it ends up in the landfill). Clearly, the era of abundant and cheap resources is over and enterprises are facing rising prices of essential raw materials and minerals, the scarcity and instability of which, price volatility, negatively affect the economy.

The sustainable use of waste is placed by the EU within the framework of the more ample strategy for the sustainable use of resources. This approach stems from the changes in current growth and consumption models so as to define a coherent action plan covering various areas and sectors.

Our economic system continues to encourage the inefficient use of resources, pricing some of these below their actual cost. Against this backdrop, it is essential to transform waste into a resource. The following figures are sufficient to prove the need for prompt and concrete actions to change the current system: every year the EU generates 2.7 billion tons of waste, of which 98 million tons are hazardous waste. On average, only 40% of municipal waste is reused or recycled, the rest is disposed of in landfills or incinerated. Equally worrying is the increase in certain waste flows, such as construction and demolition waste, sewage sludge, marine litter; it has been estimated that electrical and electronic waste will grow by approx. 11% between 2008 and 2014.

Not all Member States have introduced efficient waste management systems: some recycle over 80% of waste, thus proving that waste can become a resource, while others continue to dispose up to 90% of their waste in landfills.
Improving waste management unquestionably leads to a better use of resources and can open up new markets and create jobs, resulting in less dependence on imported raw materials and helping reduce environmental impacts.
Unfortunately, current management models have often proved inadequate, like the control systems that often use insufficient procedures. This has also favoured the development of illegal trafficking run by organized crime that has turned waste management into a thriving business.
A solution to the need for an efficient information and control system has been provided, in Italy, through the introduction of the Waste Tracking System (SISTRI), an electronic system that allows to monitor and acquire real time data on the handling of special waste as well as information on municipal waste management.

Via Ministerial decree dated 17 December 2009, Italy established a Waste Tracking System (SISTRI) that allows to monitor in real time special waste streams from generation to final destination.

The SISTRI system, implemented via Ministerial Decree dated 17 December 2009, is not yet fully operational, but when it is, Italy will have a monitoring tool capable of responding adequately to the European Commission requirements against the illegal trafficking of waste, but also of collecting information on the adequacy and conformity of the system to the applicable legislation.
The new system for collecting information on the waste management cycle developed by SISTRI will enhance the effectiveness and comprehensiveness of the accounting system developed by the ISPRA and ensure better and easier compliance with the communication requirements of the European Union.
To date, ISPRA, via the Waste Registry, has acquired, processed and validated all of the information relating to the generation and management of municipal and special waste, ensuring its dissemination through the publication of an Annual Waste Report.

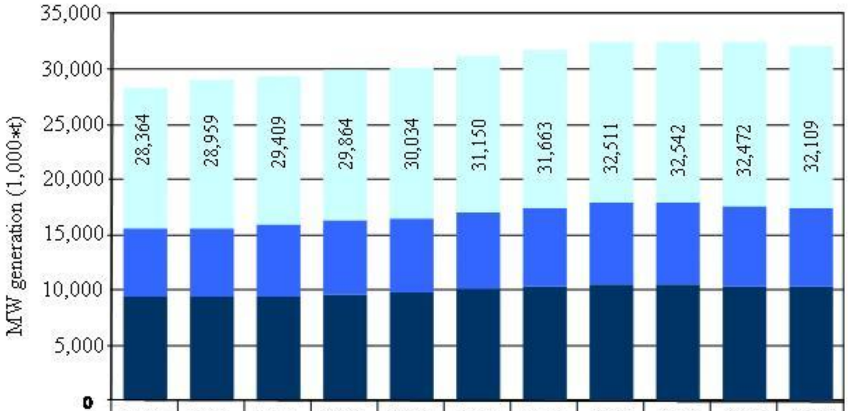
Municipal waste generation and management

The information relating to the generation and management of municipal waste shows, in several aspects, a considerably evolved system that can be compared to the best practices in other Member States.
The scenario, however, is extremely diversified. Much more work has to be done to achieve the objectives set down by the new Framework Directive No. 2008/98/EC on waste, especially as regards the prevention and recovery of municipal waste.
The new provisions, aimed at improving the current management system, are put forth in Italian Legislative Decree No. 205/2010 in application of the Directive.
The first important data regards the generation of municipal waste: in 2009, in correlation with the socio-economic indicator trends such as GDP and household consumption, we saw an approx. 1.1% decrease in generation compared to 2008 (down from 32.5 million tons to 32.1).

In 2009, a 1.1% drop in municipal waste generation was recorded.

This decrease follows the slight drop already observed in the period between 2007 and 2008 (-0.2%).
The 2009 value of per capita waste generation is 532 kg/person per year compared to the approx. 541 kg/person value of 2008 (Figs. 12.1 and 12.2).

In 2009, an approx. 1.1% drop in generation was observed compared to 2008, in the wake of the slight drop already seen in the period from 2007 to 2008.



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
North	12,856	13.276	13,402	13,632	13,576	14,028	14,175	14,604	14,617	14,829	14,621
Centre	6,068	6.214	6,501	6,594	6,586	6,941	7,230	7,352	7,350	7,302	7,186
South	9,440	9,469	9,506	9,637	9,872	10,181	10,258	10,555	10,575	10,340	10,303

Fig. 12.1: Municipal waste generation[1]

Per capita generation, in 2009, amounted to 532 kg/person per year compared to541 kg/person in 2008.

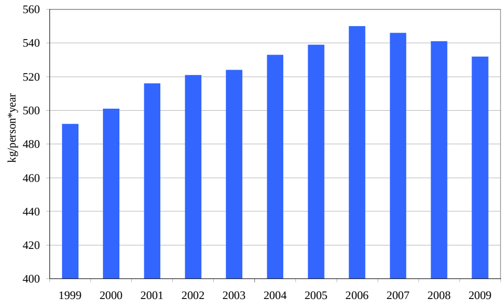
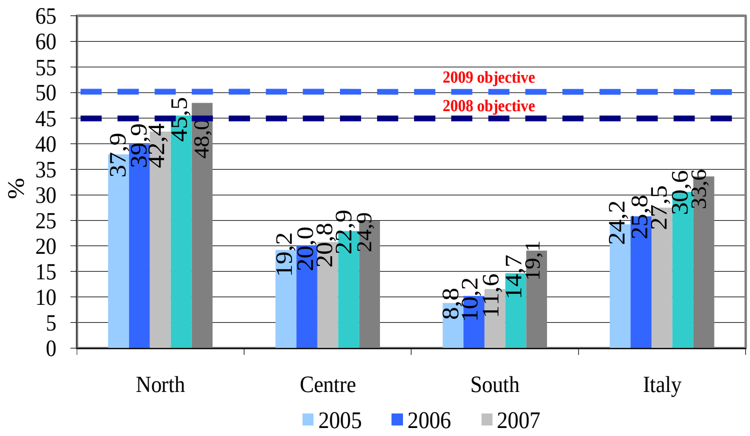


Fig. 12.2: *Per capita* municipal waste generation[1]

Another important element of evaluation is separate collection that in 2009 reached 33.6% of overall generated municipal waste, showing continuation in the upward trend observed in previous years (Fig. 12.3).
The situation, yet again, is very diverse in the three geographical macro-areas: the North, while not yet reaching the target set by the Italian law, recorded a percentage of approx. 48%, while the Centre and the South, in the same year, recorded rates of 24.9% and 19.1%, respectively.

In 2009, separate collection accounted for 33.6% of overall generated municipal waste.

[1] Source: ISPRA



The upward trend in separate waste collection continues, reaching 33.6% of total municipal waste generation in 2009. The situation in Italy's three macro-areas differs greatly: the North reached 48% while the Centre and the South totalled about 24.9% and 19.1%, respectively.

Fig. 12.3: Percentage of separately collected municipal waste[2]

In 2009, as in previous years, the biodegradable waste component from separate collection is the organic one (kitchen and garden and park maintenance waste).

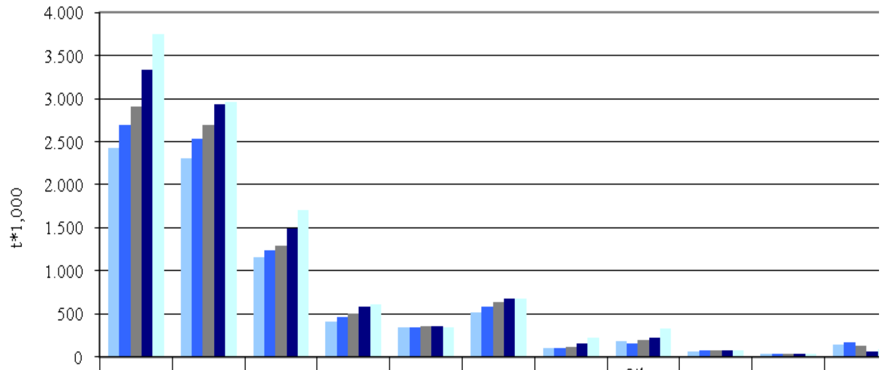
This waste fraction, amounting to over 3.7 million tons, accounts for approx. 34.7% of overall separate collection waste, that in 2009 reached a total of approx. 10.8 million tons (Figs. 12.4 and 12.5).

The organic component accounts for approx. 34.7% of overall separate collection waste.

In the period from 2008 to 2009, the organic fraction increased by about 400 thousand tons (approx. +12.1%) following the increase of over 430 thousand tons observed between 2007 and 2008.

The last two-year period therefore shows an approx. 28.7% increase in the separate collection of bio-waste compared to more modest increases observed in the previous 2004-2007 period (on average, approx. 230 thousand tons of annual growth).

[2] Source: ISPRA



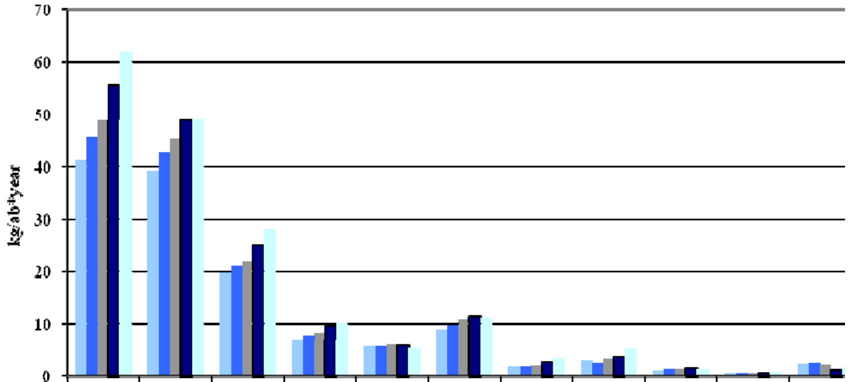
	Organic fraction	Paper	Glass	Plastic	Metal	Wood	RAEE	Other bulk waste	Textiles	Selective collection	Other
2005	2.426,8	2.305,3	1.158,9	409,2	340,1	517,4	102,0	180,3	63,3	30,8	137,9
2006	2.701,1	2.528,5	1.239,6	458,5	337,0	580,7	106,3	158,3	70,4	32,3	162,9
2007	2.909,6	2.698,1	1.297,2	500,3	361,8	642,6	116,2	201,3	73,4	30,5	129,1
2008	3.340,4	2.934,1	1.496,2	577,4	353,7	681,0	156,6	221,2	80,3	32,2	59,7
2009	3.743,7	2.962,1	1.702,6	613,4	340,2	675,5	216,9	328,7	71,5	36,6	85,5

2005 2006 2007 2008 2009

In 2009, as in previous years, the organic fraction amounted to 3.7 million tons, accounting for the largest portion of separately collected waste (34.7% of total).

N.B.:
The amounts relating to the glass, plastic, metal and wood components are the result of the sum of the quantities of packaging and of other kinds of waste consisting of these collected materials.

Fig. 12.4: Separate collection broken down by waste fraction[3]

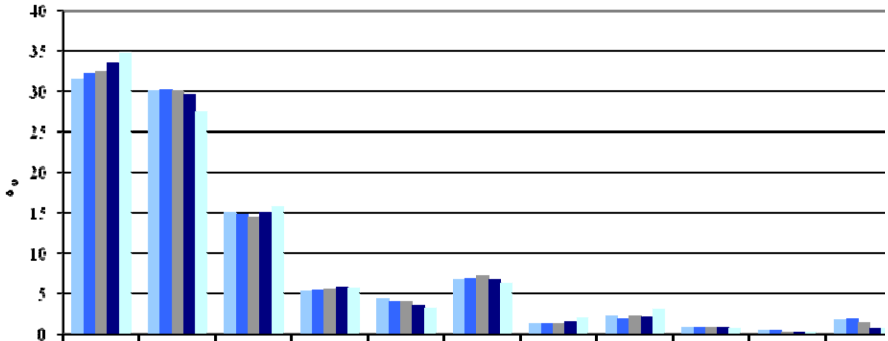


	Organic fraction	Paper	Glass	Plastic	Metal	Wood	RAEE	Other bulk waste	Textiles	Selective collection	Other
2005	41,3	39,2	19,7	7,0	5,8	8,8	1,7	3,1	1,1	0,5	2,3
2006	45,7	42,8	21,0	7,8	5,7	9,8	1,8	2,7	1,2	0,5	2,8
2007	48,8	45,3	21,8	8,4	6,1	10,8	1,9	3,4	1,2	0,5	2,2
2008	55,6	48,9	24,9	9,6	5,9	11,3	2,6	3,7	1,3	0,5	1,0
2009	62,0	49,1	28,2	10,2	5,6	11,2	3,6	5,4	1,2	0,6	1,5

At national level, the per capita value of organic fraction collection in 2009 amounted to approx. 62 kg/person per year compared to 55.6 kg/person per year in 2008.

Fig. 12.5: P*er capita* separate collection by wastefraction[3]

[3] Source: ISPRA



	Organic fraction	Paper	Glass	Plastic	Metal	Wood	RAEE	Other bulk waste	Textiles	Selective collection	Other
2005	31,6	30,0	15,1	5,3	4,4	6,7	1,3	2,4	0,8	0,4	1,8
2006	32,2	30,2	14,8	5,5	4,0	6,9	1,3	1,9	0,8	0,4	1,9
2007	32,5	30,1	14,5	5,6	4,0	7,2	1,3	2,2	0,8	0,3	1,4
2008	33,6	29,5	15,1	5,8	3,6	6,9	1,6	2,2	0,8	0,3	0,6
2009	34,7	27,5	15,8	5,7	3,2	6,3	2,0	3,1	0,7	0,3	0,7

Cellulose and the organic fraction in toto accounted for over 62% of all separately collected waste. Together with textiles and wood, these components make up the so-called "biodegradable waste".

N.B.:
The amounts relating to the glass, plastic, metal and wood components are the result of the sum of the quantities of packaging and of other kinds of waste consisting of these materials.

Fig. 12.6: Percentage distribution of separate collection[4]

In 2009, Southern Italy achieved a higher percentage of organic component collection (+47%).

In the three Italian macro-areas the quantity of bio-waste collected in 2009 amounted to almost 2.6 million tons in Northern Italy, up by about 130 thousand tons compared to 2008, almost 520 thousand tons in Central Italy and about 660 thousand tons in Southern Italy.
In the latter, the collection of bio-waste was up by about 210 thousand tons compared to the previous year, corresponding to a percentage increase just shy of 47%.
The growths seen in the last year bring the *per capita* values of separate bio-waste collection to about 93 kg/person per year in Northern Italy (89 kg/person per year in 2008), to over 43 kg/person per year in central Italy (approx. 38 kg/person per year in 2008) and to almost 32 kg/person per year in Southern Italy (approx. 22 kg/person per year in 2008).
Although increased in all three macro-areas, these data highlight the wide gap still existing between the northern regions and the ones in central and southern Italy.
At national level, the *per capita* bio-waste collection value for the year 2009 is approx. 62 kg/person per year (approx. 56 kg/person per year in 2008).
The separate collection of paper and cardboard in 2009 is slightly lower than 3 million tons, substantially unchanged compared to the previous year (approx. +1%, equivalent, in absolute terms, to an increase of less than 30 thousand tons).
The national *per capita* value amounts to about 49 kg/person per year (quite similar to the value in 2008) with an average value of about 63 kg per person per year in Northern Italy (down when compared to 66 kg/person per year in 2008), 57 kg per person per year in Central Italy and almost 26 kg per person per year in the South.
Cellulose and bio-waste together account for over 62% of overall separate waste collection.

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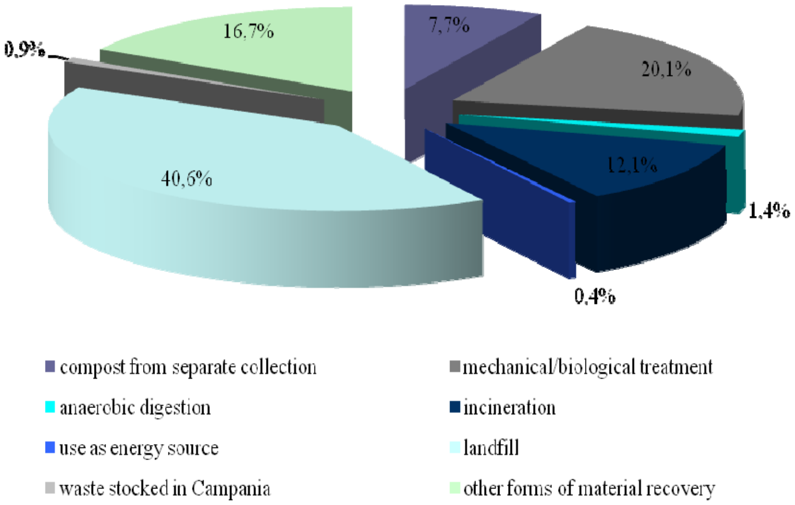
[4] Source: ISPRA

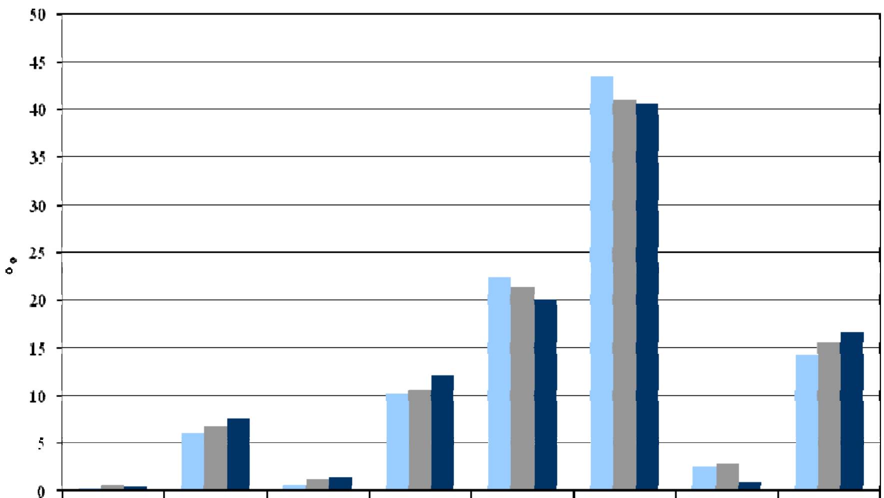
These waste components, together with textiles and wood, constitute the so-called biodegradable waste, regarding which Italian Legislative Decree No. 36/2003 has introduced specific objectives for the reduction in their disposal to landfills.
The quantity of separately collected biodegradable waste in 2009 amounted to almost 7.5 million tons, up by approx. 5.9% compared to 2008.
This waste component constitutes about 69% of overall waste from separate collection.
In *per capita* terms, the collection of the biodegradable component of municipal waste in 2009 amounted to approx. 123 kg/person per year, up by 6.3 kg per person compared to the previous year.
In 2009, the separate collection of glass amounted to about 1.7 million tons, equivalent to an approx. 13.8% increase compared to 2008, while the separate collection of plastic reached almost 614 thousand tons (+6.2% year on year).
Slightly down, in the period from 2008 to 2009, was the separate collection of wood (about -0.8%) thus amounting in 2009 to over 675 thousand tons.
Consistent growth has been observed in the collection of waste from electric and electronic equipment (WEEE), up by 38.5% in the period from 2008 to 2009, equivalent to an increase of over 60 thousand tons in absolute terms.
Compared to 2007, this value is up by over 100 thousand tons, resulting in a percentage increase of about 87%.
In 2009, at national level, about 217 thousand tons of WEEE were collected.
The analysis of the municipal waste management data for the year 2009 shows that landfill disposal accounted for about 40.6% of the total waste managed.
This means that the landfill is the most common waste management method although it is not the predominant one. Indeed, the other methods of recovery, treatment and disposal account for over half of the waste managed (59.4%).
In particular, 20.1% undergoes mechanical and biological treatment, 16.7% is recycled, 12.1% is incinerated, 7.7% undergoes composting, 1.4% is subjected to anaerobic digestion and 0.4% is used for energy recovery in production plants.

The separate collection of biodegradable waste (organic, paper, wood and textile components) in 2009 reached almost 7.5 million tons, up by approx. 5.9% compared to 2008. This type of waste accounted for about 69% of all separate collection waste.



Next to the increase in separate waste collection is developing an industrial system for the recycling of separately collected materials, that today accounts for 25.8% of all municipal waste managed (compost from selected components, anaerobic digestion and other forms of recovery of materials).

Fig. 12.7: Percentage distribution of municipal waste management, 2009[5]



	use as energy source	compost from separate collection	anaerobic digestion	incineration	mechanical/biological treatment	landfill	waste stocked in Campania	other forms of material recovery
2007	0,2	6,1	0,6	10,2	22,5	43,5	2,6	14,3
2008	0,6	6,8	1,2	10,6	21,4	41,1	2,9	15,5
2009	0,4	7,7	1,4	12,1	20,1	40,6	0,9	16,7

In 2009, although landfill disposal was still the most commonly used form of disposal, a further decrease in its weight percent was observed.

Fig. 12.8: *Trend* in percentage distribution of municipal waste management[5]

Compared to 2008, disposal to landfill decreased by 650 thousand tons (-4%), as also the quantity of waste disposed of via mechanical and biological treatment, by about 790 thousand tons (-9.4%), while the amount of waste managed using various forms of material recovery (composting and others) increased overall by 6%.

The amounts of mixed municipal waste disposed of by aerobic and anaerobic digestion treatment have decreased due to both the drop in generation of mixed waste and to the increase in separate collection.

Compared to 2008, landfill disposal decreased by 650 thousand tons (4%), along with a decrease in waste quantities subjected to mechanical and biological treatment

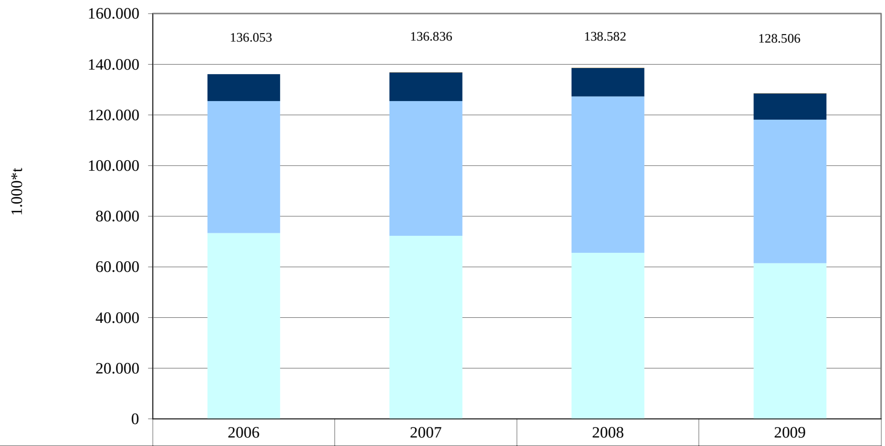
[5] Source: ISPRA

At the same time, the forms of recovery regarding the various waste components by type of separate collection, such as paper, plastic, glass, metals and wood, exceeded 6 million tons (+4.6%).
The waste treated by anaerobic digestion plants increased from 461 thousand tons in 2008 to 546 in 2009, of which 98.8% consisted also of separately collected organic materials (the remaining part consists of other mixed organic components coming from sorting of mixed municipal waste). Waste amounts treated by these plants are expected to increase further in coming years, due to the results of the survey conducted that shows how many treatment plants have not been started up or are not fully operational yet.
The composting of biowaste from separate collection (29 million tons in 2009). This growth, however, remains constricted by the scarce results in the separate collection of the organic waste component in many parts of Italy.
Municipal waste incineration concerned about 4.6 million tons (+ 468 thousand tons) and represented 12.1% of all waste managed, up by 11.3% compared to 2008.

amounting to about 790 thousand tons (9.4%), while the waste subjected to the various forms of recovery of materials increased (+6%).

Special waste generation and management

The generation of special waste was quantified based on the information contained in the MUD (annual waste compulsory declarations) from the yearly statements returned according to the laws in force. The data given herein refer to 2009 and were taken from the statements submitted in 2010.
In order to fill the gap in information caused by exemptions from the obligation to submit the MUD envisaged in Italian Legislative Decree No.152/2006, ISPRA integrated the MUD data using specific estimation methods. These methods were applied solely to several production sectors (and in some cases to sections within certain production sectors), featuring a history of lack of information; for this reason, the integrated data too could be partially underestimated.
The total generation of special waste amounted, in 2009, to approx. 128.5 million tons, down year on year by approx. 7.3%, as a result of the dropping GDP and, therefore, of the economic crisis.
The generation of non-hazardous special waste, based on the data processed by the MUD, amounted to approx. 52.6 million tons, to which we must add approx. 8.7 million tons from the supplementary estimates made for the manufacturing and the health sectors, and approx. 56.7 million tons of inert waste, fully estimated, relating to the construction and demolition sector, as a result of which the non-hazardous special waste totalled 118.2 million tons.
Hazardous special waste amounted, in 2009, to approx. 10.3 million tons (of which approx. 1.6 million tons, equal to 15.6%, from end of life vehicles struck off for demolition).
The estimated quota amounted to over half of the overall special waste generation data, especially due to the considerable amounts of waste generated by construction and demolition activities.



	2006	2007	2008	2009
waste list code not available	0	5	7	3
H SW	10.561	11.361	11.291	10.315
NH SW from C&D	52.083	53.202	61.720	56.681
NH SW excluding C&D	73.409	72.268	65.564	61.507

The overall generation of special waste in 2009 totalled about 128.5 million tons, down by approx. 7.3% compared to 2008.

Fig. 12.9: National special waste generation[6]

The largest amounts of non-hazardous special waste came from the construction and demolition sector (ATECO 45) and from manufacturing activities, totalling 49.8% and 25.8% of the total, respectively.
Waste treatment activities accounted for the generation of almost 20 million tons of non-hazardous waste, i.e. 16.9% of the total, while the remaining activities in toto accounted for about 7.5%.
The manufacturing sector produced over half of all hazardous waste, namely 52.9%, of which 22.7% coming from the “services, trade and transport” sector that included about 1.6 million tons di end of life vehicles struck off for demolition by the Vehicle Registry (PRA), while 16.4% comes from waste treatment activities.
The 71.4% (3.9 million tons) of hazardous waste generated by the manufacturing sector derived from refineries and from the chemical, rubber and plastic industries.
In 2009, managed waste totalled over 135 million tons, 93% non-hazardous and 7% hazardous waste.
The predominant form of management was represented by material recovery (R3, R4, R5), for 57.5%, amounting to 77.7 million tons of waste, followed by chemical-physical and biological treatment and waste reconditioning prior to disposal (more than 21 million tons, equal to 15.6%); landfill disposal, with approx. 13 million tons, accounted for 9.6% of the total. (Fig. 12.10).
Data analysis show that about 80 million tons of special waste were recovered, in the form of either materials or energy.
Energy recovery accounted for over 2 million tons of special waste, while 35 million tons were disposed of and more than 20 million tons were sent to preliminary storage which is intermediate form of management preliminary to final destination.

[6] Source: ISPRA

The predominant form of management was the recovery of materials, for 57.5%, (77.7 million tons) followed by other disposal operations (over 21 million tons, equal to 15.6%); landfill disposal totalled approx. 13 million tons (9.6%).

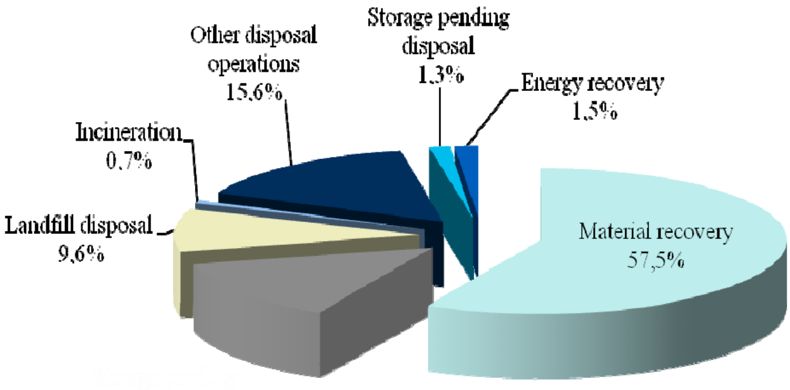


Fig. 12.10: Special waste managment[7]

The data relating only to non-hazardous waste show that 69.6 million tons underwent material recovery treatment, while 6.5 million tons underwent to land treatment resulting in benefit to agriculture or ecological improvement. About 18 million tons of non-hazardous waste were sent to preliminary storage plants prior to recovery, while about 29.4 million tons were disposed of, 12.4 of which to landfills.
The total quantity of hazardous waste recovered amounted to 2.1 million tons. The most commonly used recovery operation was the recycling/reclamation of metals, totalling approx. 602 thousand tons (28.6% of total), followed by the recycling/reclamation of organic substances, amounting to 239 thousand tons (10.7% of total) and by the “recycling/recovery of other inorganic substances” at 228 thousand tons (10.8% of all hazardous waste recovered). Energy recovery involved 129 thousand tons. Conversely, 7.4 million tons of hazardous waste was disposed of, amounting to about 78% of the total waste managed. The most widely used form of disposal was via chemical and physical treatment with over 5.3 million tons, i.e. 72% of the total amount of hazardous waste disposed of, while 8.2% of it (about 605 thousand tons) was disposed of to landfill.
With regard to landfill disposal, the number of plants dropped by 65 units, year on year. Overall, there are 506 landfills in Italy, of which 47% are for inert waste (239), 51% for non-hazardous waste (257) and only 2% for hazardous waste(10). In 2009, approx. 13 million tons of special waste were disposed of in landfills, down year on year by almost 25%. This drop is particularly high in Southern Italy (-45%), while in the North it dropped by 29%, as opposed to the Centre, where there was an 8% increase, mainly due to the increased landfill disposal of the construction and demolition waste from the new underground railway line in Rome.
The incineration plants treating hazardous waste, in 2009, totalled 104, most of them in the North (65), with 24 and 15 in the South and

[7] Source: ISPRA

Centre, respectively. Overall, in excess of 939 thousand tons of special waste were incinerated (402 thousand tons of hazardous and 537 thousand tons of non-hazardous waste); waste from health care totalled approx. 161 thousand tons (17% of the total), down year on year by 14%.

With regard to energy recovery, in 2009, the number of industrial plants using waste as an energy source totalled 530, of which 379 used a quantity of waste in excess of 100 t/years, while the remaining 151 used small quantities of waste exclusively for the recovery of thermal energy for driving their own production cycle.

The total amount of special waste recovered in the form of energy amounts to approx. 2.1 million tons, down year on year by 7%. Hazardous waste totalled about 129 thousand tons (6% of the total).

At regional level, most of the special waste, totalling 83%, is treated in seven regions only: Lombardy with over 549 thousand tons (26%), Emilia Romagna with 359 thousand tons (17%), Piedmont with 221 thousand tons (11%), Friuli-Venezia Giulia with almost 187 thousand tons (9%), Veneto with approx. 161 thousand tons (8%), Puglia with more than 128 thousand tons (6%) and Umbria with 125 thousand tons (6%).

The waste management analysis would not be complete without the computation of imported and exported quantities too. In 2009, the quantity of special waste exported amounted to 3.2 million tons, of which about 2 million tons were non-hazardous waste (62%) and over 1.2 million tons were hazardous (38%). The largest quantities of waste were exported for use in plants located in Germany (1.4 million tons) and China (391 thousand tons). Germany received approx. one million tons of hazardous waste, which it disposed of in salt mines. Non-hazardous waste alone was exported to China. The amount of imported waste is slightly higher, totalling approx. 3.4 million tons, consisting primarily of non-hazardous waste, while hazardous waste totalled approx. 9 thousand tons.

Germany ranks first also with regard to imports (877 thousand tons), consisting almost entirely of non-hazardous waste, 94% of which is scrap metal.

GLOSSARY OF TERMS

Waste:
Any substance or object which the holder discards or intends or is required to discard.

Bio-waste:
Biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises, and comparable waste from food processing plants.

Home composting:
Composting performed at home of the organic components taken from household waste with the intent of using the resulting compost on site.

Waste management:
The collection, transport, recovery and disposal of waste, including the supervision of such operations and the after-care of disposal sites, and including actions taken as a dealer or broker.

Separate collection:
Waste collection where a waste stream is kept separately by type and nature in order to facilitate a specific treatment.

Reuse:
Any operation by which products or components that are not waste are used again for the same purpose for which they were conceived.

Recovery:
Any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy.

Recycling:
Any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations.

Disposal:
Any operation other than recovery even where the operation has as a secondary consequence the reclamation of substances or of energy.

CHAPTER 13

TOOLS FOR ENVIRONMENTAL KNOWLEDGE AND AWARENESS AND MARKET INTERFACE

Introduction

This chapter is an overview of different knowledge tools of environmental matrices and factors, which can be used to increase the awareness of citizens about the various environmental issues and promote eco-sustainable life-styles.

Environmental knowledge tools to increase the citizens' environmental awareness

The knowledge enhancement tools discussed further on include reporting activities and their products, online access to environmental data and information, library services, environmental education and training activities, strictly speaking, and the range of activities for achieving the goal of combining environmental improvements and market competition, through the introduction of the applicable EMAS and EU Ecolabel regulations.

By increasing the volume of reporting activities – a systematic collection and dissemination of data on the environment, including the use of an information and monitoring system – the central and local public authorities can guarantee access by the general public to environmental information and, together with the international environmental bodies that publish reports, contribute to disseminating data on the environmental state of our Planet.

The most widespread environmental reporting products

The most widespread reporting products are environmental reports, which may be defined as follows: cross-subject reports on the state of the environment (also based on indicators), statistical highlights, thematic reports, others (policy reports, special studies, annual documents published by agencies).

The report on the state of the environment

At national level, a report is often completed with a description of the state of the environment in the reference area, and of the evolution of the relevant environmental phenomena, identifying the main causes of pressure and, possibly, also explaining the policies and measures introduced by the public decision-makers to remedy/reduce/mitigate environmental damage.

Any difference in the presentation of information and data or in the format and frequency of publication makes it difficult to sort out a framework of the products for the dissemination of environmental information on a local level (region, province, municipality).

In the most recent examples, these documents are integrated with an evaluation of the state of the environment and of environmental trends, also with respect to the social and economic activities in the region, which can be connected through an assessment of the efficiency of the current environmental policies and the feasibility of the future prospects.

As far as supranational reporting is concerned, in 2011 the European Environmental Agency (EEA) published "Europe's Environment – An Assessment of Assessments"[1] (EE-AoA 2011) for the Seventh

[1] http://aoa.ew.eea.europa.eu

"Environment for Europe" Ministerial Conference of the UN Economic Commission for Europe (UNECE) held in Astana (Kazakistan) from 21 to 23 September 2011.

The requirement of the UNECE ministries for the environment to the EEA was met with the EE-AoA project for supporting the development of an ongoing process aimed at the continuous monitoring of the pan-European environment.

EEA: EE-AoA 2011.

The project was inspired by the first AoA relating to the state of the marine environment. Launched in 2005 by the UN General Assembly (resolution 60/30), it was a pioneering experience aimed at laying the basis for a standing global reporting and assessment of the state of the oceans worldwide.

A similar approach, based on a division into modules and steps, was introduced for the EE-AoA project, so that information could be collected from the various ongoing projects or activities, especially from the EEA report "The European Environment – State and Outlook 2010" (SOER 2010).

This project will not only lay the foundations for the development of a process of environmental assessment in the pan-European area, but it will also have a remarkable importance for the EEA and the EU.

The report consists of an introduction and five chapters: 1. Setting the scene; 2. Water and related ecosystems; 3. Green economy; 4. Cross-thematic analysis; 5. Recommendations.

The EEA is also responsible for the preparation of "Environmental Signals".

This is a report (first issued in 2000) where several signals from the European environment are identified, interpreted and understood in the form of accounts.

EEA: Environmental signals 2011.

The 2011 issue of the report is about globalisation and the environment[2], and it largely draws on the SOER 2010, being based on some key messages such as: nature delivers hugely valuable services to humankind, determining our wellbeing and prosperity; global consumption patterns are a key driver of humanity's environmental impacts; globalisation creates new challenges but it also offers solutions including sharing of innovations and knowledge and new mechanisms of governance.

The OECD's "2010 Factbook"[3], published in 2010, also provides a general overview of today's main economic, social and environmental indicators, in a large number of user-friendly formats.

OECD Factbook 2010.

Lastly, a useful tool for consulting nationwide publications is the SERIS (State of the Environment Reporting Information System), an inventory of the national environmental reports published from 1997 onwards by the EEA/Eionet.

EEA: SERIS.

Its website (http://www.eionet.europa.eu/seris) contains links to accessible reports by geographical region or year of publication and to the main organizations which contributed to their preparation.

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[2] http://www.eea.europa.eu/it/publications/globalisation-environment-and-you-signals-2011

[3] http://www.oecd.org/newsEvents/0,3382,en_2649_34283_1_1_1_1_37465,00.html

According to the data published in the Eighth Censis Report on Communication, accesses to the Internet between 2006 and 2010 increased from 29% to 48.7%. In 2009, 47% of interviewees claimed to use the web at least once a week, compared to 20% in 2001.

The web is an indispensable tool for the capillary dissemination of environmental information.

Government in general is on the forefront of communication innovation, especially with regard to the web, and is committed to integrating new communication and information tools in the websites, giving members of the public increasing opportunities to build up their awareness of the issues affecting the environment in which they live.

Libraries of environmental interest cover an important area of dissemination of knowledge in the field of environmental protection and the earth sciences, offering a range of services to internal and external users.

The Environmental Agencies System is no exception, thus fulfilling one of its institutional duties. Libraries and documentation centres specializing in environmental issues[4] scattered throughout the country provide a significant contribution to dissemination of information and knowledge in the field of environmental protection and the earth sciences, offering a wide range of services: open to the public; on-site book reading and consulting; bibliographic guidance and assistance for reference purposes; internal or interlibrary loans (ILL); locating information resources from other libraries; document delivery (DD); online resource consultation (online catalogues – OPAC –, e-journals, environmental databases of legal and technical regulations).

Environmental education promotes the activation of a process of cultural and social change at the service of sustainability.

The spread of new computer tools has significantly changed the way users communicate with a library and use its services: physical contact is steadily decreasing and users increasingly connect themselves from a distance, through the Intranet and Internet, with authentication credentials and IP addresses.

Emails, for example, are commonly used to send requests about information or loans, to buy publications or make searches.

Through a historical and cultural process of profound transformation, which has involved both epistemological (the subject-matter of investigation) and methodological aspects, environmental education is now regarded as a prerequisite for sustainable development and is considered a permanent active teaching method, which makes reference to a precise framework of values, based on an eco-systemic and interdisciplinary approach and finally aimed at bringing society closer to the achievement of a political, economic and cultural model inspired by a balance between man and the environment, rather than by its exploitation, which has been the case so far.

Environmental education, through increased technical skills building, contributes to the study and research of environmental prevention and remediation tools.

Environmental education, in order to ensure the consistency of its objectives and methods, should propose strategies, projects and tools capable of acting on both the cognitive and affective processes of individuals, in order to guide them towards an understanding of the complex interactions that underlie the relationship between man and the environment and the convinced adoption of sustainable lifestyles.

The Lisbon European Council of 2000 highlighted the importance of the role played by the education and instruction systems to enable Europe to emerge as a knowledge society and efficiently compete in the global economy.

[4] A list of Italian Environmental libraries, telephone numbers and websites comprehensive, is available on the website of ISPRA Library

The Strategy for sustainable development promoted by the Göteborg European Council in 2001, later updated in 2006, underlined the basic role of education, professional training and research as tools for stimulating a behavioural change and provide citizens with the skills they need to achieve the proposed targets.
Continuous professional training in environmental matters determines the broadening of one's knowledge of environmental issues, contributing to the study, research and application of environmental prevention and remediation tools.
The ISPRA and Agency System promote environmental education on the issues of sustainability, public health and the valorisation of natural resources, by holding courses and seminars, with the aim of enhancing technical knowledge in the field of environmental protection and disseminating the operational methods and any innovatory approaches in this field.
Furthermore, internship and tuition periods are arranged with universities and training centres to allow a useful synergy to be created between the environmental agencies and the world of research.
Thus they are able to respond to the increasing demand for continual professional training on environmental protection issues that arise following changes in the world of labour, the production system and technological development, thus adjusting to the process of decentralization of the institutional training functions.

DISSEMINATION OF ENVIRONMENTAL INFORMATION

The knowledge of reality (*ex ante* and *ex post*) and the dissemination of knowledge are the prerequisites for any policies and action plans.
Particularly in the environmental field, the spreading of information plays both the role of providing the appropriate authorities with the information they need to formulate and implement careful and efficient environmental policies, and promoting increased levels of knowledge and awareness among the public, towards an increasingly responsible participation in environmental prevention and remediation programmes.

In almost all the most advanced countries, the basic functions of environmental agencies is to manage the scientific/statistical environmental information, for knowledge-building and awareness-raising purposes

Owing to the strategic importance of information, as affirmed and recognized based on national and supranational regulations, actions have been carried out to improve the quality of information and its timeliness.
In almost all the most advanced countries, these tasks have been assigned to Environmental Agencies which, regardless of their background context, are basically aimed at managing environmental information, either of a scientific/statistical type or for knowledge-building and awareness-raising purposes, to promote the achievement of eco-sustainable models.

In Italy, one of the priorities of the ISPRA-ARPA/APPA System is to disseminate adequate

In Italy, one of the priorities of the ISPRA-ARPA/APPA System, since its establishment, has been to disseminate adequate knowledge, a prerequisite for developing the numerous tasks assigned to it by the applicable regulations, including monitoring, inspection and reporting.
In particular, in line with the Aarhus Convention, EU directives and

national regulations, it disseminates environmental information and data using the web, as well as reports, library services and mass communication media.

knowledge, which is a prerequisite for monitoring, inspection and reporting.

In addition, the Agency System promotes other environmental communication activities aimed at disseminating technical and scientific information, such as the arrangement of conferences and meetings, participation in events, dissemination of information documents, access to available information and the creation of multimedia products.

All the ISPRA publications can be consulted online and users can download the documents they are interested in from the Institute's website, although there is still a considerable demand for paper documents.

The most popular publications are "Key topics", "The quality of urban areas", "Urban Waste Report", "Special Waste Report", as well as maps and other materials on biodiversity.

The users who are most interested in paper documents are libraries, universities and students. Distribution is mainly carried out directly (requests are collected locally, during fairs and meetings).

Dissemination of Environmental information from reporting and mass communication media

Over the last decade, environmental reporting activities have featured, besides a significant development of the reporting methods, an increase in the number of information dissemination products.

In particular, following the establishment of the Environmental Agencies, which were given environmental control and monitoring functions, the substantial flow of environmental and statistical data has been gradually harmonized and organized, awaiting the definition of a nationwide environmental knowledge system.

Recently, with the "2010-2012 Programme", the Agency System has, among other things, launched an activity under the coordination of ISPRA for the preparation of reporting guidelines and the definition of a indicators core set.

ISPRA-ARPA/APPA "2010-2012 programme".

The objective is to develop a process for gradually laying down shared rules for the production of environmental reports, to fulfil specific data and information communication requirements, and of thematic and inter-thematic reports on the state of the environment.

In 2011, the ISPRA published the "Guidelines for developing reports on the state of environment at local level"[5], the first product of the above process of harmonization.

Publication of the "Guidelines for developing reports on the state of the environment at local level".

Since 2003 ISPRA, through its Environmental Data Yearbook, has circulated the results of the Agency System's reporting products, in particular, on the state of the environment/yearbooks, manuals/guidelines, thematic reports and proceeding of technical/scientific events (conferences, seminars, study days, etc.).

Through its Environmental Data Yearbook, ISPRA circulates the results of the Agency System's reporting products

It is worth remembering that, on at community and international level, the reporting activity is not subject to a structured analysis based on shared indicators.

[5] http://www.isprambiente.gov.it/site/it-IT/Pubblicazioni/Pubblicazioni_del_Sistema_Agenziale

In particular, thanks to the periodicity of the publication of reports, yearbooks and thematic reports, these documents have become fundamental to assess the efficiency of environmental policies and to inform the citizens on the quality of the environment in which they live, in order to promote eco-sustainable behaviour and informed participation in decision-making processes.

To achieve these objectives, dissemination policies have been enforced regarding the environmental information held by institutional subjects, and for this reason the development of electronic communication tools, portals, publicly accessible databases of environmental indicators, websites and catalogues has been promoted.

Table 13.1 shows a summary picture of the environmental information disseminated by the Agency System from 2009 to 2010, through environmental data yearbooks, reports and thematic reports.

Among the above products, the most used reporting product is the “thematic report”, which has reached about one hundred publications, on average, per year.

In 2010, the most popular topic area was the air, accounting for approx. 43% of the thematic reports published by the Agency System (Figure 13.1).

Table 13.1: Environmental information dissemination by means of reports and publications[6]

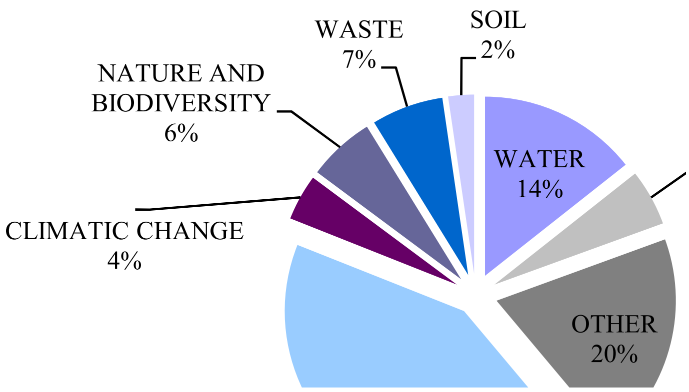
Summary picture of the dissemination of environmental information by the Agency System from 2009 to 2010 by means of environmental data yearbooks, reports and thematic reports.

Agency System	2009		2010	
	Environmental data yearbook / Reports of the state of the environment	**Thematic reports**	**Environmental data yearbook / Reports of the state of the environment**	**Thematic reports**
	Presence/absence	**No.**	**Presence/absence**	**No.**
ARPA Piedmont	● ▲	3	▲	33
ARPA Aosta Valley		6	▲	3
ARPA Lombardy	●	-	▲	14
APPA Bolzano-Bozen		33		4
APPA Trent	▲	0		1
ARPA Veneto		7	▲	6
ARPA Friuli-Venezia Giulia		-		4
ARPA Liguria	▲	3		-
ARPA Emilia-Romagna	● ▲	2+23[a]	●	24
ARPA Tuscany	▲	10		18
ARPA Umbria	●	12	●	14
ARPA Marche		8		25
ARPA Lazio		0		0
ARPA Abruzzo		4		0
ARPA Molise		1		0
ARPA Campania	▲	3		2
ARPA Apulia	▲	33	▲	29
ARPA Basilicata		8		2
ARPA Calabria		0		-
ARPA Sicily	●	3	●	1
ARPA Sardinia		1		4
ISPRA	●	29	●	32

Legend:
● : Environmental Data Yearbook
▲: Reports on the state of the environment
Note:
a) ARPA Emilia-Romagna published 23 provincial thematic reports

Regarding the "Report on the state of the environment" product, it should be stressed that in several cases it consists of yearbooks (list of statistical data related to environmental components and factors) rather than actual "reports" (documents including not only statistical data on environmental components and factors, but also information on the reference assumptions for environmental policies).
Regarding the "yearbooks/reports" joint reporting product, its number has achieved approx. ten on a yearly basis.

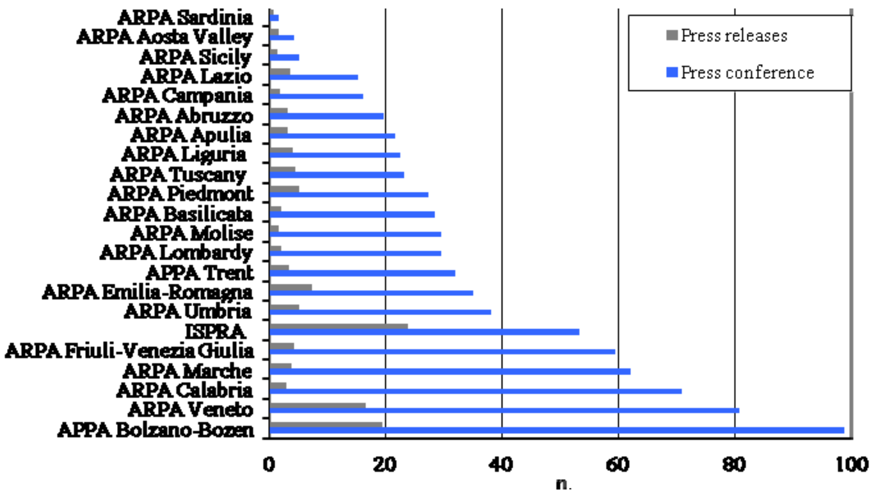
[6] Source: ISPRA/ARPA/APPA data processed by ISPRA



In 2010, the most popular topic area was the air, accounting for approx. 43% of the thematic reports published by the Agency System.

Figure 13.1: Percentage of topic areas covered by the thematic reports (2010)[7]

As far as the environmental information disseminated through the mass media is concerned, it has been found that the average number of press releases by the Agency System amounted to over seven hundred per year and press conferences to approx. one hundred from 2006 to 2010.
The figures 13.2 recorded over the years by the individual Agencies can be significantly influenced by the environmental events occurring in the monitored reference area during a year.
Moreover, the activities of the individual Agency may be still quite uneven on account of the type of information services provided, of the local environmental issues and of the holding of meetings/fairs of environmental interest.



Over the period 2006-2010, the average number of press releases of the Agency System amounts to more than seven hundred and press conferences are approx. one hundred.

Figure 13.2: Average number of press releases and press conference on a yearly basis over the period 2006-2010[8]

Web-based environmental information and communication

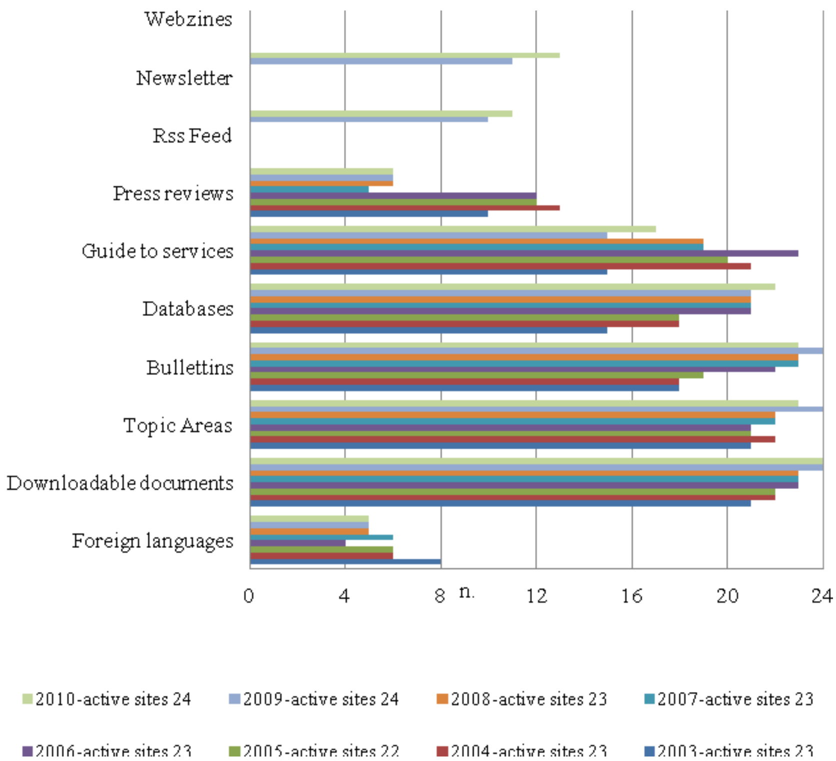
Data on the *Web-based environmental information* indicator (Figure 13.3) generally shows a fairly consistent trend, year on year.
The most dynamic variables are those introduced recently, which

Data on the "Web-based

[7] Source: ISPRA/ARPA/APPA data processed by ISPRA
[8] Source: ISPRA/ARPA/APPA data processed by ISPRA

mirror the innovative nature of the *Web 2.0*: the information tools "Rss Feed" (*Rss: Rich Site Summary or Really Simple Syndication*[9]), "*Newsletter*" and "Online magazines" are adopted by 46%, 54% and 58%, respectively, of the monitored websites and all feature a growing trend.
This result confirms a different methods for informing the general public, which is playing an increasingly active and selective role in gathering the information they are interested in.
The "Guide to services" (96%) and "Databases" (91%) have slightly recovered compared to last year, while the presence of the following information tools: "Downloadable documents" (100%), "Press review" (25%) and "Site translation into at least one foreign language" (21%) remain stable.
The "Bulletins" and "Topic Areas" – 96% of monitored websites – are slightly decreasing.

environmental information" indicator generally shows a fairly consistent trend, year on year, while Rss Feeds, Newsletters and Webzines information tools feature a growing trend.



The information tools: Rss Feed, Newsletter and On line magazines feature a growing trend.

Figure 13.3: Web-based environmental information trends (2003-2010)[10]

The "Web-based environmental communication" indicator, Figure 13.4, shows a clear tendency towards the use the emails, being present in all the monitored websites.
Actually, this is one of the most common means of communication, being inexpensive, quick, versatile and, therefore, highly effective.
There are several methods for accessing emails and they no longer

The indicator "Environmental communication on the web" shows a clear tendency to use the email, which is present in

[9] Rss Feed is a family of web feed formats used to publish frequently updated works such as blog entries, news headlines, audio, and video in a standardized format. An RSS document (which is called a "feed") includes full or summarized text, plus metadata such as publishing dates and authorship. RSS feeds benefit publishers by letting them syndicate content automatically (source: Wikipedia)
[10] Source: ISPRA/ARPA/APPA/MATTM data processed by ISPRA

depend on the possession or use of a PC, following the introduction of innovative devices such as smartphones or tablets.

all the monitored websites.

Emails are widely used both for interpersonal communication and for professional purposes, because they allow the sharing of texts and multimedia files and the dissemination of content to multiple recipients.

Certified Emails (PEC) are undoubtedly an evolution of traditional emails and are present in 91% of the monitored websites. Although they were introduced in 2003 (Law 16/2003), they became widespread only after the enactment of Legislative Decree 82/2005 (also called the Digital Administration Code or DAC), later amended by Legislative Decree 235/2010 (Revised DAC), which obliged government bodies to use PECs, or equivalent solutions, for all types of communication where email tracking was required, with the obligation to open certified email boxes, or equivalent email address for each correspondence and document register, and to notify it to the DigitPa[11], which publishes these addresses in an online list.

The same obligation was extended to all businesses and professionals recorded in special registers established pursuant to a state law[12].

Based on the revised DAC, "certified emails have become the fastest and most secure and efficient way to communicate with government.

Citizens can use PECs also as an identification tool, thus avoiding the use of digital signature"[13].

In order to take account at least partly of the innovations introduced by the Web 2.0, it was decided, starting from the current edition of the Yearbook, to add the new variable "Social media".

In the last few years the social networks have progressively gained ground and given rise to an increasing flow of communication exchanges, which, besides a private interpersonal nature, also serve a professional purpose.

The number of businesses using Facebook to advertise themselves is increasing and government is no exception: 25% of the monitored websites of the Agency System use one or more social networks or insert icons in their institutional websites to promote the sharing of information with Internet users.

This situation is continually evolving, confirming that the public is playing an ingreasingly active and proactive role.

The presence of "multimedia areas" in websites containing typical Web 2.0 communications tools, such as videos, web radios and web TV, is growing compared to last year: 11 websites out of 24 have adopted these innovative communication tools.

These figures show a significant change in the style of the institutional communication models.

The monitored websites are highly informative, as mirrored by the variable "News and events", which is present in 100% of the

[11] National Agency for Digitization of Public Administration

[12] Law 2/2009, article 16

[13] Source: http://www.innovazionepa.gov.it

monitored websites. The presence of “Opinion polls” and “Online registration” is growing.
The variable “Forums and FAQs” has been partially renovated: in the prior edition its name was “Forums and mailing lists”.
The survey suggested that mailing lists are always missing, while the FAQs are quite often used alongside the forums.
This aspect was considered worth reporting, being present in 16 websites out of 24 (66%).

The most common environmental communication tools in the Agency System are emails, online forms, news and events.

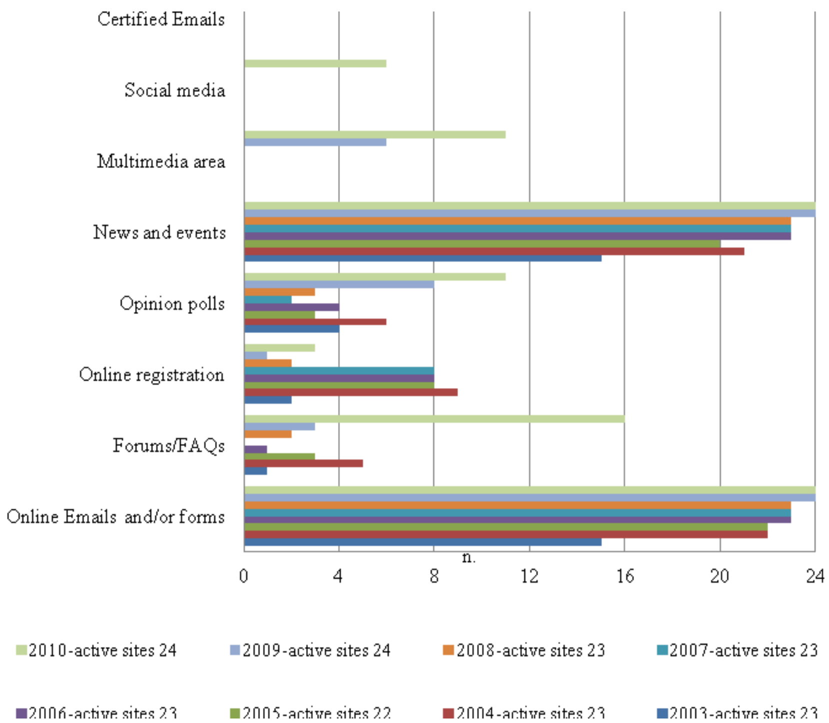


Figure 13.4: Trend of environmental communication on the web (2003-2010)[14]

Library services and user resources

Libraries and documentation centres specialized in environmental issues[15], which are scattered throughout the country, provide a significant contribution to the dissemination of information and knowledge in the field of environmental protection and the earth sciences, through various services:

- open to the public;
- reading and consultation;
- guidance and assistance for reference purposes;
- internal and interlibrary loans (ILL);
- locating information resources from other libraries;
- document delivery (DD);
- consultation of online resources (online catalogue - OPAC -,

[14] Source: ISPRA/ARPA/APPA/MATTM data processed by ISPRA
[15] A list of Italian Environmental libraries, telephone numbers and websites comprehensive, is available on the website of ISPRA Library

electronic journals, databases of environmental, legal and technical regulations).

The internal and external users of libraries and documentation centres can access the available multiple information resources by visiting their websites and by consulting the online catalogue (OPAC).

The services and information resources that are made available to users by the libraries and/or documentation centres specializing in environmental issues of the Agency System, are unevenly distributed throughout the country. Not all Agencies have the availability of a library or documentation centre, or of library services in the strict sense (Piedmont, Aosta Valley, Friuli-Venezia Giulia, Basilicata, Sardinia). The ISPRA library boasts the most important document supply and the most remarkable collection updating rate, followed by ARPA Tuscany and ARPA Lazio. Some Agencies (ISPRA, ARPA Lombardy, ARPA Tuscany, ARPA Marche, ARPA Lazio, ARPA Campania) have introduced a management system (UNI EN ISO 9001 or ISO/IEC 17025).

The Piedmont, Aosta Valley, Friuli-Venezia Giulia, Basilicata and Sardinia Agencies do not have a library or documentation centre, nor library services in the strict sense.

A good number of libraries have joined national cooperation networks (SBN, NILDE, ACNP, SBA, etc.) where they can enjoy derived and/or shared cataloguing, and projects for mutual documentation supply (DD, ILL) that they can made available to final users for free.

ENVIRONMENTAL EDUCATION AND INSTRUCTION PROGRAMS

Face-to-face and remote environmental education projects and training courses in Italy are very diversified and difficult to describe briefly. This is due to the variety of promoters and operators, for either teaching method, and to the wide range of education topics and sectors – scientific, economic and cultural – all falling in the cross-disciplinary area that, for several years now, is referred to as the “science of sustainability”. On the one hand, this is a positive sign, proving that the integration process targeted by international strategies is taking place, little by little, but on the other hand it indicates a panorama where boundaries are difficult to trace and new classification and evaluation criteria are needed.

In Italy there is a wide range of available environmental education projects and training courses, provided by institutions or other entities.

In the field of sustainability-oriented environmental education, the latter are however basically associated with a static (quantitative) assessment of the projects, and only partially with a quality-based evaluation of the educational services provided, and the results of the educational effort as such are still difficult to grasp and measure, being dependent on complex factors such as learning subjectivity, the time needed to internationalise complex values and concepts and the non-automatic mechanism of attitude and behavioural change.

As already focused in the prior edition, the Italian institutional reference framework for environmental education is full of lights and shades. On the one hand, the implementation efforts of the “Decade of sustainable development education” (2005-2014) are continuing with the coordination of the Italian UNESCO National Commission and the contribution of the National Committee

In 2011 the UNESCO Week on Education for Sustainable Development was dedicated to Water including, among others, the ISPRA and Agency System. In 2011, the UNESCO National Week on Education for Sustainable Development was dedicated to water.

On the other hand, the two Italian Ministries involved (MATTM and MIUR) have launched several activities and projects, within the scope of the Interdepartmental Agreement (2008) and the Charter of Intents on school, environment and legality (2009), for example the competitions “School, environment and legality” (for middle schools) and “Things change if …” (for infant schools). The MATTM has also advertised a competition with prizes worth 1,500,000 euros from the “Sustainable Development Fund” for projects for promoting environmental education and sustainable development launched by associations, foundations and NGOs at national or inter-regional level. It has also promoted a number of awareness-raising campaigns for young people and adults on environmental protection and the promotion of eco-sustainable behaviour, such as a “Tree Day”, “Summer in the parks”, “Eco-beach” and a “Cycling Day”, in partnership with several institutions and associations.

Among the objectives of the RIO+20 Conference, the importance has been restated of sustainability-oriented education.

The prospects for the National INFEA system are still rather uncertain, as it has not received new planning and programming inputs nor new funds for structures and activities for quite some years now. Conversely, the Italian Ministry for the Environment in charge of soil and land protection has been strongly involved in the preparation of the Conference on Sustainable Development (UNCSD) “Rio+20”, to be held in June 2012 after twenty years from the “historical” Conference of 1992, where the concept of sustainable development was enunciated officially for the first time. The objective of Rio+20 is both that of assessing the progress made during these twenty years and the remaining gaps, and to set new targets for the future, especially regarding two priority topics: Green Economy as a function of sustainable development and poverty eradication and the reformation of the international governance of sustainable development. The idea of Rio+20 is to stimulate the participation of all civil society members (industry, youth, women, farmers, local communities, local governments, NGOs, scientific community, workers and unions) through a consultative process. Under the impulse of the MATTM, Italy is also mobilizing and trying to set up a coordinated national network to give an authoritative contribution in this respect, where environmental education is an integral part of its functional and strategic role of promotion and spreading of sustainability values, methods and practices. Furthermore, the contributions received by the Secretariat for the preparation of the negotiating text of the Conference have highlighted education on sustainable development as one of the priorities (together with sustainable consumption and production patterns, sustainable water management, sustainable construction and urbanization and new employment).

As far as the Agency System is concerned, a favourable aspect can be found in the steady and sometimes increasing commitment of some Agencies to the preparation of environmental education programs and plans at local level. Some examples are ARPA Friuli-Venezia Giulia, which has lately integrated its standard tasks of regional coordinator for INFEA activities, with the role of coordination of and focus point for the projects related to the Decade of sustainable development education; ARPA Abruzzo, which has set up an internal Register, or list, of internal experts and technicians, who can be used for awareness-raising and educational actions for schools or adult groups; ARPA Calabria, which has set up an Environmental Education Group (GEA), made up of representatives from the central office and provincial departments, whose tasks include the preparation of planning guidelines and the development of an annual environmental education plan including all involved local entities. An unfavourable aspect, as focused in the last edition, is that ARPA Tuscany has stopped its remarkable contribution to environmental education after several years, following the reorganization of the regional system.

In the Agency System, the EOS work team has resumed its activities under the coordination of the ISPRA.

As far as nationwide coordination is concerned, the Interagency Work Team on Sustainability-Oriented Education (EOS) has, following the confirmation of its mandate by the Federal Council, resumed its activities and is presently engaged in the preparation of new guidelines for sustainability-oriented education, to strengthen the role of environmental education in organization and skill-building terms.

European strategies recognise the importance of human resources valorisation and technical skill enhancement to tackle environmental, economic and social challenges.

The environmental education projects promoted by the Agency System meet the principles enshrined in and serving as the basis of the European strategies for recognizing and, indeed, acknowledging the importance of valorizing human resources and enhancing technical skills, with a view to effectively tackling and addressing the environmental, economic and social challenges. The conclusions of the 2000 Lisbon European Council stress the fundamental role of education and training, for the transition to a knowledge-based economy and society, and the duty for every member state to put into place strategies and practical measures to promote permanent education. Continuous professional training is also important for the enhancement of natural resources and environmental protection. For this purpose, the Agency System is committed to launching education events for the improvement and establishment of the professional skills of technicians, researchers and other operators involved in environmental protection in different roles. A survey of the institutional websites of the Environmental Agencies suggests that some of them publicize their continuous training programs and projects on the environment through the web. Examples of them are ARPA Lazio, which has set up a school for environmental education, offering a number of courses for employees and external users, and ARPA Sicily, which offers continuous and permanent training programs for employees.

Also in connection with the Lisbon Conference strategy, based on the idea of transforming Europe into a knowledge-based economy, the European Commission is promoting a large number of programs and projects to accelerate the spreading of structures and applications related to the promotion of the information society, both Europe-wide and at member State level.

In this respect, e-learning is the most popular tool to invest in, because of its flexibility. The use of this tool in the EU is supported by programs related to information society promotion, which have played a basic role in attracting the attention of training centres, government bodies and private entities. Strong impulse to e-learning was given by the 2002 Barcelona European Council, where the European Commission was asked to prepare an action plan for spreading the availability and use of broadband networks throughout the EU and for the development of Internet network security protocols. For this reason, among all the environmental education activities, this publication highlights not only specialist face-to-face courses, but also e-learning programs and the dissemination of technical and scientific topics through the web. As continuous environmental education mainly targets adults, it must take into account the increasing and steady demand for skill-building and improvement and the need for more adequate and functional teaching methods. In order to test the application of new teaching methods allowing the dissemination of training contents in a flexible, easily customizable and accessible way, by removing all time and space restrictions, the ISPRA is pursuing the development of e-learning environmental education programs, particularly for the technicians of the Agency System, which will be first published in 2012.

The partnership with universities and other training centres on environmental education is very important. In addition to other methods, this target is pursued with internships, training and orientation programs, so that undergraduates and graduates can alternate study with work, during their education, and acquire first-hand knowledge of the world of labor in the environmental field. Besides signing agreements with several Italian universities for the implementation of training and orientation programs, the ISPRA has recently entered into an agreement with the Foundation of the Rectors of Italian Universities for the startup of the "ISPRA-Italian Universities" program, which offers tuition periods to undergraduates and graduates from Italian universities, which can be used at the Institute. In 2011 more than 90 training projects were offered by the ISPRA technical units. Furthermore, in order to enhance and harmonize the environmental education system of the ISPRA and ARPA/APPA, in 2011 an inter-agency work team was set up for the creation of a permanent school, within the framework of the Environmental Agency System. During the development of this project, a study will be conducted on the professional figures of the Agency System, starting from the reference regulatory framework for training at local and national level, including the mapping of skills and the identification of training requirements so that specialist courses can be planned based on shared criteria and methods.

Environmental education supply

The picture of awareness-raising and education projects aimed to the promotion of sustainability is extremely varied and complex, as the above description also suggests.

With respect to environmental priorities, 2011 was the International Year of Forests, a topic descending from 2010 Biodiversity. In this case too, the ISPRA has taken advantage of the skills and projects developed in this field and has contributed to the promotion of better knowledge and information by organizing a Conference on "*National forest resources and eco-system services. The role of the institutions*".

As far as the topic of biodiversity is concerned, the implementation of the National Strategy for Biodiversity is ongoing, for which the ISPRA is acting on behalf of the MATTM to define a first set of assessment indicators for each monitored topic area. Among them, the education and information topic area contributes to strengthening the awareness and perception of the situation and improves the degree of information and education of the entities that play a "crucial" role for the protection of biodiversity, namely political decision-makers, local authorities and teachers.

Lastly, the ISPRA has partnered with the FARENAIT (Fare Rete Natura 2000 in Italia), a project co-funded by the LIFE+ European program, whose mission is the circulation of information among local stakeholders on the advantages of the 2000 Nature Network, both in terms of environmental sustainability and economic benefits, through information, communication and education actions.

Regarding the environmental education projects for the 2011 Yearbook (2010 data), the survey is still limited to the ISPRA–ARPA/APPA system. A possible and desirable extension of the scope of the collected data to include other networks and subjects (the regions, first and foremost, but also other entities and authorities) would require a careful analysis of the survey questionnaire and formalization, which is still lacking.

The environmental education actions by the Agency System totalled 724, mainly targeting schools.

In 2010, the Agency System database recorded 724 environmental education projects, including 279 projects and 445 individual activities.

With regard to the projects, 46 were long-term, 199 were developed throughout the region, and 167 were planned in partnership with other entities and subjects[16].

With respect to the target, there is a quantitative predominance of projects and single activities targeting schools, compared to those targeting adults.

As regards the breakdown of the topic areas, most of the projects

[16] The sum of values of different types realized at regional level, developed in co-design, addressed to school population and adult population, doesn't match the total of projects (279) and total of one-off activities (445) since some projects and activities are counted in more than one of them

implemented in 2010 were dedicated to the topic of “Air, Water, Soil and the Sustainable use of resources”, followed by “Biodiversity and Protected Areas” and “Wastes”.
However, several other actions do not belong to any specific item (“Other topics”).

Operations of the local environmental education network

From 2007 to 2011, 14 Agencies guaranteed a consistent and continuous flow of data regarding the indicator of Environmental Education Network (REA): Piedmont, Aosta Valley, APPA Trento, Veneto, Liguria, Marche, Abruzzo, Basilicata, Molise, Apulia, Sicily. This number includes Lazio, Lombardy and Tuscany, although they did not send in any data in 2010.

From 2007 to date, the System of the ARPA/APPA Agencies have guaranteed a significant presence in the local network of sustainability-oriented education.

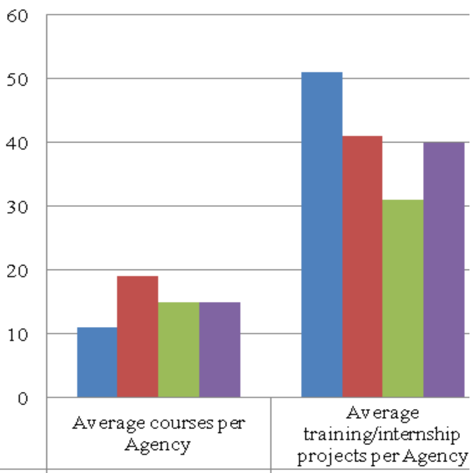
As a result, there is enough information to make a tentative analysis of the REA indicator, stressing that the coordinating role of the institutional environmental education network has been effectively carried out by the Agencies (6/14), who are “historically” responsible for it. Moreover, 4 out of 14 agencies have never been recognised this role while the remaining 4 have carried out this task only marginally.
Conversely, the participation of the INFEA network has been larger. Out of 14 Agencies, 7 have steadily contributed, 3 never, 4 only occasionally or fragmentarily.
These figures make it immediately clear that, although the ARPA/APPA system has not yet been recognised a primary role in the INFEA system, it has nevertheless offered a moderate contribution to the ministerial environmental education and information network, although this is not decisive in terms of quantity.
In quality terms however, the maintenance of the role of operating coordinator, as originally assigned to the Agencies, stresses the reliability and authority of the involved ARPA/APPA Agencies and also the political will of the regional governments to build upon the experience accrued over the years by the regional systems.
In 2008, ARPA Basilicata gave up the role of INFEA coordination, but not its environmental education functions. The participation of other national and international sustainability education networks has proved more stable and continual (e.g. the network of EA representatives in the EOS agency network).
Out of 14 Agencies, 9 have steadily contributed to at least one network, 3 never and 2 occasionally.
The function of supporting the local Agenda 21 processes is diminishing: the contribution of 10 Agencies has been discontinuous and decreasing, while Tuscany belongs to the remaining 4.
Lastly, the main function becomes strongly apparent, by which the Agency System has quantitatively interfaced with the local EA network: 8/14 ARPA/APPA agencies have provided technical-scientific and/or teaching contributions on a regular basis and 6/14 only occasionally.

Provision of environmental training projects

The environmental training project indicator has been built using a set of quantity data to ensure the uniformity and immediate comparability of the information provided by the ARPA Agencies.
As a result, this data provides a picture of the educational projects promoted by the Agency System, in terms of the number of courses and internships and the related attendance rate. A shared review of these indicators by all Agencies would be desirable, in order to collect more targeted information including quality data and be able to assess the efficiency of educational processes for skill building and improving.
It was found that the data appearing in the different issues of the Yearbook didn't always come from the same Agencies, which makes a correct diachronic analysis of information impossible. As a result, to be able to assess the data and draw conclusions, it was assumed by approximation to compare the environmental training projects by averaging the values per reference year. The 2010 survey consisted in 256 training courses by the ISPRA and by 16 environmental agencies, with an average of 15 training projects.

In 2010, 256 training courses by the ISPRA and by 16 environmental agencies were promoted, with an average of 15 educational projects.

The average of training courses and hours is in line with that of prior years. They mostly consisted in short-term courses of less than 50 training hours (96.5%), while medium-term courses, of more than 50 training hours, only account for 3.1%. The percentage of long-term courses (exceeding 150 hours) is irrelevant, because only ARPA Friuli-Venezia Giulia promoted one.
The number of trainees on environmental issues continued to be very high; in excess of 4,800 environmental experts were involved in specialist and updating courses, with an average of 19 trainees per course and a female participation of around 48%.
This latter data points out that the target of enlarging women's participation in environmental education and scientific and technical topics is approaching according to EU auspices.
A significant information is the steady propensity to use external funds for continuous-training, at 10% in 2010.
A total of 679 internships and training/orientation courses were provided by the ISPRA and Agencies in partnership with universities and training centres with the aim of promoting research and study on environmental issues.
Also in this respect, the participation of women increased significantly and approached that of men.
The environmental education courses sponsored by the ISPRA in the reporting year covered a number of topics, with a special focus on those relating to soil and water protection.
The courses targeted not only the experts of the Agency System, research bodies and local authorities, but also young graduates and undergraduates.
The internship and training programs sponsored by the ISPRA in 2010 included the development of studies and research mainly on the topics of water protection and the strategies and tools for sustainable development.



	Average courses per Agency	Average training/internship projects per Agency
2007 - 15 Agencies	11	51
2008 - 19 Agencies	19	41
2009 - 14 Agencies	15	31
2010 - 17 Agencies	15	40

The average of courses and internships arranged by every Agency is quite in line with that of prior years.

Figure 13.5 Environmental training programs: average courses and training projects carried out by each Agency (2007-2010)[17]

Within the Agency System and the ISPRA, the use of the Internet to deliver remote training courses and circulate technical and scientific contents is not yet widespread.
Only ARPA Piedmont developed an e-learning course as early as 2009, while only the ISPRA has used its website to disseminate the contents of courses, seminars and workshops.

ENVIRONMENTAL PERFORMANCE IMPROVEMENT TOOLS

While the awareness has spread that environment protection cannot be achieved without the involvement of all the parties concerned and, in particular, without the establishment of new models of partnership with the main market operators (businesses and consumers), the improvement of the environmental quality of businesses, organizations and products has taken on a central role in protecting the environment.

The improvement of the environmental quality of businesses, organizations and products has taken on a central role in protecting the environment.

The most important references towards this objective are the European EMAS and Ecolabel regulations and the International standards of the ISO 14000 series.
EMAS (EC Regulation no. 1221/2009) and EU Ecolabel (EC Regulation no. 66/2010) derive from the environmental policy launched by the European Union with the Fifth Action Program (1992-1999). The traditional command and control tools have been integrated with new voluntary instruments, aiming at promoting a better management of resources, taking direct responsibility for the environment and enhancing information to the public on the betterment of the environmental performance of processes and products.
The first years of application have revealed the strong significance of these regulations as a means for environmental prevention and

The first years of application have revealed the strong

[17] Source: ISPRA/ARPA/APPA data processed by ISPRA

improvement. Actually, the key objective at the basis of the Sixth Action Plan and the new action plan of the European Commission on “Sustainable production and consumption” and “Sustainable Industrial Policy” (COM 2008/397 def.) is the development and consolidation of a set of measures which, by appealing to environmentally-friendly production and ecologically-sensitive consumption, might lead to the creation of a green market in the medium/long run and the enforcement of sustainable production and consumption (SPC) principles.

significance of EMAS and Ecolabel as a means for environmental prevention and improvement.

This new approach has been put in practice with:

- the will, as expressed in the Sixth Action Plan of the EU, to improve the dissemination of EMAS and EU Ecolabel regulations, promote Green Procurement, to foster the creation of the ecological market, improve business-to-business and business-to-consumers environmental education by promoting, among other things, the use of environmental product declarations (EPD);
- the request to member states to develop strategies integrating the available voluntary tools (EMAS, Ecolabel UE, Product declarations, ECO Design, etc.) and law prescriptions in order to realize the “environmental efficiency” principle;
- the innovations made to the EMAS and EU Ecolabel schemes on occasion of their review and in particular: a quantity rather than quality-based approach, to focus attention on environmental performance indicators and global market introduction (EMAS III), the extension of the EMAS from the industrial sector to all businesses and the adoption of the indirect environmental impact concept (EMAS II), the consideration for social aspects besides environmental topics among the criteria for the granting of the EU Ecolabel mark, and the extension of product certification to all supply-chain products in addition to final consumption products, and
- the strategic role of the public in its broadest sense as public sector and citizens-consumers, as the entity that can develop an eco-friendly demand.

The creation of the “green market” is a commitment involving:

The creation of the “green market” is a commitment involving businesses, consumers and government

- businesses, which can improve the environmental characteristics of products and services from the design and operation stages;
- consumers, who can promote an ecologically qualified supply and correct use of purchases, and
- government, which can supply environmentally adequate services, foster the environmentally viable use of land, carry out a careful consumer role, inform and affect the awareness and behaviour of citizens, introduce rewards and incentives, promote research and harmonize development policies.

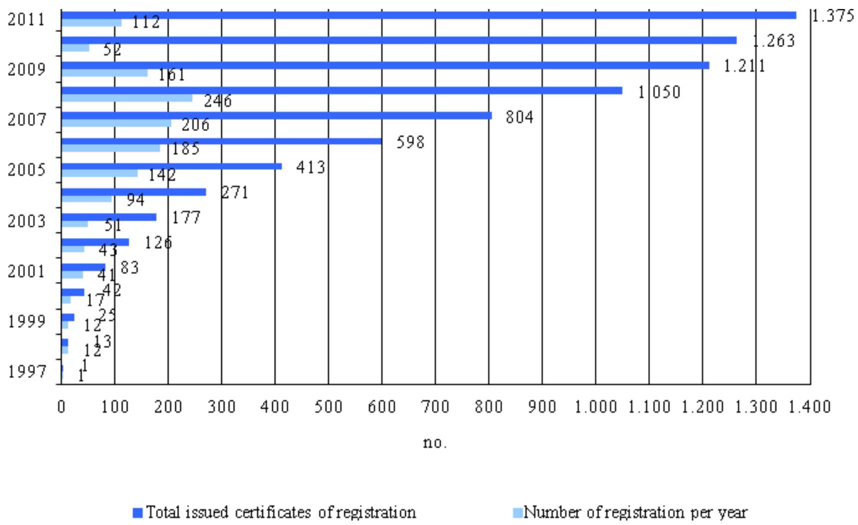
Consistently with the new action plan of the European Commission on “Sustainable production and consumption” and “Sustainable industrial policy”, according to which eco-friendly productions and aware consumptions are the synergetic elements to aim at in order to get a new production and consumption model, the available tools (EMAS, EU Ecolabel, Green Public Procurement, EPD, etc.) are varied and technically well-established; now, their application mix must be targeted, in the strategies of companies, as a function of market competitiveness and of government, as a function of development decisions and plans.

Very briefly, the driving actions to build harmonized strategies should be:

- to lever on economic interest by simplifying red tape, taxes and aid in order to foster the introduction of environmental certification by organizations;
- to develop tools and incentives promoting more eco-friendly consumption, by acting on demand and information, including the introduction of awareness-raising measures for the government departments, agencies and entities in charge of procurement, and
- to promote the supply of eco-friendly products and services, by introducing tools for information comparison, encouraging data accountability and dissemination and promoting eco-sustainable designs and environmental compatibility compliance.

In line with the EC approach to fully accept the EMAS and EU Ecolabel – along with the GPP – among the new policies for sustainable production and consumption, the European Council and Parliament have issued the new EMAS III and Ecolabel III texts, enforced on 11th January 2010 and 19th February 2010 respectively. From 1997 (when the EMAS and Ecolabel schemes were implemented in Italy) to date, the penetration of the two schemes has been growing at a significant annual rate (Figures 13.6 and 13.7).

From 1997 to date, the penetration of EMAS and EU Ecolabel has been increasing, at a significant yearly growth rate.



The most virtuous regions for number of EMAS registered organizations are: Emilia-Romagna, Lombardy, Tuscany , Trentino-Alto Adige and Apulia. This uneven geographical development reflects the different levels of awareness and/or local incentives

Figure 13.6: Evolution of the EMAS registration certificates issued in Italy[18]

[18] Source: ISPRA

In Europe, Italy ranks third after Germany and Spain for EMAS, and first followed by France and Denmark for Ecolabel. The most virtuous regions for number of EMAS registered organizations are: Emilia-Romagna, Lombardy, Tuscany and Trentino-Alto Adige, and Apulia in the fifth position.

The greatest number of EU Ecolabel licenses have been issued by Trentino-Alto Adige, Emilia-Romagna, Tuscany, Lombardy and Piedmont.

The greatest number of EU Ecolabel licenses have been issued in Trentino-Alto Adige, followed by Emilia-Romagna, Tuscany, Lombardy and Piedmont.

The spreading of EMAS and EU Ecolabel has been promoted, among other things, by the growth of skills and professionalism following the attendance to local EMAS and Ecolabel schools, whose aim is the basic training of qualified professional figures as organization assistants (EMAS environmental auditors and consultants and Ecolabel consultants) and the promotion of special university master degrees for the achievement of excellence education in partnership with the academic world.

However this growth, for which Italy is among the top ranking countries in Europe, is not yet a structural given.

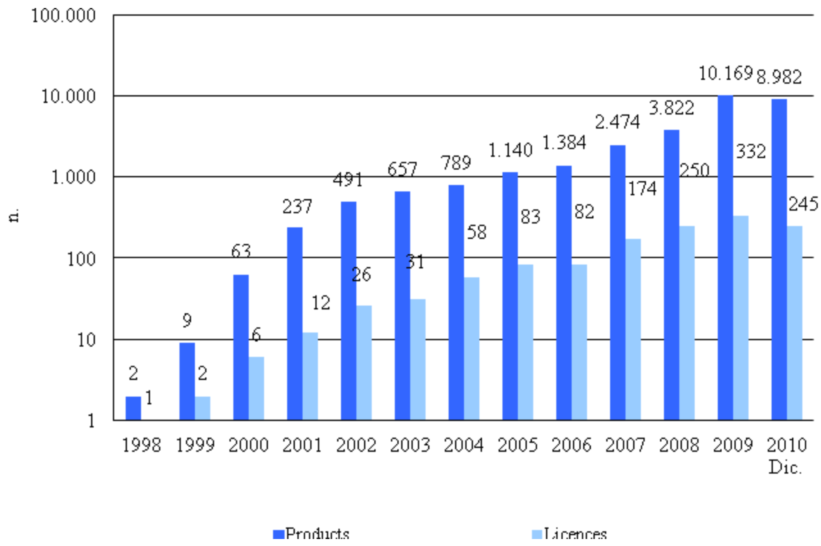
The growth of the EMAS and Ecolabel (Italy is among the top ranking countries in Europe) is not yet a structural given and is affected by different sensitivity and/or incentives among regions and industrial sectors.

Geographical development is uneven and affected by different sensitivity and/or incentives among regional and local authorities, industrial sectors, trade associations, etc.

Despite art. 18 of Law 93/2001 (which, however, was not followed up with the relevant enforcement decrees) and the new set of environmental laws (Legislative Decree 152/2006) that paved the way for the EMAS, there is not yet an effective and efficient sponsoring of voluntary instruments by government and the parties involved.

In particular, the most critical factors for the EMAS seem to be:

- the lack of a systematic commitment by the involved parties to the preparation of strategies aiming at integrating environmental requirements with market competitiveness and to the development of incentive proposals for the entities applying the EMAS scheme, and
- the multiplicity of public entities involved in approving and monitoring processes and the low propensity to promote prevention policies.



Between 1998 and 2010, a total of 245 EU Ecolabel licenses were issued, for a total of 8,982 products/services labelled. The drop in the number of licenses and products which occurred in 2010 was due to the need for companies to renew the use contract of the EU Ecolabel mark, based on the new criteria that came into force.

Figure 13.7: Evolution of the EU Ecolabel licenses and products/services in Italy[19]

Regarding the EU Ecolabel mark, the interest of companies in this certification continues to be high.

However, in 2010 the number of licenses and consequently the number of certified products and services dropped, due to the need for companies to renew their contracts for use of the mark, following the enactment of new criteria.

Any late submission of an application for renewal beyond the mandatory deadline involved the cancellation of licenses from official records.

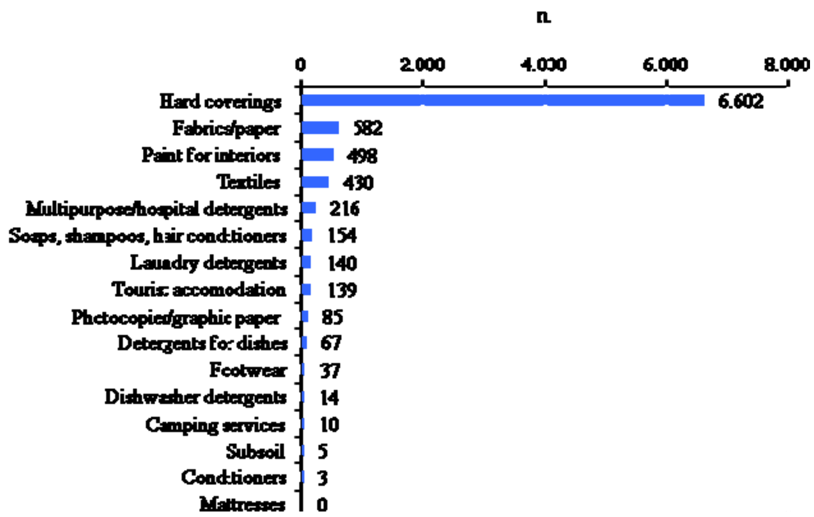
The number of applications for renewals and new contracts received in 2010 however reveals the growing trend of this tool.

The integration of environmental criteria to the contracts tendered by the Government authorities and the advantage for companies of having EU Ecolabel certified products to prove their compliance with environmental criteria are a stimulus to seek for the EU Ecolabel environmental product certification.

A growth in the number of certified products was reported in 2010 compared to 2009 for a number of product groups including detergents, paints, soaps and shampoos, paper and fertilizers.

As reported in Figure 13.8, out of fifteen active product groups in Italy, most products bearing the EU Ecolabel mark fall into the "hard coverings" category, with as many as 6,602 certified products.

[19] Source: ISPRA



In Italy the largest number of products with the EU Ecolabel belongs to so-called "hard coverings", with as many as 6,602 certified products

Figure 13.8: Breakdown of EU Ecolabel products/services by product group in Italy (December 2010)[20]

GLOSSARY

OPAC (***On-line Public Access Catalogue***):
an online catalogue made available to library users.

Environmental certification:
a certificate issued to companies which, based on a management system, can prove that they are continually reducing the environmental impacts of their production processes and are committed to pollution prevention.

EU Ecolabel:
a European Union logo showing the ecologic quality of products and services that comply with environmental standards.

e-learning:
online learning methods.

EMAS:
a voluntary eco-management and audit system of the European Commission that can be adopted by companies controlling their environmental impacts according to high standards.

Newsletter:
an information message delivered from time to time, by email, for free to all users who have completed an online registration form.

Environmental reporting:
the systematic collection and dissemination of environmental monitoring data. The results of environmental reporting are summarised in an environmental report.

[20] Source: ISPRA

Social network:
a platform based on new communication media, where users can manage their social contacts.

ISO 14000 standard:
a set of internationally-recognised eco-management specifications developed by the ISO (*International Organization for Standardization*).

ACRONYMS

Listed below are the meaning of some of the acronyms found in the publication.

ACI	Italian Automobile Club
ACNP	Italian Union Catalogue of Serials
AE	Equivalent Inhabitants
AEEG	Italian Authority for Electricity and Gas
APHEKOM	*Improving Knowledge and Communication for Decision Making on Air Pollution and Health in Europe*
AIA	Italian Association of Aerobiology
AISCAT	Italian Association of Motorway and Tunnel Concessionaire Companies
AM	Italian Air Force
ANCI	National Association of Italian Municipalities
ANPA	National Environmental Protection Agency
APAT	Environmental Protection and Technical Services Agency (now ISPRA)
APPA	Provincial Environmental Protection Agency (only autonomous provinces)
ARPA	Regional Environmental Protection Agency
ASI	Italian Space Agency
ASIA	Archive for Italian businesses
ASL	Local Healthcare Enterprise
ATO	Optimal Territorial Area
AWB	*Artificial Water Body*
BaP	Benzo(a)Pyrene
BAT	*Best Available Techniques*
BCAA	Good Agronomic and Environmental Conditions
BEN	National Energy Balance
BIA	Low Environmental Impact
BIOFORV	working group for the Forest Biodiversity Nursery
BITS	*Benthic Index based on Taxonomic Sufficiency*
BOLAM	Bologna Limited Area Model
BPCO	Chronic Obstructive Pulmonary Disease
BRI	*Building Related Illness*
BTEX	Benzene Toluene Ethyl benzene Xylenes
CAD	Digital Administration Code
CAFE	Clean Air For Europe
CAP	*Common Agricultural Policy*
CARG	Geological Cartography
CARLIT	Coastal Cartography
CBD	*Convention on Biological Diversity*
cCASHh	*Climate Change and Adaptation Strategies for Human Health*
CCM	National Centre for Diseases Prevention and Control
CCTA	Carabinieri Police Command for the Defence of the Environment
CEFOG	*Classification Of Function Of Government*:
CEHAP	*Children Environmental Health Action Plan*
CEM	Electromagnetic Fields
CFP	Common Fisheries Policy
CFS	State Forestry Corps

CGO	Statutory Management Requirements
CIA	Italian Farmers' Confederation
CIESM	*The Mediterranean Science Commossion*
CIPE	Inter-Ministerial Committee for Economic Planning
CIRA	Italian Aerospace Research Centre
CIRIAF	Interuniversity Centre for Research on Pollution from Physical Agents
CISO	Italian Centre of Ornithological Studies
CLC	*CORINE Land Cover*
CLEAR-UP	*Clean and resource efficient buildings for real life*
CMCC	Euro-Mediterranean Center for Climate Change (CNR)
CNCC	National Conference on Climate Change
CNLSD	National Committee for the Fight against Drought and Desertification
CNOSSOS	*Common Noise Assesment Methods*
CNR	National Research Council
CNT	National Transportation Report
COFOG	*Classification Of Function Of Government*
CONACEM	National Co-ordination for Defence against Electromagnetic Fields
CONECOFOR	Control of Forest Ecosystems
COP	*Conference of the Parties*
CORINAIR	*COoRdination InformatioN AIR*
COSMO	*Consortium for Small-Scale MOdeling*
COV	Volatile Organic Compounds
COVNM	Non-methane Volatile Organic Compounds
CPUE	*Catch per Unit of Effort*
CPD	*Construction Products Directive*
CRA-CMA	Agricultural Research and Testing Council - Agricultural Climatology and Meteorology Research Unit
CSS	National Board of Health
CTN	National Topic Centre
CTN-TES	National Topic Centre – Soil and Land
DAISIE	*Delivering Alien Invasive Species Inventories for Europe*
DALY	Disability Adjusted Life Years
DBMS	*Database Management System*
DD	*Document Delivery*
DG SANCO	European Commission Directorates-General for Health and Consumer Policy
DEN	*Dengue*
DESS	International Decade of Education for Sustainable Development
DISMED	*Desertification Information System for the Mediterranean*
DPC	Civil Protection Agency
DPSIR	*Driving force – Pressures – Status – Impact – Responses*
EAP (EU)	*Environmental Action Plan (European Union)*
EBCC	*European Bird Census Council*
EBD	*Environmental Burden of Disease*
EBoDE	*Environmental Burden of DiseasE in Europe*
EC	*European Commission*
ECC	*European Economic Community*
ECOEHIS	*Development of Environment and Health Indicators for EU Countries*
ECE	*Economic Commission for Europe*
ECF	*European Climate Foundation*
EDO	*European Drought Observatory*

EEA	*European Environment Agency*
EE-AoA	*Europe's Environment Assesment of Assesment*
EEI	*Ecological Evaluation Index*
EFF	*European Fisheries Fund*
EFSA	*European Food Safety Authority*
EIA	Environmental Impact Assesment
ELF	*Extremely Low Frequency*
EMF	Electromagnetic Fields
ENAC	Italian Civil Aviation Authority
ENEA	Agency for New Technologies, Energy and the Environment
EoI	*Exchange of Information*
EPD	Environmental Product Declaration
EPER	*European Pollutant Emission Register*
EQB	Biological Quality Elements
EQR	*Environmental Quality Ratio*
EQV	*Ecological Quality Value*
ER	*Exposure Ratio*
ERSAF	Regional Agency for Agriculture and Forestry Services
ESAs	*Environmentally Sensitive Areas*
ETC	*European Topic Centres*
ETC-LUSI	*European Topic Centre-Land Use and Spatial Information*
ETS	*Emissions Trading System*
EU	*European Union*
EUAP	Official List of Protected Areas
EUCC	*European Union for Coastal Conservation*
EUROSTAT	*Statistical Office of the European Communities*
FAO	*Food and Agriculture Organization of the United Nations*
FA.RE.NA.IT	Networking on Nature 2000 sites in rural areas of Italy
FBI	*Farmland Bird Index*
FEP	European Fisheries Fund
FSC	*Forest Stewardship Council*
GARD	*Global Alliance against Chronic Respiratory Disease*
GEA	Environmental Education Group
GDF	Italian Treasury Police
GDP	*Gross Domestic Product*
GEF	*Global Environment Facility*
GER	*Green Economy Report*
GES	*Good Environmental Status*
GFS	Sustainable Forestry Management
GIG	Geographic Intercalibration Group
GIS	*Geographical Information System*
GIZC	Integrated Coastal Areas Management
GMM	*Genetically Modified Micro-organisms*
GMO	*Genetically Modified Organisms*
GMP	*Genetically Modified Plants*
GNDT	National Earthquake Defence Group
GNDCI	National Geo-hydrological Catastrophes Protection Group (CNR)
GPL	Liquefied Petroleum Gas
GPP	*Green Public Procurement*
GPS	*Global Positioning System*
GPSD	*General Product Safety Directive*

GSE	Energy Services Managers
GTS	*Global Telecommunication System*
HABs	*Armful Algal Blooms*
HEALTH-VENT	*Health Based Ventilation Guidelines*
HESE	*Health Effects of Schools Environment*
HESE-INT	*Interventions on Health Effects of School Environment*
HEV	*Hepatitis E Virus*
HIA	Health Impact Assesement
HMP	Hydrological Monitoring Plan
HMWB	*Heavily Modified Water Bodies*
HNV	*High Nature Value*
IAIAQ	*Impact Assesment of IAQ*
IAQ	*Indoor Air Quality*
IAEA	*International Atomic Energy Agency*
IARC	*International Agency for Research on Cancer*
IBA	*Important Bird Areas*
IBE	Extended Biotic Index
IBI	Italian Botanic Representative
ICCAT	*International Commission for the Conservation of Atlantic Tuna*
ICDM	Sea Defence Service of the Ministry of the Environment
ICNIRP	*International Commission on Non-Ionizing Radiation Protection*
ICRAM	Central Institute for Research on the Marine Environment (now ISPRA)
ICZM	*Integrated Coastal Zone Management*
IEA	*International Energy Agency*
IFFI	Inventory of Landslide Events in Italy
ILL	*Inter Library Loan*
INEA	National Agrarian Economy Institute
INES	National Inventory of Emissions and their Sources
INFC	National Inventory of Forests and of Forest Reservoirs of Carbon
INFEA	Information, Training and environmental Education
INFS	National Institute for Wildlife (now ISPRA)
INGV	National Institute of Geophysics and Volcanology
INSPIRE	*Infrastructure for Spatial Information In Europe*
IOC	*Intergovernmental Oceanographic Commission*
IPCC	*International* (or *Intergovernmental*) *Panel on Climatic Change*
IPP	*Integrated Product Policy*
IPPC	*Integrated Pollution Prevention and Control*
IPR	Main Reference Institute
IQB	Index of Bacteriological Quality
IREPA	Institute of Economic Research for Fishing and Aquaculture
IRES	Company Income (or Capital) Tax
IRPEF	Individual Income tax
IRSA	Water Research Institute
ISAC – CNR	Institute of Atmospheric and Climate Sciences – National Research Council
ISCR	Central Institute of Conservation and Restoration
ISO	*International Organization for Standardisation*
ISPESL	National Institute for Occupational Safety and Prevention
ISPRA	Institute for Environmental Protection and Research
ISS	Italian National Health Institute

ISSDS	Experimental Institute for the Study and Defence of the Soil
ISTAT	National Statistics Institute
ISTIL	Institute of Science and Technology of Luminous Pollution
ITALIC	*Information System on Italian Lichens*
ITF	*Italian Trust Fund*
ITHACA	*Italy Hazard from CApaple faults*
IUCN	*International Union for Conservation of Nature*
IUUF	*Illegal Unreported Unregolamentated Fishing*
IWS	Integrated Water Service
JRC-IES	*Joint Research Centre-Institute for Environment and Sustainability*
LAN	Snow Level
LCA	*Life Cycle Assessment*
LDCs	*Least Developed Countries*
LIFE	*L'Instrument Financier Pour l'Environment*
LIM	Level of Pollution from Macro-Descriptors
LIPU	Italian League for Bird Protection
LPG	*Liquid Propane Gas*
LULUCF	*Land Use, Land Use Change and Forestry*
MAH	*Major Accident Hazard*
MAI	Italian MetaOPAC Azalai
M-AMBI	*Multivariate-Azti Marine Biotic Index*
MAP	Ministry of Production Activities
MATTM	Ministry of the Environment, Land and Sea
MAV	Venice Waters Magistrate
MED	*Minimum Erythemal Dose*
MEDALUS	*Mediterranean Desertification and Land Use*
MIPAAF	Ministry of Agricultural, Food and Forestry Policies
MIT	Ministry of Infrastructure and Transport
MITO	ITalian Ornithological Monitoring
MIUR	Ministry of Education, Universities and Research
MPA	Marine Protected Areas
MSE	Ministry of Economic Development
MSFD	*Marine Strategy Framework Directive*
MUD	Consolidated Environmental Declaration Form
NAMEA	*National Accounting Matrix including Environmental Accounts*
NAP	*National Action Plan*
NAPA	*National Adaptation Programmes of Action*
NCDC	*National Climatic Data Center*
NCEP/DOE	*National Centers for Environmental Prediction Department Of Energy*
NEC	*National Emission Ceiling*
NEHAP	*National Environment and Health Action Plan*
NESDIS	*National Environmental Satellite, Data and Information Service*
NFP	*National Focal Point*
NILDE	*Network Inter-Library Document Exchange*
NIR	*Non Ionising Radiation*
NVZ	*Nitrate Vulnerable Zone*
NOAA	*National Oceanic and Atmospheric Administration*
NOISE	*Noise Observation and Information Service for Europe*
NORM	*Naturally Occurring Radioactive Materials*
NRT	*Near Real Time*
NYMEX	*New York Mercantile Exchange*

ODP	*Ozone Depleting Potential*
OECD	*Organization for Economic Cooperation and Development*
OPAC	*On-line Public Access Catalogue*
OPR	Oasis for the Protection and Refuge of Fauna
PAA	Environmental Action Program
PAC	Common Agricultural Policy
PAEE	Action Plan for Energy Efficiency
PAI	Plan of Hydrogeological Array
PCAR	Plans of Noise Reduction and Abatement Measures
PCBs	Polychlorinated Biphenyls
PCP	Common Fisheries Policy
PD	Prevention Department
PEC	E-Certified Mail
PEFC	*Programme for Endorsement of Forest Certification scheme*
PESERA	*Pan European Soil Erosion Risk Assessment*
PFR	Regional Focal Point
PAH	Polycyclic Aromatic Hydrocarbons
PIFFI	Landslide Event Identifying Point
PIL	Gross domestic Product
PMP	Multizone Prevention Facilities
PN	National Park
PNA	National Allocation Plan
PNR	Regional Nature Park (RNP) or National Radon Plan (NRP)
POM	*Princeton Ocean Model*
POP	Multiyear Guidance Programs
POPs	*Persistent Organic Pollutants*
POSEIDON	*Previsional Operational System for the mEditerranean basIn and the Defence of the lagOon of VeNice*
POT	*Peak Over Threshold*
PPAE	Provincial Mining Plan
PRAE	Regional Mining Plan
PSN	National Strategic Plan
PSR	*Pressure-Status-Responses*
PTA	Water Resources Protection Plan
PTCP	Provincial Territorial Coordination Plans
PYLL	*Pontential Years of Life Lost*
QUEST	*Quick Earthquake Survey Team*
RADPAR	*Radon Prevention and Remediation*
RAEE	Waste Electrical and Electronic Equipment
R&D	*Research and Development*
RBS	*Radio base Stations*
RDF	Refuse Derived Fuel
REACH	*Registration, Evaluation and Authorisation of Chemicals*
REC	*Regional Environmental Centre for Central and Eastern Europe*
ReNDIS	National List of Land Defence Interventions
RESORAD	National Monitoring Network of Environmental Radioactivity
RF	Radio Frequency
RFI	Italian Railway System
RIBES	Italian Network of Germplasm Banks for the conservation Ex Situ of spontaneous flora
RICE	*Radium of Influence of Coastal Erosion*

RID	Italian Dikes Register
RIR	Major Accident Hazard
RMLV	Meteomareographic Network of Lagoon of Venice and the North-Adriatic Coast
RMN	National Mareographic Network
RON	National Ondametric Network
RNA	*RiboNucleic Acid*
RNR	Regional Nature Reserve
RNS	State Nature Reserve
ROD	*Reporting Obligation Databases*
RRN	National Rural Network
RSA	Report on the State of the Environment
RSS	*Rich Site Summary* (or *Really Simple Syndacation*)
RTC	Risk Threshold Concentration
RTV	Radio and TV media
SACs	*Special AreaS of Conservation*
SAR	*Synthetic Aperture Radar*
SAU	Usable Agricultural Surface
SBA	Ateneo Library Sistem
SBN	National Library Service
SCALE	*Science, Children, Awareness, Legal Instruments, Evaluation*
SCAS	Chemical State of Ground Waters
SCI	*Sites of Community Importance*
SCIA	National System for collecting, processing and diffusing Climate Data of Environmental Interest
SCL	Sporadic Cutaneous Leishmaniasis
SCN	Nature Preservation Service
SEA	*Strategic Environmental Assessment*
SEARCH	*School Environment and Respiratory Health of children*
SECA	Ecological Status of Waterways
SEIS	*Shared Environmental Information System*
SEL	Ecological Status of Lakes
SERIS	*State of the Environment Reporting Information System*
SIAS	Development of Soil Environmental Indicators
SIC	Site of Community Importance
SIDS	*Sudden Infant Death Syndrome*
SIGC	Geographical Coastal Information System
SIMM	Hydrologic and Meteomareographical System
SIMN	National Service for Study of Waters and Seas
SINA	National Information System on Environment
SINAB	National Information System on Biological Agriculture
SINAL	National Laboratory Accreditation System
SINAnet	Network of the National Information System on Environment
SINPHONIE	*Schools Indoor Pollution and Health: Observatory Network in Europe*
SINTAI	Information System for Italian Water Protection
SISTRI	Waste Tracking System
SITAP	Information System on the Territory, Environment and Landscape
SNAP	*Selected Nomenclature Air Pollution*
SNI	Site of National Interest
SOER	*European Environment State and Outlook Report*
SOMO0	*Sum of Ozone Means Over 0 pph*

SOMO35	*Sum of Ozone Means Over 35 pph*
SPAs	*Special Protection Areas*
SPI	*Standardized Precipitation Index*
SPC	Coastal Prediction System
SSN	*National Seismic Service* or National Health Service
ST	Total Surface Area
SWH	*Significative Wave Height*
TAC	Total Allowable Catches
TAF	Agrarian and Forestry Territory
TEEB	*The Economics of Ecosystems and Biodiversity*
TERM	*Transport and Environment Reporting Mechanism*
THADE	*Towards Healthy Indoor Air in Dwellings in Europe*
TOFP	*Tropospheric Ozone Forming Potential*
TSP	Total Suspended Particulates
TVC	Threnshold Value of Contamination
UAA	*Utilised Agricultural Area*
UCEA	Agricultural Climatology and Meteorology Research Unit
UE	European Union
UMTS	*Universal Mobile Telecomunications System*
UN	*United Nations*
UNCCD	*United Nations Convention to Combat Desertification*
UNCSD	*United Nations Conference on Sustainable Development*
UNCED	*United Nations Conference on Environment and Development*
UNECE	*United Nation Economic Commission for Europe*
UNEP	*United Nations Environment Programme*
UNESCO	*United Nations Educational, Scientific and Cultural Organization*
UNFCCC	*United Nations Framework Convention on Climate Changes*
US-EPA	*United States - Environmental Protection Agency*
USLE	*Universal Soil Loss Equation*
UV	Ultraviolets
VVF	Fire Fighters Corps
WAM	*WAve Model*
WFD	*Water Framework Directive*
WHO	*World Health Organisation*
WISE	*Water Information System for Europe*
WMO	*World Meteorological Organization*
WWF	*World Wildlife Fund*
ZRC	Zones for Repopulation and Capture of Wildlife
ZVL	Zoonotic Visceral Leishmaniasis