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ITALIAN ENVIRONMENTAL DATA YEARBOOK 2009

KEY TOPICS

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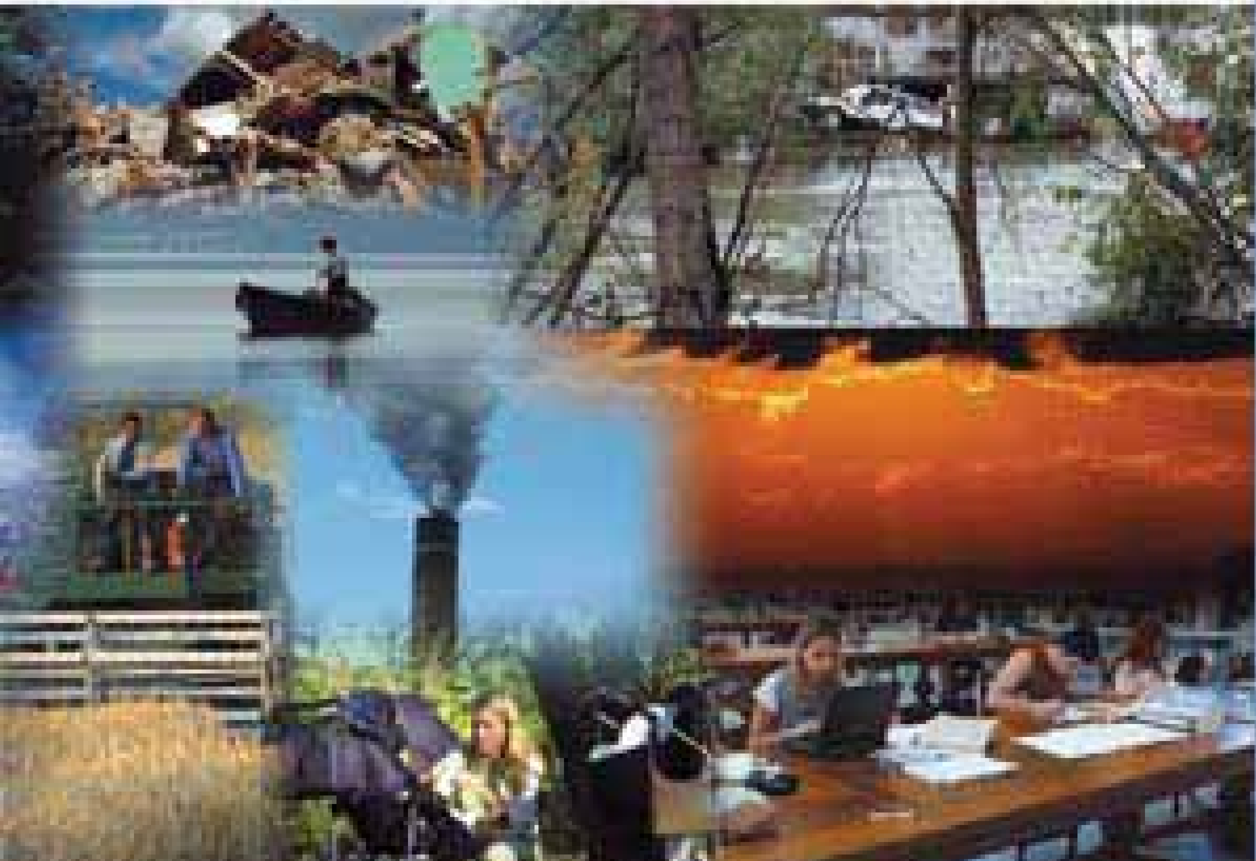

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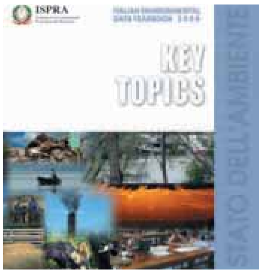
Italian Environmental Data Yearbook

2009

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 (the former INFS) and of the Central Institute for Scientific and Technological Research Applied to the Sea (the former ICRAM).

ISPRA – Institute for Environmental Protection and Research
State of Environment and Environmental Metrology Department
Environmental Statistics and Yearbook Project Service
Via Vitaliano Brancati, 48 - 00144 ROME

www.isprambiente.it

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Graphic treatment
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Cover graphics: Franco Iozzoli, ISPRA
Cover photo: Paolo Orlandi, ISPRA

Typographic coordination:
Daria Mazzella
ISPRA – Publishing Department

Administration:
Olimpia Girolamo
ISPRA – Publishing Department

Distribution:
Michelina Porcarelli
ISPRA – Communication Service

Translation:
Parole S.a.s. di Alessandra Angelini
Via Vigna del Piano, 29 - 00060 Riano (RM)

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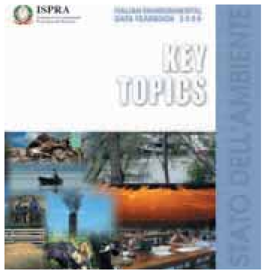
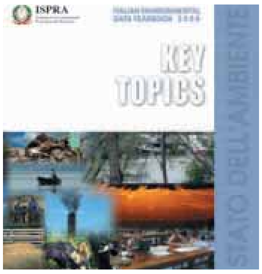


"…namque alid ex alio clarescet nec tibi
caeca nox iter eripiet, quin ultima naturai
pervideas: ita res accendent lumina rebus …".[1]

Titi Lucretii Cari – De rerum natura
(Liber I, 1115-1117*)*

[1] "…for one thing after other will grow clear, nor shall the blind night rob thee of the road, to hinder thy gaze on Nature's farthest forth. Thus things for shall kindle torches new …" (Translated by William Ellery Leonard)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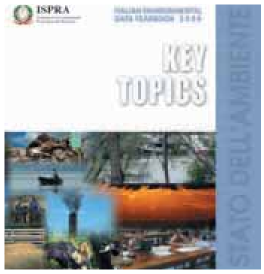


Foreword

I would like to express my great satisfaction for the 2009 edition of ISPRA Environmental Data Yearbook. It represents an important endeavour for disseminating environmental information which is a key mission of ISPRA.

There is also no doubt on the high expectations by decision-makers, operators, citizens and all those who consider environmental information as a fundamental tool of knowledge and participation.

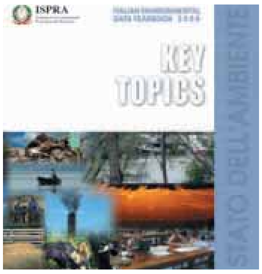
For some time now, all planning and legislative initiatives of the European Union acknowledge the strategic role of information, both as a fundamental element of knowledge and as a tool for communication.

A solid and complete knowledge base is also being created to accompany decision making for one of the greatest European and global challenges: climate change and adaptation. As anticipated in the EU White Paper on this topic, a Clearing House Mechanism to improve information and knowledge sharing is being created on the impact of climate change, on vulnerability and on successful practices of adaptation.

ISPRA's Yearbook also works in this direction, as underlined by our institution during the hearing held by the 8th Environmental Commission of the Italian Chamber of Deputies on the issue of adaptation to climate change.

I wish to thank all the experts who made this publication possible and I shall take it upon myself to ensure that the resources needed to carry out this important endeavour will be always available.

Prefect Vincenzo Grimaldi
ISPRA's Commissioner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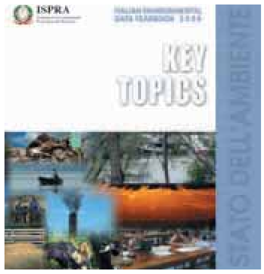


Introduction to the Environmental Data Yearbook

The Environmental Data Yearbook represents Italy’s most complete collection of environmental data and information.

Born out of the environmental reporting experience of the former APAT, the Yearbook has expanded its information base through the valuable contributions of ICRAM and INFS merged with APAT into ISPRA since 2008.

As always, a key factor in the successful preparation of the work was the sharing of environmental information between ISPRA and the other components of the national environment agencies system, i.e the environmental protection agencies of the Italian regions and of the autonomous provinces.

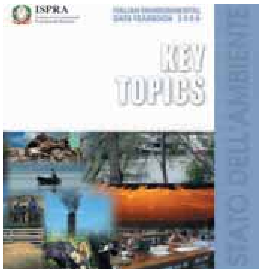
This year, ISPRA was once again aided by numerous technical-scientific institutions in drafting the various sections, as well as in data validation and information processing.

The important activity of revising the core-set of indicators, initiated in the last edition, was continued this year through the following procedures: 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; assessment of the indicator’s ability to represent the phenomenon being investigated; verification of the availability of the data needed to populate the indicator; evaluation of the scientific relevance and solidity of the indicator.

The indicator fact-sheets of the full version of the Yearbook provide a widely analytical and detailed information on the environmental topics addressed.

The overview that introduces the fact-sheets contains information on the indicators and on how they are represented in tables and figures. Starting from this year, the overview also provides information on the frequency of updates.
The structure of the fact-sheets (meta-data section), as compared to the format used in the Yearbook Database, was simplified by selecting the key information on the indicator.

This led to the exclusion of the following fields: Source of the Data, Frequency of Updates, Aim and Limits.



The Yearbook is structured in four sections: Introductory Elements, Production Sectors, Environmental Conditions and Responses.

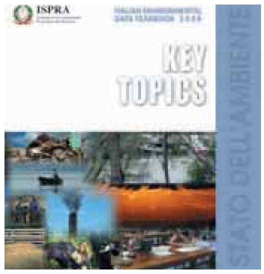
The chapter on the socio-economic framework, first included in the 2008 edition, was updated and expanded, in order to provide a scenario as reliable as possible for interpreting the environmental information provided.

Under the section Production Sectors, the chapters Agriculture, Energy and Transportation were further rationalised , thanks also to the revision of the core-set of indicators.
A number of modifications were also made in the Environmental Conditions section. In particular, the contents of the chapters on the Biosphere and Hydrosphere were supplemented. Finally, the set of indicators for the Atmosphere chapter was expanded by including indicators on adaptation.
As for the chapter on Monitoring and Control, the activities of the ad hoc working group set up to to draw up adequate indicators are continuing.

In keeping with ISPRA's publishing strategy, the full version of the 2009 edition is produced in both paper and electronic formats (PDF available on CD-ROM and at the sites www.isprambiente.it and http://annuario.apat.it).

In addition to the full version of the Yearbook, the basic information is provided in the following four products:
- Key Topics – A version containing supplementary information on priority environmental issues, subject to specific prevention and reclamation;
- Vademecum – A short version (pocket) of the assessments contained in the preceding volume;
- 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.

In the volume Key Topics (also available in English), the information base of the Yearbook is used to evaluate a number of situations related to key environmental policy concerns. Their choice was inspired by topics addressed by the EU's 6th Environmental Action Plan and by key 2009 events , such as the earthquake in L'Aquila, the landslide in Messina (Environmental Risk), the problems of algae (Coastal Environment) and waste. Particular consideration was given to Climate Change and Biodiversity,



both central to the 2009 Environment G8 in Siracusa and continuing to remain at the forefront of international policy debate as for 2009. Copenhagen Summit and the 2010 Year of Biodiversity.

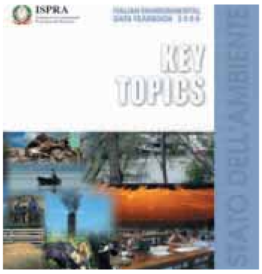
The same key topics are dealt in a summarised form in the Vademecum (also available in English),

The Database of the Yearbook, together with the Full Version, allow for a deeper examination of the topics.
A new release of the database has been created, in order to improve the operating performance, rationalising the processing of the indicators and facilitating the consultation of the information collected. Of particular note are the improvements made to the report editing phase, through a smoother management of the xls files, plus a much more extensive, well stocked section of .pdf files.

The information base of ISPRA's Environmental Data Yearbook also constitutes the backbone for other important publications. These include the document "Le sfide ambientali" ("Environmental Challenges"), issued by the Ministry of the Environment, Land and Sea, and the European Environment State and Outlook Report 2010 (SOER 2010), drawn up by the European Environment Agency.

It is hoped that the different publications originating from the information base provided by ISPRA will make a tangible contribution to the dissemination of environmental information and to the raising of environmental awareness among an ever broader group of users, policy-makers, researchers and citizens alike. Progress towards more sustainable forms of human development on our planet is possible only through informed decisions by all citizens, based on their full understanding of the environmental consequences of consumption and production patterns.
ISPRA's intense activity on environmental information contributes to the technical and -scientific groundwork needed to develop such understanding.

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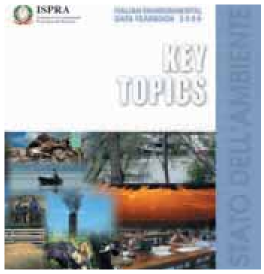


Contributors and Thanks

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.
New features include an expansion of the information contents, beyond the topics already dealt with, through the addition of the valuable contributions of the former ICRAM and INFS institutes, which have become a part of ISPRA.
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,* carried out in the past by the former APAT;
- *Monitoring of Environmental Quality, Prevention and Mitigation of Impact, Defence of Habitats and Biodiversity,* formerly carried out by ICRAM and INFS.

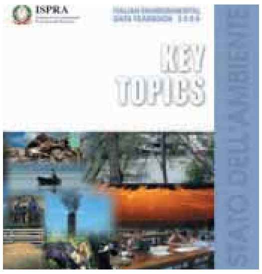
Equally important were the contributions of the ARPA/APPA agencies, plus the numerous technical-scientific bodies.

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, both units that were formerly part of the APAT.

Specific contributions to the document Key Topics

I. Purposes and structure of the document

Author: Luca SEGAZZI



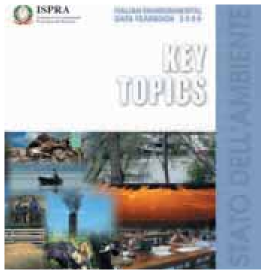
II. Socio Economic Framework
Coordinator: Mariaconcetta GIUNTA
Authors: Giovanni FINOCCHIARO, Cristina FRIZZA, Alessandra GALOSI, Silvia IACCARINO, Luca SEGAZZI, Paola SESTILI

Chapter 1. Climate Change
Coordinator: Domenico GAUDIOSO, assisted by Alessandra GALOSI
Authors: Antonio CAPUTO, Franco DESIATO, Aldo FEMIA (ISTAT), Domenico GAUDIOSO, Francesca GIORDANO, Renato MARRA CAMPANALE, Andrea TORETI
Contributors:
Mario CONTALDI, Giulia IORIO (ENEA), Piero LEONE (TERNA), Claudio PICCINI

Chapter 2. Biodiversity and Natural, Agricultural and Forest Areas
Coordinators: Claudio PICCINI (general coordination), Lorenzo CICCARESE (coordination for agricultural and forest areas), with the assistance of Giovanni FINOCCHIARO
Authors: Sabrina AGNESI, Anna ALONZI, Pierangela ANGELINI, Antonella ARCANGELI, Valter BELLUCCI, Roberta CAPOGROSSI, Lorenzo CICCARESE, Rocio CONDOR, Massimo DALU', Taira DI NORA, Stefania ERCOLE, Dania ESPOSITO, Giovanni FINOCCHIARO, Diego FLORIAN (FSC), Vanna FORCONI, Piero GENOVESI, Valeria GIOVANNELLI, Michela GORI, Matteo GUCCIONE, Mario GUIDO (ISMEA), Lucilla LAURETI, Stefano LUCCI, Maria Cecilia NATALIA, Emanuela PACE, Pietro PARIS, Claudio PICCINI, Roberto SANNINO, Paola SESTILI, Leonardo TUNESI

Chapter 3. Air Quality
Coordinator: Anna Maria CARICCHIA, assisted by Silvia IACCARINO
Authors: Patrizia BONANNI, Anna Maria CARICCHIA, Giorgio CATTANI, Mario CONTALDI, Maria Carmela CUSANO, Roberto DAFFINÀ, Riccardo DE LAURETIS, Alessandro DI MENNO di BUCCHIANICO, Alessandra GAETA, Giuseppe GANDOLFO, Cristina SARTI
Contributors:
Antonella BERNETTI, Antonio CAPUTO, Rocio CONDOR, Eleonora DI CRISTOFARO, Andrea GAGNA, Barbara GONELLA, Daniela ROMANO, Ernesto TAURINO, Marina VITULLO

Chapter 4. Water Quality
Coordinator: Ardiana DONATI, assisted by Silvia IACCARINO
Authors: Ardiana DONATI, Silvia IACCARINO, Marco MARCACCIO (ARPA Emilia Romagna), Paolo NEGRI (APPA Trent), Massimo PALEARI (ARPA Lombardy)
Contributors:
Ottavia BARISIELLO, Serena BERNABEI, Michele BOLDIZZONI, Francesca DE GIACOMETTI, Giancarlo DE GIRONIMO, Patrizia FIORLETTI, Emanuela PACE, Simona RAMBERTI (ISTAT), Silvana SALVATI, Stefano TERSIGNI (ISTAT)
Focus Coordinator: Anna Maria CICERO and Erika MAGALETTI (*Coastal Marine Waters*), Ardiana DONATI (*Inland Waters*), assisted by Silvia IACCARINO



Authors *(Focus and case study inland waters)*: Fedra CHARAVGIS (ARPA Umbria), Alessandra CINGOLANI (ARPA Umbria), Ardiana DONATI, Silvia IACCARINO, Angiolo MARTINELLI, (ARPA Umbria), Alessandra SANTUCCI (ARPA Umbria)
Authors *(Focus and case study coastal marine waters)*: Tiziano BACCI, Andrea BONOMETTO, Rossella BOSCOLO, Federica CACCIATORE, Anna Maria CICERO, Paola GENNARO, Franco GIOVANARDI, Silvia IACCARINO, Erika MAGALETTI, Chiara MAGGI, Marina PENNA, Benedetta TRABUCCO

Chapter 5. Exposure to Physical Agents

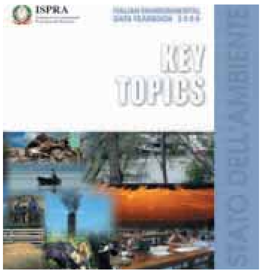
Coordinators: Salvatore CURCURUTO (*Noise, Non-Ionising Radiation and Ultraviolet Radiation*), Giancarlo TORRI (*Ionising Radiation*), assisted by Cristina FRIZZA and Matteo SALOMONE
Authors of *Noise, Non-Ionising Radiation and Ultraviolet Radiation*: Salvatore CURCURUTO, Cristina FRIZZA, Maria LOGORELLI, Celine NDONG, Francesca SACCHETTI, Rosalba SILVAGGIO, Roberto SPAMPINATO, Luisa VACCARO
Authors for *Ionising Radiation:* Sonia FONTANI, Valeria INNOCENZI, Giuseppe MENNA, Francesca SALVI, Anna Maria SOTGIU, Giancarlo TORRI

Chapter 6. Environment and Health

Coordinator: Luciana SINISI, assisted by Cristina FRIZZA
Authors: Francesca DE MAIO, Sabrina RIETI, Luciana SINISI, Jessica TUSCANO
Contributors:
Giorgio BARTOLINI (CIBIC), Veronica BEGLIOMINI (ARPA Tuscany), Tommaso BIANCHI (ARPA Tuscany), Valentina BIGAGLI (ARPA Tuscany), Monica Francesca BLASI (ISS), Paola BOTTONI (ISS), Giovanni BRACA, Martina BUSSETTINI, Mario CARERE (ISS), Lorenzo CECCHI (CIBIC), Annamaria DE MARTINO (Ministry of Health), Benedetta DELL'ANNO (Ministry of the Environment, Land and Sea), Valentina DELLA BELLA (ISS), Maria Paola DOMENEGHETTI (ARPA Tuscany), Anna Maria FAUSTO (University of the Tuscia), Giancarlo MAJORI (ISS), Laura MANCINI (ISS), Stefania MARCHEGGIANI (ISS), Angiolo MARTINELLI (ARPA Umbria), Marzia ONORARI (ARPA Tuscany), Simone ORLANDINI (CIBIC), Valter RAINERI (ARPA Liguria), Roberto ROMI (ISS), Danila SCALA (ARPA Tuscany), Daniele SPIZZICHINO, Tommaso TORRIGIANI MALASPINA (CIBIC), Franco VANNUCCI (Local Board of Health 3 of Pistoia)

Chapter 7. Environmental Risk

Coordinators: Eutizio VITTORI (*Natural Risk)* and Alberto RICCHIUTI (*Anthropogenic Risk*), assisted by Alfredo LOTTI (*Anthropogenic Risk*), Luca SEGAZZI and Giorgio VIZZINI (*Natural Risk)*
Authors of *Natural Risk*: Anna Maria BLUMETTI, Stefano CALCATERRA, Valerio COMERCI, Piera GAMBINO, Carla IADANZA, Mauro LUCARINI, Alessandro TRIGILA, Eutizio VITTORI, Giorgio VIZZINI
Authors of *Anthropogenic Risk*: Francesco ASTORRI, Alfredo LOTTI, Alberto RICCHIUTI



Chapter 8. Soil and Land

Coordinator: Fiorenzo FUMANTI, assisted by Alessandra MUCCI and Paola SESTILI
Authors: Marco DI LEGINIO, Fiorenzo FUMANTI, Anna LUISE
Contributors:
Federico ARANEO, Eugenia BARTOLUCCI, Riccardo BOSCHETTO, Carlo DACQUINO, Laura D'APRILE, Andrea DI FABBIO, Maria Cristina GIOVAGNOLI, Carlo JACOMINI, Michele MUNAFÒ, Fabio PASCARELLA, Francesca QUERCIA, Irene RISCHIA, Lycia ROMANO, Luca SALVATI, Antonella VECCHIO

Chapter 9. Coastal Areas

Coordinator: Stefano CORSINI, assisted by Silvia IACCARINO
Authors: Angela BARBANO, Patrizia BORRELLO, Stefano CORSINI, Roberta DE ANGELIS, Paola LA VALLE, Luisa NICOLETTI, Daniela PAGANELLI, Elena PALLOTTINI, Massimo SCOPELLITI (Ministry of the Environment, Land and Sea), Laura SINAPI, Emanuela SPADA

Chapter 10. The Waste Cycle

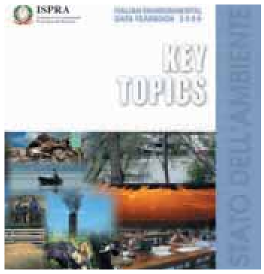
Coordinator: Rosanna LARAIA, assisted by Cristina FRIZZA
Authors: Gabriella ARAGONA, Andrea Massimiliano LANZ, Rosanna LARAIA
Contributors:
Letteria ADELLA, Valeria FRITTELLONI, Fabrizio LEPIDI, Antonio MANGIOLFI, Andrea PAINA, Elisa RASO, Angelo SANTINI

Chapter 11. Instruments for Environmental Knowledge and Awareness and Interfacing with the Market

Coordinators Rita CALICCHIA (*Dissemination of Environmental Information)*, Luigi CAIONI and Stefania MINESTRINI (*Instruments for Improving Environmental Services),* Adolfo PIROZZI (*Dissemination of Environmental Information, Environmental Education and Training Programmes)*, assisted by Paola SESTILI
Authors of *Dissemination of Environmental Information:* Maria Alessia ALESSANDRO, Simona BENEDETTI, Rita CALICCHIA, Fabrizio CIOCCA, Alessandra GALOSI, Daniela GENTA, Anna Laura SASO, Filomena SEVERINO
Authors of *Environmental Education and Training Programmes:* Daniela ANTONIETTI, Silvia BONAVENTURA, Stefania CALICCHIA, Alessandra CASALI, Claudio LA ROSA, Patrizia POLIDORI
Authors of *Instruments for Improving Environmental Services*: Gianluca CESAREI, Mara D'AMICO, Rossella GAFÀ, Stefania MINESTRINI, Valeria TROPEA

Annex –Yearbook Indicators Database

Authors: Raffaele MORELLI, Matteo SALOMONE



Editing

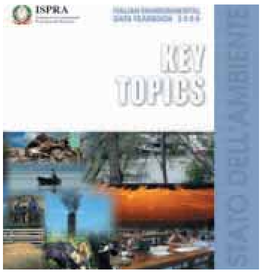
The phases of the editing of the Yearbook products were handled by a workgroup coordinated by Mariaconcetta GIUNTA and consisting of: Giovanni FINOCCHIARO (processing and statistical validation of the data), Cristina FRIZZA (processing and statistical validation of the data), Alessandra GALOSI (processing and statistical validation of the data), Silvia IACCARINO (coordination of the fact-sheets and technical revision), Alessandra MUCCI (revision and editing of texts), Matteo SALOMONE (processing and statistical validation of data, plus multimedia processing), Luca SEGAZZI (technical revision and processing and statistical validation of data), Paola SESTILI (contact for the processing and statistical validation of data). 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 – Reference Units

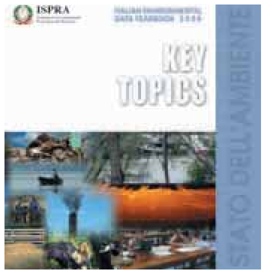
The work involved in the preparation of the information contents of the "Environmental Data Yearbook" was carried out by a Task Force coordinated by Mariaconcetta GIUNTA. In the interests of updating the indicators found in the Yearbook Indicators Database for each environmental topic, the following contacts were identified within the Institute:

former APAT

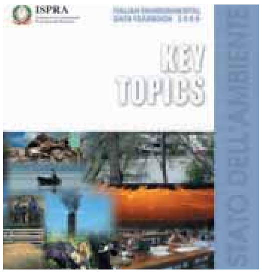
Environmental Topics	**Topic Coordinator**	**Department Service/Sector**	**Statistical Coordinator**
Guide to the Yearbook	Mariaconcetta GIUNTA	AMB-ASA	
Spatial coverage of the indicators	Mariaconcetta GIUNTA	AMB-ASA	
Socio Economic framework	Mariaconcetta GIUNTA	AMB-ASA	
AGRICULTURE and FORESTRY	Lorenzo CICCARESE Stefano LUCCI	NAT-SOS	Luca SEGAZZI
ENERGY	Domenico GAUDIOSO	AMB-MPA	Alessandra GALOSI
TRANSPORT	Mario CONTALDI (Emissions and Technology) Roberta PIGNATELLI (Socioeconomics and the Environment)	AMB-MPA AMB-RAS	Paola SESTILI



Environmental Topics	Topic Coordinator	Department Service/Sector	Statistical Coordinator
TOURISM	Silvia IACCARINO	AMB-ASA	Luca SEGAZZI
INDUSTRY	Antonino LETIZIA	ISP	Luca SEGAZZI
ATMOSPHERE	Riccardo DE LAURETIS (Emissions) Anna Maria CARICCHIA (Air Quality) Franco DESIATO (Climate)	AMB-MPA	Alessandra GALOSI Cristina FRIZZA
BIOSPHERE	Claudio PICCINI	NAT-BIO	Giovanni FINOCCHIARO
HYDROSPHERE	Angela BARBANO (Coasts) Maria CAROTENUTO (WISE) Marco CORDELLA (the Venice Lagoon) Ardiana DONATI (Inland Waters) Gabriele NARDONE (Physical State of the Sea)	ACQ-COS ACQ-DAT ACQ-VEN ACQ-MON ACQ-MAR	Silvia IACCARINO
GEOSPHERE	Fiorenzo FUMANTI, in collaboration with Andrea DI FABBIO and Marco DI LEGINIO, and with assistance from Anna LUISE (Desertification)	SUO-IST AMB	Paola SESTILI Alessandra MUCCI
WASTE	Rosanna LARAIA assisted by Andrea LANZ	AMB-RIF	Cristina FRIZZA
IONISING RADIATION	Giancarlo TORRI, assisted by Sonia FONTANI and Giuseppe MENNA	RIS-LAB RIS-RDP	Silvia IACCARINO
NON-IONISING RADIATION	Salvatore CURCURUTO	AMB-AGF	Matteo SALOMONE
NOISE	Salvatore CURCURUTO	AMB-AGF	Cristina FRIZZA



Environmental Topics	Topic Coordinator	Department Service/Sector	Statistical Coordinator
NATURAL RISK	Eutizio VITTORI, assisted by Giorgio VIZZINI	SUO-RIS SUO-IST	Giovanni FINOCCHIARO
ANTHROPOGENIC RISK	Alberto RICCHIUTI, Alfredo LOTTI, assisted by Francesco ASTORRI (Industrial Risk) Leonardo ARRU, assisted by Laura D'APRILE (Contaminated Sites)	RIS-IND EME	Luca SEGAZZI
ENVIRONMENTAL EVALUATION AND CERTIFICATION	Luigi CAIONI (EMAS) Stefania MINESTRINI (Ecolabel) Maria BELVISI (EIA)	CER AMB-OAM	Silvia IACCARINO
MONITORING and CONTROL	Maria BELLI, assisted by Maria Gabriella SIMEONE (Monitoring) Antonino LETIZIA (Control)	AMB-LAB ISP	Paola SESTILI Alessandra MUCCI
PROMOTION and DISSEMINATION of ENVIRONMENTAL CULTURE	Adolfo PIROZZI Rita CALICCHIA (Environmental Information)	BIB-FOR AMB-RAS	Matteo SALOMONE
ENVIRONMENTAL PLANNING INSTRUMENTS	Patrizia FIORLETTI (SEA) Patrizia BONANNI (Air) Angela BARBANO (Coasts) Ardiana DONATI (Waters) Salvatore CURCURUTO (Noise) Eutizio VITTORI (Natural Risk) Claudio PICCINI (Biosphere)	AMB-VAL AMB-MPA ACQ-COS ACQ-MON AMB-AGF SUO-RIS NAT-BIO	Cristina FRIZZA
ENVIRONMENT and HEALTH	Luciana SINISI	AMB-VAL	Cristina FRIZZA



Former ICRAM

Department II, “Prevention and Mitigation of Impacts”, provided additional information on contaminated sites and on the topic of the hydrosphere (Coasts). Elena ROMANO (Contaminated Sites) and Luisa NICOLETTI (Coasts) worked with the topic coordinators.
Department III, “Defence of Habitats and Biodiversity”, provided further information on Protected Marine Areas and Protected Species (marine). The Department Director, assisted by Sabrina AGNESI, Taira DI NORA and Giulia MO, worked with the coordinator of the biosphere topic.

Former INFS

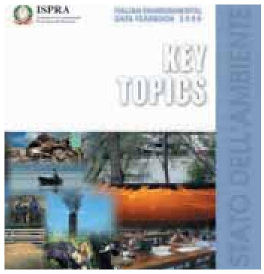
Piero GENOVESI served as the liaison with the other members of the task force, focussing attention on providing further information on the Biosphere environmental topic.

Contacts were also identified for the phases of implementation not directly connected with the information contents of the Yearbook, as shown below:

Connected Activities	**Topic Coordinator**	**Department Service/Sector**	**Statistical Coordinator**
ISPRA website	Franco GUIDUCCI	BIB-WEB	Matteo SALOMONE
SINAnet databases	Michele MUNAFÒ	AMB-NET	
Printing	Renata MONTESANTI Daria MAZZELLA	DIR-COM	Matteo SALOMONE
Graphics/Photography	Franco IOZZOLI Paolo ORLANDI	DIR-COM DIR	Matteo SALOMONE

The full meanings of the symbols for the departments, inter-departmental services, services and sectors are spelled out below:

Departments/Inter-Departmental Services of the former APAT	**SYMBOL**
Commissioner’s Office	DIR
Communications Service	DIR/COM
Inter-Departmental Service for Guidance, Coordination and Control of Inspection Activities	ISP
Inter-Departmental Service for Environmental Emergencies	EME
Inter-Departmental Service for Environmental Certification	CER
Department for Land Resources and Soil Protection	SUO/DIR
Service of Background Investigations, Basin Plans and Data Collection	SUO/IST
Natural Risks Service	SUO/RIS
Department for Marine and Inland Waters Protection	ACQ/DIR



Departments/Inter-Departmental Services of the former APAT	**SYMBOL**
Coastal Protection Service	ACQ/COS
Data Collection and Management Service	ACQ/DAT
Service for the Monitoring and Hydrology of Inland Waters	ACQ/MON
Service for the Lagoon of Venice	ACQ/VEN
Department for the State of Environment and Environmental Metrology	AMB/DIR
Special Yearbook Project and Environmental Statistics Service	AMB/ASA
Special Environmental Observatory Project	AMB/OAM
Service for the Monitoring and Prevention of Atmospheric Impact	AMB/MPA
Physical Agents Service	AMB/AGF
Environmental Metrology Service	AMB/LAB
SINANET Service	AMB/NET
Environmental Assessment Service	AMB/VAL
Environmental Reporting and Instruments of Sustainability Service	AMB/RAS
Waste Service	AMB/RIF
Department of Nuclear, Technological and Industrial Risk	RIS/DIR
Radiation Protection Service	RIS/RDP
Industrial Risk Service	RIS/IND
Radiometric Measurement Service	RIS/LAB
Department of the Protection of Nature	NAT/DIR
Service for the Sustainable Use of Natural Resources	NAT/SOS
Service for the Protection of Biodiversity	NAT/BIO
Department of Library, Documentation and Information Activities	BIB/DIR
Environmental Education and Training Service	BIB/FOR
Library Service	BIB/DOC
Web Portal Service	BIB/WEB

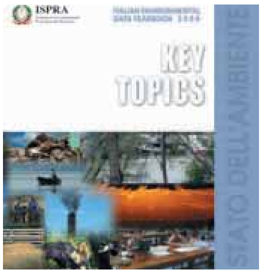
Authors of information contents

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 role of liaison between the ISPRA and the individual ARPAs was carried out by: Giovanni AGNESOD (ARPA Aosta Valley), Rossella AZZONI (ARPA Lombardy), Fabio BADALAMENTI (ARPA Sicily), Milena BRANDINELLI (ARPA Marche), Antonio Nicolò CORRAINE (ARPA Sardinia), Chiara DEFRANCESCO (APPA Trent), Luciana DI CROCE (ARTA Abruzzo), Alessandro Di GIOSA (ARPA Lazio), Giuseppe DI NUZZO (ARPA



Basilicata), Ferruccio FORLATI (ARPA Piedmont), Marco GANI (ARPA Friuli Venezia Giulia), Donatella GRIMALDI (ARPA Liguria), Armando LOMBARDI (ARTA Abruzzo), Roberto MALLEGNI (ARPA Emilia Romagna), Anna Maria MATRONE (ARPA Campania), Luca MENINI (ARPA Veneto), Luigi MINACH (APPA Bolzano), Pina NAPPI (ARPA Piedmont), Paolo Michele RICCI (ARPA Molise), Stefano ROSSI (ARPA Tuscany), Vincenzo SORRENTI (ARPA Calabria), Stefano SPAGNOLO (ARPA Apulia), Paolo STRANIERI (ARPA Umbria).

Other contributions from the ISPRA technical units

Other specific *technical contributions* were made by units of the former APAT, including:

- on topics regarding the *Atmosphere, Waste, Noise, Non-Ionising Radiation, Environment and Health, Monitoring (Metrology), Environmental Impact Assessment, Dissemination of Environmental Information* and the production sectors of *Energy*, *Industry*, *Tourism* and *Transport*, from the State of the Environment and Environmental Metrology Department;
- on topics regarding *Water Resources* and *Coastal Defence*, from the Marine and Inland Waters Department;
- on topics regarding the *Soil and Natural Risk*, the Land Resources and Soil Protection Department;
- on topics involving the *Biosphere* and the *Agriculture* production sector, from the Nature Protection Department;
- on topics regarding *Ionising Radiation* and *Anthropogenic Risk,* from the Nuclear, Technological and Industrial Risk Department;
- on topics regarding the *Promotion and Dissemination of Environmental Culture*, from the Library, Documentation and Information Activities Department;
- on the topic of *Control*, from the Inter-Departmental Service for Guidance, Coordination and Control of Inspections Activities;
- on considerations regarding the *Environmental Quality of Organisations, Businesses and Products*, from the Inter-Departmental Service for Environmental Certification.

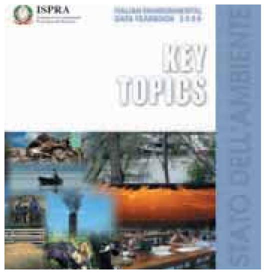
Further specific *technical contributions* were provide by the former ICRAM, including:

- for topics regarding the *Biosphere*, from Department III, "Defence of Habitats and Biodiversity";
- for topics regarding the *Hydrosphere*, from Department II, "Prevention and Mitigation of Impacts", and from Department I, "Monitoring of Environmental Quality"

Specific *technical contributions* were also provided by the former INFS, especially with regard to topics involving the *Biosphere.*

Specific contributions *on considerations of methodology and liaison* were supplied by:

- SISTAN interface, through the Statistics Office of the former APAT: Mariaconcetta GIUNTA;



- coordination of the *EIONET* network (formerly handled by the APAT): Claudio MARICCHIOLO, as the *National Focal Point* for Italy;
- chapter on the *Promotion and Dissemination of Environmental Culture*: Inter-Agency Workgroup for Education Geared towards Sustainability (EOS), the network of libraries and contacts for environmental instruction of the Agency System.

Other contributions by units of the former APAT

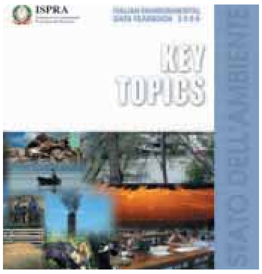
The following contributions were made on operating considerations:
- procedural and administrative considerations: Vincenzo PEZZILLO, Elisabetta GIOVANNINI;
- administrative considerations: the Department of General Services and Personnel Management and the Inter-Departmental Service for the Administration 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 the Ministry of the Environment, Land and Sea, the Ministry of Economic Development, the Ministry of Cultural Resources and Activities, the Ministry of Infrastructures and Transportation, the Ministry of Agricultural, Food and Forestry Policies, the Ministry of Labour, Health and Social Policies, the Carabinieri Police Command for the Protection of the Environment, the Italian National Forestry Corps, the Manager of the National Transmission Network, the Marine Environmental Unit of the Harbourmasters' Corps, the National Fire-Fighters' Corps, the Regional and Provincial Waste Observatories, the Commissioners for the Waste Emergencies in the Regions of Campania, Calabria, Apulia and Sicily, the regional, provincial and municipal governments, the PMP and local government bodies. Of the technical-scientific authorities and organisations, both public and private, the following should be acknowledged: the ISTAT, the ISS, the basin authorities, the magistrates of bodies of water, the CNR, the ACI, the ENEA, the Italian Glaciological Committee, the Italian Meteorological Society, the ENEL, the European Soil Bureau of the Common Research Centre of the European Commission in Ispra (VA), EUROSTAT, Agecontrol S.p.A., Biobank, the National Register of the Organisations EMAS, ISTIL, ODYSSEE, TELEATLAS, TERNA and IREPA.

Referees

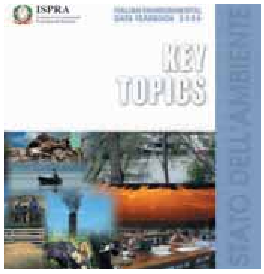
As was done with previous editions, in addition to the numerous contributions received from subjects (individual experts and organisations) outside of the Agency System



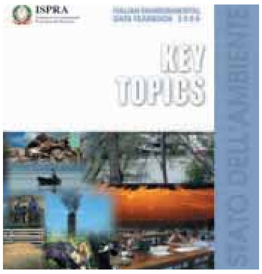
during the phases involving the formulation and production of the Yearbook, it was held best to request an additional and independent assessment of the final product from experts on the individual topics addressed in the publication.
It was not always possible to utilise all or a part of these contributions. 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), Guido BENASSAI (University of Naples), Gianfranco BOLOGNA (WWF Italy), Giovanni BRAMBILLA (IA CNR), Fabrizio BULGARINI (WWF Italy), Anna Maria DE MARTINO (Ministry of Labour, Health and Social Policies), Vincenzo FERRARA (ENEA), Alessandro Maria MICHETTI (University of Insubria - Como), Romano PAGNOTTA (IRSA CNR), Alessandro POLICHETTI (ISS), Sabina PORFIDO (IAMC CNR), Giuseppe RANDAZZO (University of Messina), Rachele SCHETTINI (Chairwoman EUROPA 2010), Anna Maria SIANI (University of Rome, La Sapienza Campus), Paolo VECCHIA (ISS), Giuseppe VIVIANO (ISS).

Thanks

Heartfelt thanks are once again expressed to those whose contributions have made publication of the 2009 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 organisations 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.



CONTENTS


ISPRA
KEY
TOPICS
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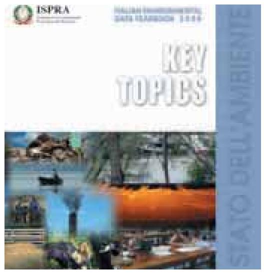
I. Purposes and Structure of the Document



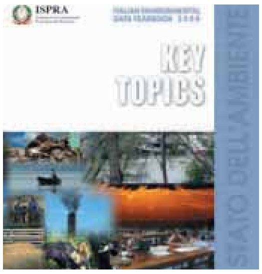
Purposes

This document is meant to provide a sufficiently thorough description of the underlying context for the environmental topics currently given priority in the formulation of environmental policy, especially as regards the topics held by the European Union to be “priority areas for policy initiatives”.

Unlike the complete edition of the Yearbook, which provides detailed descriptions by means of the indicator fact-sheets, this work offers the reader the environmental data structured according to the information base of the Yearbook, which follows the underlying logic of the DPSIR model.

To ensure that the contents are suited to the widest possible audience, the latest reporting techniques have been employed, together with a style of language both clear and precise.

Special care has been taken with the graphic illustration of the information, in order to streamline the communication of the contents. The images included in the text are always accompanied by comments on what is being shown.



Structure of the Document

The document is structured in 11 chapters: each of the first 10 focuses on a different environmental topic, while the eleventh is devoted to instruments of environmental knowledge.

Among the topics examined, special attention is placed on: *climate change, natural risk* (earthquakes, landslides and floods), *the marine coastal environment* (dune, banks of Posidonia, water quality for swimming and marine algae) and *biodiversity*, seeing that these were the issues focussed on by public opinion, together with national and international institutions, in the year 2009.

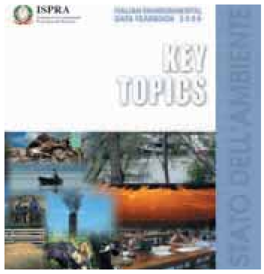
Each environmental topic has been described according to the following logical sequence: first the current environmental conditions are presented, following by an analysis of the underlying causes of these conditions and, finally, a presentation of the solutions currently implemented or that will hopefully be put in place in the future. Special boxes have been included in this edition, where judged to be appropriate, for in-depth examination of certain topics, such as the application of the new regulations for monitoring internal waters and marine coastal waters.

There are three different ways of reading the various chapters: the text provides the reader with a complete and exhaustive analysis of the topics; the “focuses” in the margins make easier the rapid identification of the topics addressed before deciding whether to examine them in depth; by consulting the graphs and the figures, the reader can obtain information that is sufficiently complete, though limited to the individual aspect illustrated.

The information elements found in the document are the end result of a painstaking selection process carried out on the far more extensive stock of information contained in fact-charts of the Yearbook Indicators Database.

An appendix provides a description of the structure and function of the Yearbook Database, a computerised instrument for managing the indicator fact-sheets that contain the Institute’s store of environmental information.

II. Socio Economic Framework



Characteristics of Italy

Italy is a peninsula located in southern Europe, with a territory that includes the Alpine mountain chain and numerous islands, the largest of which are Sicily and Sardinia, while the smaller islands are about 70.

Italian territory consists of hilly and mountainous zones, plus a lengthy coastline, ensuring a wide variety of landscapes.

The environmental features of Italian territory, and the Mediterranean climate in particular (dry and seasonably hot) are similar to those of other Mediterranean countries, such as Spain, Portugal and Greece.
Italy has a total territorial surface of 301,336 km^2. The territory consists primarily of hilly and mountainous zones (accounting for 41.6% and 35.2% of the total respectively), plus a lengthy coastline (8,353 km). These features ensure a territory with a wide variety of landscapes.

The climate in Italy is generally temperate, with regional variations.

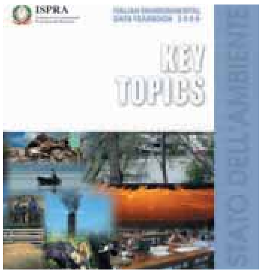
Climate conditions are generally temperate, with regional variations. In summer, the northern regions are hot, with occasional rain, the central regions are humid, and the south scorches under the dry heat. In winter the northern cities undergo cold temperatures, noteworthy humidity and fog, while temperatures in the south are more comfortable (10-20°C).

Due to its position, Italy is one of the countries at greatest risk for earthquakes and volcanoes in the Mediterranean area.

The specific location of Italian territory within the Mediterranean geodynamic context (convergence of the European and African plates, interposition of the Adriatic micro-plate, opening of the Tyrrhenian basin) makes Italy one of the countries at greatest risk for earthquakes and volcanoes.
The areas at greatest risk for earthquakes are the Friuli sector, the central-southern Apennine mountain chain, and especially the sectors of the intra-Apennine basin, as well as along the Tyrrhenian coast of Calabria and in southeast Sicily. The highest volcanic risk is naturally tied to the presence of Italy's active volcanoes, meaning in the Vesuvius and Phlegrean area, on the Island of Ischia, in and around Etna volcano, on the Aeolian Islands and, in part, in the Alban Hills.

Italy is one of the European countries with the richest supply of biodiversity.

Italy is one of Europe's countries, in terms of biodiversity, essentially on account of its favourable geographic position as well as its extensive geo-morphological, microclimatic features and vegetative variety, plus the additional influence of factors of history and culture factors. Italy contains one half of all the plants species and a third of the animal species currently found in European territory.



At the end of 2008, Italy's population numbered more than 60 million. As has been the case for a number of years now, any growth is due almost exclusively to the arrival of immigrants.
The average population density in Italy is approximately 200 inhabitants per square kilometre.

Italy is one of the most densely populated countries in Europe.

Levels of population density higher than the national average tend to be registered by smaller towns, especially in the southern regions and on Italy's islands, where peaks of more than 900 inhabitants per square kilometre can be found.
Seen within the context of the European Union, Italy is one of the most densely populated states. The majority of the Italian population lives in lowland areas.
Thanks to its lengthy history of urban development, Italy is one of the countries with the greatest wealth of cultural resources and monuments (42 Italian cultural sites are included on the UNESCO World Heritage list).

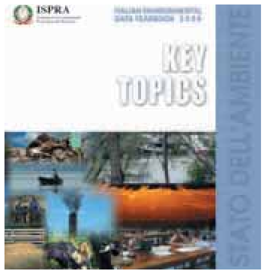
Compared to the rest of Europe, Italy's enterprises are more geared towards manufacturing activities, creating what is referred to as the "made in Italy" sector.

Looking at Italy's production structure, service enterprises are prevalent in the central regions, while the micro-enterprises are predominant in the South , and medium-size enterprises are the most widespread in the northeast regions. In the northwest, on the other hand, large-scale industry plays the leading role.
Compared to the rest of Europe, a higher percentage of our companies are involved in manufacturing activities (despite a late-arriving but rapid development of service industries), with a relative specialisation in the sub-sectors that can be referred to under the category of "*Made in Italy*" products.

II.1 Key developments in Italian society

The last 60 years have been characterised by a sharp drop in the birth rate and a gradual ageing of the population, together with increased immigration.

During the last 60 years, major socioeconomic transformations have occurred in Italy: from a poor society based on agriculture, it has become an advanced post-industrial society.
In accordance with the reference framework, the structure of the Italian population has also changed, in terms of inhabitants and forms of behaviour, going from 47 million inhabitants in the 50's to 60 million at present.
This period was characterised by a sharp drop in the birth rate



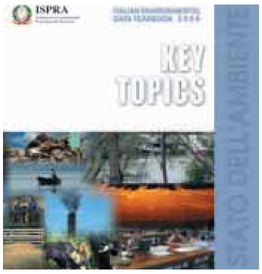
and by the gradual ageing of the population, along with increased immigration.

After a period of relatively stable growth of the Italian economy in the years following the Second World War (1945-1950), the population rose at an astonishing pace, reaching annual growth rates of 1%, especially in urban and suburban areas.
The years between 1958 and 1963 came to be known as those of “Italy’s Economic Miracle”, though it should be noted that economic development noteworthy regional differences, especially between the Centre-North and the South.
Potentially better job prospects in urban areas were the primary cause of the intensive exodus from countryside to the cities, drawing flows of internal immigrants from the Alpine hinterland and the Apennine hills, as well as Sicily and Calabria, in the direction of Rome, Milan, Turin and Genoa. This exodus towards industrial areas still exists, though it has slowed, due to the current depressed state of the economy.

The years of the “Italian Economic Miracle” widened the gap between the Central-North regions and the South.

In 1970, the Italian population numbered approximately 54 million inhabitants, of whom approximately 4 million worked in agriculture (20.1% of the total workforce), while more than 8 million were employed in the service industries (41.5%) and approximately 7.6 million in the industrial sector (38.4%), making for a total active workforce of roughly 20 million. Between 1970 and 2008, the population grew by approximately 6 million inhabitants (+11%), with an equally significant change in the distribution of the workforce among the various categories of employment: the total number of actively employed inhabitants rose by slightly more than 5.5 million (+27%); there was a drop of 992,000 in the number employed in agriculture (-75%), while the number in the service industries rose above the 17 million mark (+107.7%), and the number in the industrial sector fell slightly below 7 million (-7.1%).

Between 1970 and 2008 the Italian population grew by 11% and the structure of the country’s workforce changed significantly, with the emphasis on farming and industry shifting in favour of the service industries.



Between 1970 and the present, the structure of the Italian workforce changed significantly, with the emphasis on farming and industry shifting in favour of the service industries.

Table II.1: Total employed[1]

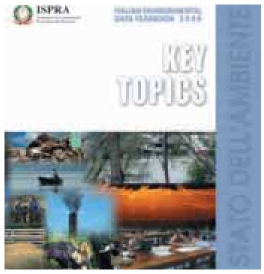
Economic activities	1970	1980	1990	2000	2008
	figures in the 1,000's				
Agriculture, forestry and fishing	4,008.2	2,856.6	1,689.9	1,102.9	991.7
Industry in the strict sense	5,689.7	6,429.1	5,820.1	5,189.5	5,179.1
Construction	1,970.4	1,709.9	1,511.4	1,553.9	1,938.1
Trade repairs, hotels and hotels and restaurants, transport and communications	3,932.4	4,742.8	5,561.2	5,631.7	6,175.0
Monetary and financial intermediation; real estate and business activities	707.7	1,068.8	2,091.8	2,949.8	3,783.7
Other service activities	3,623.0	4,565.8	5,935.1	6,502.3	7,195.3
TOTAL	**19,931.4**	**21,373.0**	**22,609.5**	**22,930,1**	**25,262.9**

Economic activities	1970	1980	1990	2000	2008
	%				
Agriculture, forestry and fishing	20.1	13.4	7.5	4.8	3.9
Industry in the strict sense	28.5	30.1	25.7	22.6	20.5
Construction	9.9	8.0	6.7	6.8	7.7
Trade repairs, hotels and hotels and restaurants, transport and communications	19.7	22.2	24.6	24.6	24.4
Monetary and financial intermediation; real estate and business activities	3.6	5.0	9.3	12.9	15.0
Other service activities	18.2	21.4	26.3	28.4	28.5
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

II.2 The main driving forces and the resulting environmental pressures and impacts

The distinguishing characteristics of the country's territorial and socio-economic framework, and especially the demographic dynamics and the models of behaviour of economic subjects (families and businesses), are closely connected with the anthropogenic pressures that threaten the national environment (air pollution, water, soil and nature, waste generation, consumption and deterioration of natural resources).

[1] Source: ISTAT data processed by ISPRA



Socio-demographic considerations

The question of the environment is closely tied to production activities and to the individuals found in a given territory. These two factors are the main causes of pressures on the environment in terms of consumption, waste generation, emissions etc.. It follows that any analysis of the environmental situation must also take into account the demographic factor, which has noteworthy repercussions from a socio-economic point of view.

The individuals found in a given territory are one of the main sources of pressure on the environment.

During 2008, Italy's resident population rose above the threshold of 60 million inhabitants. As of 31 December 2008, the total was 60,045,068[2] inhabitants, for an increase of 425,778 over the same date in 2007, determined exclusively by the arrival of immigrants from abroad. The population increase presents regional differences, as a result of contrasting dynamics that channel the majority of the migratory, both internal and from abroad, towards the regions of northern and central Italy, while the balance of natural population growth is positive in Southern Italy (including islands). In terms of the territorial make-up, therefore, noteworthy differences can be observed not only between the surface areas of the different regions but as regards their demographic profiles as well.

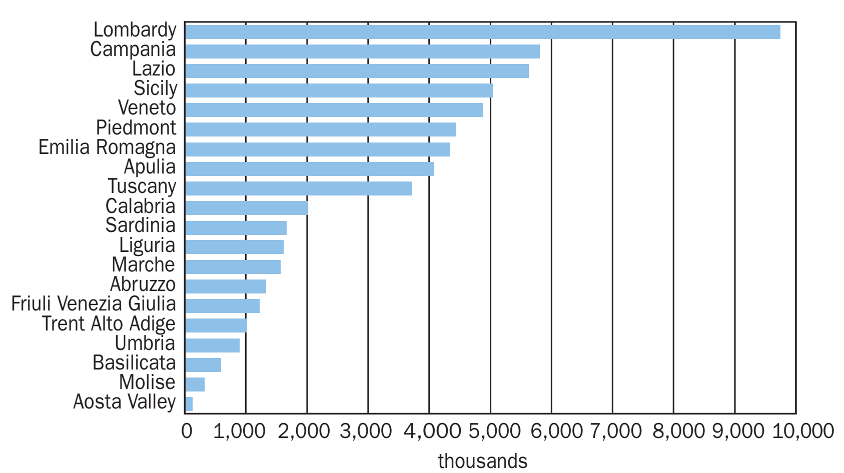
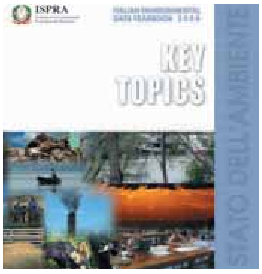


Figure II.1: Resident population as of 31 December 2008[3]

During 2008 Italy's resident population rose above the threshold of 60 million inhabitants.

[2] Source: ISTAT (for all the data indicated in this section)

[3] Source: ISTAT data processed by ISPRA



Within Europe as a whole, Italy is one of the most densely populated countries. The most densely populated Italian regions, at respective levels of 428 and 404 inhabitants per km², are Campania and Lombardy.

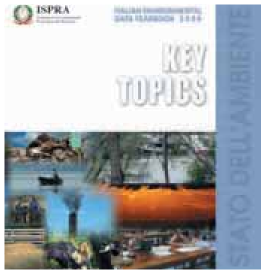
The most heavily populated region, with more than 9.7 million residents, is Lombardy, followed by Campania (over 5.8 million) and Lazio (over 5.6). The regions with the largest surface area, on the other hand, are Sicily, Piedmont and Sardinia, with Lombardy in fourth place.
Breaking down the population by age, 20.1% are individuals aged 65 or older, 14% are young people up to the age of 14, and 65.9% of the population is in active age group, meaning the 15 to 64 year-old segment.

Consumption patterns also reflect demographic changes, with variations in family size having an especially noticeable effect on the allocation of available spending. As of 31 December 2008, 99.5% of Italy's resident population lived in a family. The average number of family members remained stable, at 2.4, compared to 2007. It should be noted that 11.3% of the families residing in Italy find themselves in relative poverty (8 million and 78 thousand people), 4.6% live in conditions of absolute poverty (2 million and 893 thousand people).

Spending on food and beverages accounts for 19.1% of total monthly family spending.

Compared to 2007, levels of spending for healthcare, transportation, leisure-time and cultural activities, as well as clothing and footwear, furnishings, home appliances and home services, all fell.

In 2008 average monthly spending per family was equal, at current values, to 2,485 euro (2,480 euro in 2007), varying from a minimum of 1,692 euro (single-member families) to a maximum of 3,251 euro (families of 5 or more people). Spending on food and beverages stood at 475 euro, while spending on non-food goods was 2,009 euro. Spending on food and beverages accounts for an average of 19.1% of the total monthly spending of families. Compared to 2007, levels of spending on healthcare, transportation, leisure-time and cultural activities, clothing and footwear, furnishings, home appliances and household services fell. On the other hand, the percentages of spending that families allocated to education, communications and tobacco products remained stable, while spending on fuel and energy was on the rise. Looking at regional differences, Veneto remained the region with the highest average level of family spending, at 2,975 euro (3,047 euro in 2007), while Sicily, which registered 1,742 euro (1,764 euro in 2007) once again was the region with the lowest level.



Spending on food and beverages represents 19% of total monthly family spending, while transportation accounts for approximately 14% and housing for roughly 27%.

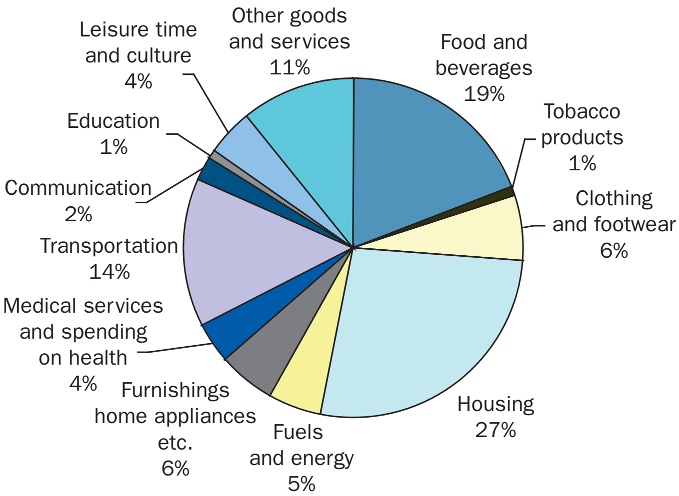


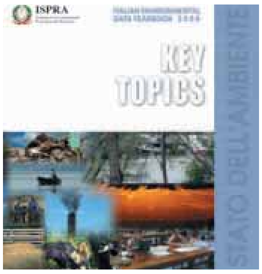
Figure II.2: Average monthly family spending by category (2008)[4]

Economic factors

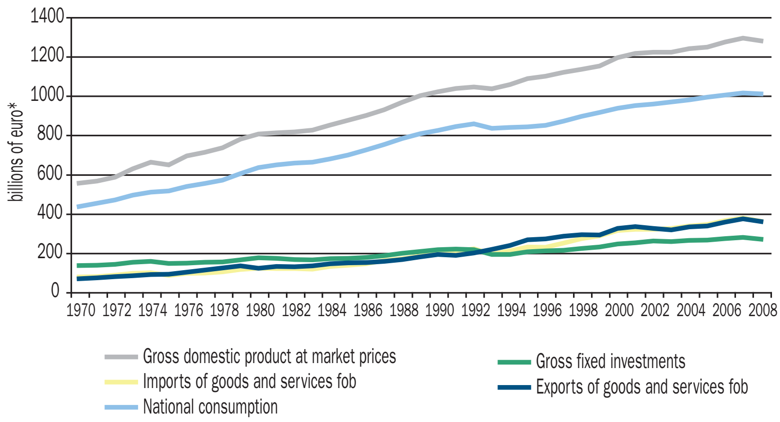
Until such time as the European project "Beyond GDP" generates indicators able to measure long-term economic and social progress more thoroughly and accurately than GDP, and in particular the capacity of a given society to deal with issues such as climate change, the efficient use of resources or social inclusion, classic macroeconomic indicators, estimated on the basis of countrywide results, shall continue to be used to analyse the distinctive features of Italy's economy.

Between 1970 and 2008, the main categories on the income statement for resources and investments registered noteworthy growth, with the GDP, consumption and investments doubling their levels, while imports and exports rose no less than fourfold (Figure II.3).

[4] Source: ISTAT data processed by ISPRA



Between 1970 and 2008 the GDP, consumption and investments doubled. Imports and exports increased nearly fourfold.



*= values keyed to the reference of 2000 year

Figure II.3: Main aggregates of the income statement of resources and investments[5]

The national GDP for 2008, calculated in keyed to the reference year of 2000, fell by 1% compared to 2007.

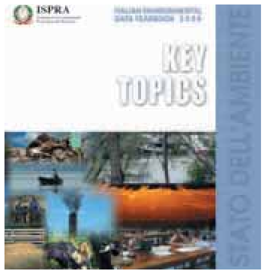
The gap between Italy's northern and southern regions is not being reduced.

In almost all the countries of Europe, consumption amounts to more than 70% of the national GDP.

The Gross Domestic Product (GDP), which gives the final result for all the goods and services produced in a country during a given period, stood at approximately 1.277 trillion euro for Italy in the year 2008, calculated in values keyed to the reference year of 2000, representing a decrease of 1% over the previous year. Unlike the trend within the European Union (EU27), where the countries that start at the lower levels of per capita GDP corrected for ppp[6] are the ones that grow fastest, in Italy do not show this convergence of growth rates, with the southern regions proving unable to close the gap with the richer northern zones.

As for consumption, which constitutes the main component of aggregate demand[7] all the EU countries, except for Ireland and Luxembourg, present levels of consumption that exceed 70% of their GDP. In 2008 consumption in Italy (74.3% of which is tied to the spending of the resident families) was equal to 1.007 trillion euro, or 79% of the GDP, while gross fixed investments

[5] Source: ISTAT data processed by ISPRA
[6] ppp = purchasing power parity
[7] Eurostat, New Cronos Database



accounted for 21%. In certain countries[8], especially outside the EU(15), the sum of consumption and investments as percentages of the GDP is greater than 100, meaning that these countries consume and invest more than they produce, and thus need to draw on foreign markets.
The above situation, which holds for the majority of the countries outside of the EU(15), is also found in southern Italy, whose regions are forced to imports goods and services to sustain levels of consumption and investment which, taken together, exceed the GDP.

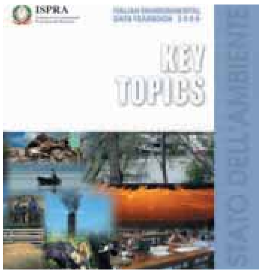
In all the countries of the European Union (EU25), more than 60% of the GDP (70.4% in Italy) is generated by the services-industry sector (which include banking activities, tourism, transport and insurance). Industry and agriculture, though they still play significant roles, have declined in economic importance in recent years. In Italy, the incidence of the primary sector in terms of value added for 2008 was only 2.5 percentage points, while the industrial sector (meaning industry in the strict sense, plus construction) accounted for 26.9%.

In all the countries of the EU25, more than 60% of the GDP is generated by the services-industry sector.

The composition by sectors of Italy's production structure, as shown by "ASIA" [9] , the archive of Italian enterprises of ISTAT for 2006, is similar to that illustrated for Germany in the EUROSTAT[10] statistics for EU enterprises of 2005, though in Germany large-scale enterprises predominate, as is the case in all the economies of continental Europe. Within Italy, on the other hand, the central regions show a greater vocation towards service enterprises, though the two regions with the largest enterprises in the services sector are Lazio and Lombardy. As for the South, the predominant role is played by micro-enterprises, with a particular emphasis on the services sector in Campania, Calabria, Sicily and Sardinia, while industrial firms are the leading force in Apulia, Basilicata and Molise. In the northeast regions medium-size industrial enterprises are the most widespread, while large-scale industry is dominant in the northwest, and especially in Piedmont.

Italy's central regions show a greater propensity for service enterprises, while micro-firms are predominant in the South, and medium-size enterprises are the most widespread in the northeast regions. Large-scale industry plays the leading role in the Northwest.

[8] Ibidem
[9] ISTAT, Statistical Archive on Active Enterprises (ASIA)
[10] Eurostat, *Structural Business Statistics* (SBS)



Industry

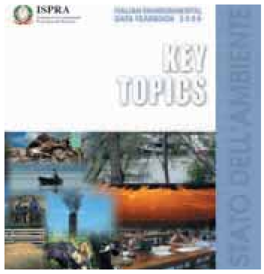
Small-scale enterprises continue to play the predominant role in the Italian production structure.

In 2007, there were 4.4 million Italian industrial and service enterprises, employing approximately 17 million workers (11.4 million salaried employees) and generating roughly 722 million euro of value added. The predominant role in the Italian production structure continues to be played by small-scale enterprises. Within the framework of Europe as a whole, our companies are more focussed on manufacturing activities (despite a late but rapid development of the service industries), with the chief manufacturing sub-sectors being those referred to under the umbrella term "*Made in Italy*". Specialisation in these primarily low-tech sectors was further reinforced in the early 2000's. The limited size of the average company is accompanied by a high incidence of self-employment.

In 2007 there were 1.13 million Italian industrial firms employing approximately 6.72 million workers (5.19 million salaried employees) and turning out value added of more than 333 million euro. The average industrial firm had 5.9 employees, while each company in the sector of traditional industry operates with an average of 9.2 workers.
An analysis of the total number of people employed compared to the resident population highlights the fact that industrial activity is carried out primarily by the resident populations of Veneto, Lombardy, Emilia Romagna and Marche.

In recent years industry has increasingly been called upon to reconcile considerations of growth and competitiveness with those of environmental compatibility and sustainable development.

It should be stressed that the effect of the industrial sector on the environment regards not only the possibility of different forms of environmental pollution, but also the exploitation of natural resources.
In recent years industry has increasingly been called upon to reconcile considerations of growth and competitiveness with those of environmental compatibility and sustainable development, optimising production processes and applying techniques to eliminate or minimise environmental impact while reducing the use of resources, raw materials and energy and observing principles of prevention, including:
- avoiding or reducing the production of pollutants;
- making effective use of energy resources and raw materials;



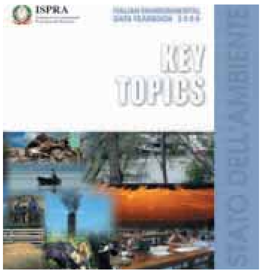
- reducing scrap and, if possible, recycling it within the production cycle.

The number of plants in Italy considered to be at risk of a major accident decreased by a few dozen units in absolute terms.

It is interesting to observe that the number of industrial establishments in Italy considered to be at major accident hazards (MAH), and therefore subject to the obligations stipulated under arts. 6/7 and 8 of Legislative Decree 238/05 (which partially modified the earlier Legislative Decree 334/99), decreased compare to the previous year (2007) by a few dozen units in absolute terms. This variation is due primarily to modifications in the regulations and to the placement in full operation of the procedures that the managers of the plants are required to respect. Only a small portion of the change constitutes actual modifications in industrial activities (closings for the termination of activities, new activities or expansions of existing plants). In terms of the distribution within the national territory of the establishments subject to notification (under arts. 6/7 and art. 8 of Legislative Decree 334/99), fully a fourth are found in Lombardy, while other regions with significant numbers of industrial operations posing risks are: Piedmont, Veneto and Emilia Romagna (all northern regions accounting for approximately 9% each). Such activities are particularly concentrated in certain areas of these regions holding long-time refining and/or petrochemical complexes, such as Trecate (in the vicinity of Novara), Porto Marghera, Ferrara and Ravenna, and in the industrial areas of the provinces of Turin, Alessandria, Bologna, Verona and Vicenza. There are also central-southern regions with a significant presence of activities subject to notification, and specifically: Sicily (approximately 7%), Lazio and Campania (with slightly more than 6%), Tuscany (approximately 5%), Apulia and Sardinia (approximately 4%); these regions also contain petroleum and petrochemical plants, as in the areas of Gela (Province of Caltanissetta), Augusta-Priolo-Melilli-Siracusa, Brindisi, Porto Torres (Province of Sassari) and Sarroch (Province of Cagliari), while there are concentration of industrial activities in the provinces of Leghorn, Rome, Frosinone, Naples and Bari, plus depots for agricultural products in the Province of Ragusa.

A very low percentage (less than 4%) of MAH plants are located in zones classified as highly dangerous (zone 1).

Nationally, a very low percentage (less than 4%) of plants at major accident hazard (MAH) are located in zones classified as highly dangerous (zone 1). The regions with plants located in such zones

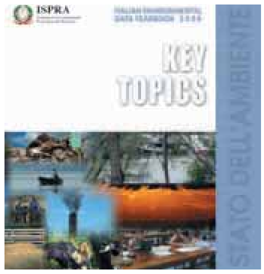


A fourth of the establishments requiring notification (arts. 6/7 and art. 8 of Legislative Decree 334/99) are concentrated in Lombardy, and in the provinces of Milan, Bergamo, Brescia and Varese in particular.

Figure II.4: Localisation within the national territory of the establishments subject to Legislative Decree 334/99 (30 June 2008)[11]

are Friuli Venezia Giulia, Umbria, Abruzzo, Molise, Campania, Calabria, Basilicata and Sicily; of these, Calabria contains 75% of the plants in a seismic zone 1. All the regions, with the exception of Trent Alto Adige, Aosta Valley and Sardinia, have MAH plants in

[11] Source: Ministry of the Environment, Land and Sea data processed by ISPRA



zones of elevated seismic risk (zone 2), especially in the case of Sicily and Campania, where more than 90% of the plants fall in such zones. It should also be noted that the plants located in zones falling under the first two seismic classifications, meaning the ones presenting the greatest danger, account for 312 out of a total of 1,090 (approximately 30%), while regions such as Calabria, Sicily, Basilicata, Campania, Molise and Marche have almost 100% of their MAH plants such zones, while the percentage for the regions of Friuli Venezia Giulia, Umbria, Lazio and Abruzzo is approximately 50%. Finally, roughly 70% of the MAH are located in the two other seismic categories (3 and 4), with approximately 40% (459 plants) found in zone 4, which called for no anti-seismic building design prior to introduction of the 2003 classification system.

70% of MAH plants are located in zones falling in seismic classes 3 and 4.

Energy

As far as the energy sector in Italy is concerned, the most recent data (ISPRA and ENEA[12]) point to a number of different results, including confirmation of the fact that primary energy intensity[13] is lower than the European average. However, a comparison with the situation in the rest of Europe over the years shows that the benefits enjoyed by Italy on account of its initially favourable position in terms of energy intensity are gradually declining, due to the fact that the situation has remained essentially unchanged in Italy over the last decade, while almost all the other European countries have registered improvements. It should also be noted that the ratio between final consumption and total consumption of energy in Italy is higher than the European average. This serves as an indirect sign of efficient conversion of primary energy sources. The increased efficiency - traceable, for example, to a rise in gross production of electric energy by cogeneration plants (starting from 1999), is partially offset by the growing percentage weight of secondary energy sources (electricity, petroleum derivatives) in the final consumption of energy, explaining the extreme variability in the information.

Apart from confirmation of a number of structural characteristics of Italy's energy system, such as the fact that it outperforms the European average in terms of energy intensity and the ratio between final and total energy consumption, a series of changes in the way energy is procured are also taking place.

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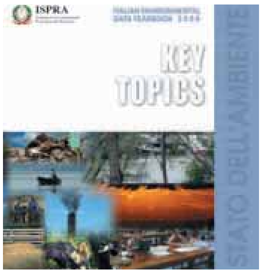
[12] ENEA, 2009, *Rapporto Energia e Ambiente 2008, Analisi e Scenari.*

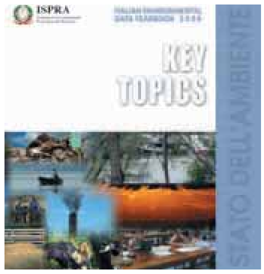
[13] The "primary energy intensity" indicator measures the energy efficiency of economic systems, meaning the quantity of energy needed per unit of GDP produced.



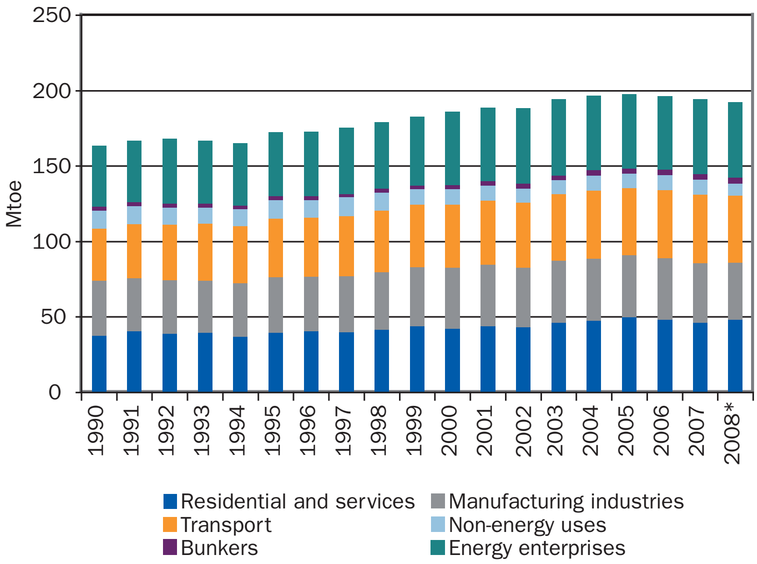
In 2008, the demand for primary energy stood at 192 Mtoe, for a decrease of approximately one percentage point compared to 2007.

In recent years there has been a series of changes in the sources of energy supplies, such as the growing role of natural gas compared to petroleum products, plus an increasing contribution from renewable sources and cogeneration, along with, from 2001 on, a revival in the consumption of solid fuels, whose contribution to total primary energy sources (including primary electric energy) went from 8.6% in 2001 to 11.5% in 2008. Furthermore, the gradual entry in operation, starting from 1999, of combined-cycle plants – with levels of efficiency higher than those of traditional plants – fuelled by natural gas or gas derivatives explains the decrease in average specific fuel consumption in the production of electric energy from fossil fuels, which has fallen by 12% since 2000 in terms of the net electricity produced.
The dynamics of the energy sector are also influenced by the performance of the international fuel market, as well as developments in the regulatory outlook, such as the liberalisation of energy markets an the introduction of new forms of incentives for the production of electric energy from renewable sources, by establishing a minimum quota of renewable sources for each producer of electricity.

In 2008, the demand for primary energy stood at 192 Mtoe, for a decrease of approximately one percentage point compared to 2007. As shown by Figure II.5, the trend in the final consumption of energy increased between 1990 and 2005, peaking at 20.7%. Starting from 2006 there was a reversal, with final consumption as of 2008 haven fallen by 4.1% compared to 2005. Overall, final consumption as of 2008 had risen by 15.7% compared to 1990. The primary sectors responsible for the general trend show decreased consumption in recent years. In terms of the break-down in final energy consumption for 2008 (excluding non-energy uses and bunkering), the residential and services sector absorbed 34.4% of consumption, followed by the transportation and industrial` sectors, at respective figures of 34.2% and 29%, while agriculture and fishing accounted for the remaining 2.4% of final consumption.



In 2008, the demand for primary energy stood at 192 Mtoe, for a decrease of approximately one percentage point compared to 2007.



Note: * Provisional figure

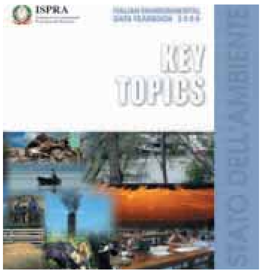
FigurE II.5: Final national energy consumption by economic sector[14]

Agriculture

Relations between agriculture and the environment are extremely complex, working on two levels. On the one hand, agricultural land is directly impacted by other production sectors (i.e. the consumption of the soil), in addition to undergoing the indirect impact of the physical and chemical alteration of the atmosphere, as well as the occurrence of extreme meteorological events. At the same time, agricultural activities – which, in recent decades, have resulted, in many cases, in intensified, concentrated and specialised uses of the land and agricultural techniques – are considered to be among the primary causes of the pollution of water, loss of stability of the land and pollution and acidification of the soil, as well as increases in the greenhouse effect, a loss of biological diversity, a simplification of the landscape and a reduction in the wellbeing of livestock. There is no doubt, however, that agriculture, in addition to guaranteeing good produc-

Agricultural land undergoes the direct impact of other production sectors, as well as the indirect impact of physical and chemical alterations of the atmosphere, and that of extreme meteorological events.

[14] Source: Ministry of Economic Development



tion capacity of foodstuffs, wood and fibres, can also play an important role (if properly managed): in the environmental defence of the territory; in the preservation of the biological diversity of ecosystems, species and genomes; in reducing the pollution and deterioration of the land and water.

Agriculture, in addition to guaranteeing good production capacity of foodstuffs, wood and fibres, can also carry out important environmental services that are specifically acknowledged and sustained under EU policies in different sectors.

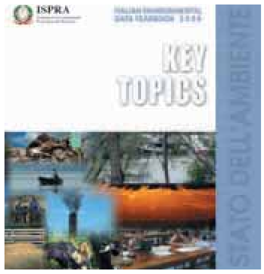
These important environmental services are specifically acknowledged and sustained under EU policies in different sectors, as well as under the strategies of the EU Environmental Action Program and under the Strategy for Sustainable Development. Along these lines, it should be remembered that the concept of "conditionality" was made a part of Common Agricultural Policy, meaning that the disbursement of direct payments allocated to enterprises depends on compliance with regulations and measures of environmental defence. For the most part, these measures regard "obligatory operating criteria" and "good agronomic and environmental conditions". At present there are no fewer than 19 legislative acts that place direct constraints on agricultural enterprises with regard to the environment, public health and the health of plants and animals.

In 2007 Italy's total Utilized Agricultural Area was equal to 12,744,196 hectares.

In 2007, Italy's Utilized Agricultural Area totalled 12,744,196 hectares, a slight increase compared to 2005 (+0.3%), but a lower figure than that for 2000 (-2.4%). The largest decreases in comparison with that year were observed in the north (-4.2%) and in the central regions (-4.5%). In terms of the management of farming soil, there was a clear prevalence, in the sequences of crops, of free alternation and rotation, at respective figures of 40.8% and 40.1% of the planted UAA. As far as covering techniques are concerned, controlled growing of grass was favoured over green manure and mulching.

Total farming enterprises number 1,677,766 units.

In 2007 there were a total of 1,677,766 agricultural enterprises. This figure was lower than the total from the previous ISTAT census of 2005 (-2.9%) and also represents a decrease compared to 2000 (-22.1%), confirming the ongoing erosion in the sector's economic importance, as well as the operational abandonment of farmland, a trend rooted in the country's economic and social transformation. The largest concentration of enterprises is found in the South (959,642 units), representing a decrease from 2005 (-3.3%) and



an even bigger drop from 2000 (-19.9%). Next comes the North, with 449,325 units, and the Centre with 268,799 units. This last zone registered the most significant drop compared to 2000 (-28.5%).
In Italy, the number of workers employed by the primary sector has fallen over time. In 2007 agriculture accounted for 4% of all men employed by the Italian economy and 3.1% of all women. These figures, lower than the EU-25 averages, placed Italy among the countries that contribute the least manpower to agricultural activities.

In 2007 agriculture accounted for 4% of all men employed by the Italian economy and 3.1% of all women.

Noteworthy in terms of productivity is the comparison between the primary sector and industry: the value added to base prices per unit of agricultural labour in 2008 was equal to 51.2% of the figure for industry. Within the overall overlook, however, the biological branch deserves separate consideration. Though it occupies only 8% of Italy's UAA, it constitutes an important driving force of development and income for the companies involved in biological farming. Though the surface utilised for, or being converted to, biological agriculture decreased by approximately 12.9% compare to the previous year, our country remains one of the main European user of this production technique, in terms of both surface area and number of enterprises involved.

The value added to base prices per unit of agricultural labour in 2008 was equal to 51.2% of the figure for industry.

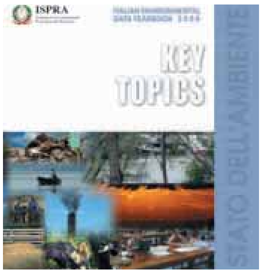
The term Standard Gross Margin (SGM) refers to "*the average level of pre-tax income in a given region or province and for a given production activity*"[15]. Used to determine the economic dimensions of farming enterprises, it is expressed in the European Size Unit (ESU), which is equal to 1,200 ECU of total standard pre-tax income.
The total national SGM for 2007 (Table II.2) was 25,000,347 ESU, making or a noteworthy increase over 2005 (+12.6%) and 2000 (+31.2%).
More than 46% of the SGM for 2007 was produced in Northern Italy, another 40% in the South, and the remaining 14% in the central regions. This break-down matches those registered in the years 2005 and 2000.

The total national SGM for 2007 was 25,000,347 ESU, a marked in crease compared to 2005.

Plant health products are used in protecting vegetables or vegetable products from harmful organisms, such as fungi, insects, mites, bacteria, viruses and weeds, and in favouring or regulating the vital

In 2007 approximately 150 thousand tons of plant care products were placed on the market.

[15] INEA definition under the RICA methodology



processes of vegetables (not including fertilisers). In 2007 approximately 150 thousand tons of such products were put on the market, a decrease of 3% compared to 2006. Fungicides account for 50.9% of the total, followed by insecticides and miticides (18.1%), herbicides (17.8%), miscellaneous products (fumigators, plant regulators, molluscicides, carriers and other) (12.9%) and biological items (0.2%). Compared to 1997, distribution has fallen by 8.1%. Decreases were registered in all categories, and especially for insecticides and miticides (-31%), apart from "miscellaneous", which rose above 39%. Sicily (Figure II.6), with more than 21,000 tons (13.7% of the national total), was the region with the highest distribution, followed by Emilia Romagna (13.4%), Veneto (12.5%), Apulia (11.1%) and Piedmont (8.6%). Almost 60% of all plant health products, therefore, are distributed in these five regions.

Sicily, at over 21.000 tons (13.7% of the national total), is the region with the highest distribution of plant care products, followed by Emilia Romagna (13.4%), Veneto (12.5%), Apulia (11.1%) and Piedmont (8.6%).

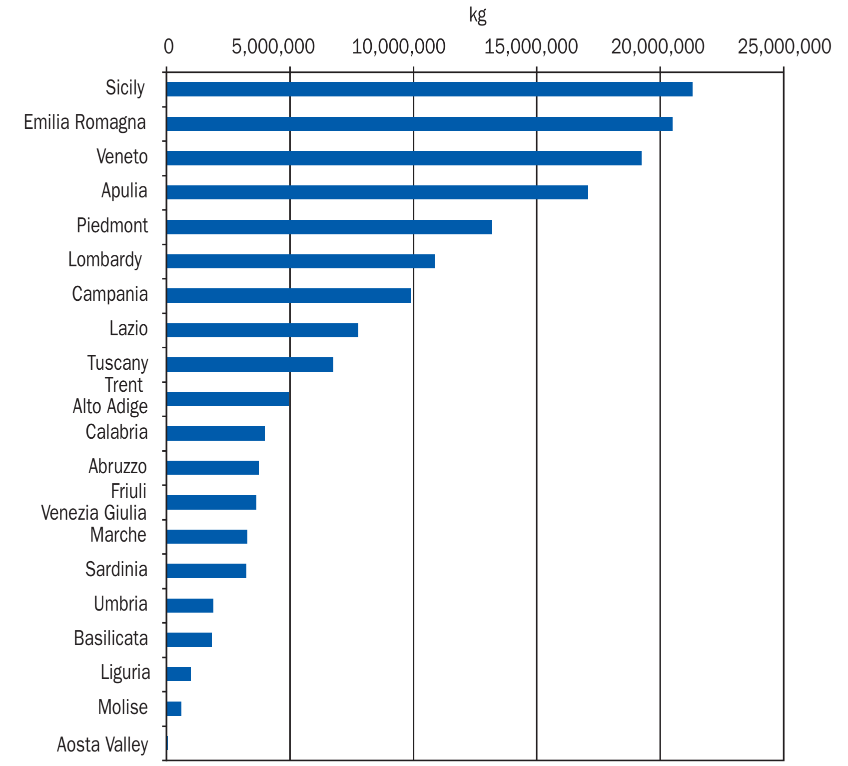
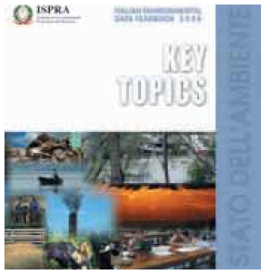


Figure II.6: Regional distribution of plant care products (2007)[16]

[16] Source: ISTAT data processed by ISPRA



Transport and Mobility

Looking at all modes of transport in Italy, mobility of freight and passengers shows constant growth in recent years. Total domestic freight transport for 2008, estimated at slightly more than 230 billion km-tons, shows an increase of 5.8% over 2004. A break-down of the freight traffic data by mode of transport points to an absolute predominance of roadway traffic, which, in 2008, still absorbed 62.3% of the total km-tons transported. In the same year, the percentages absorbed by the remaining modes of transport were: 21% by sea-way ; 16.3% by railway and pipeline; 0.43% by air-way, which continues to cover only a minimal portion of domestic freight transport, being devoted primarily to international transport (Figure II.7).

Looking at all the modes of transport in Italy, mobility of freight and passengers shows constant growth in recent years.

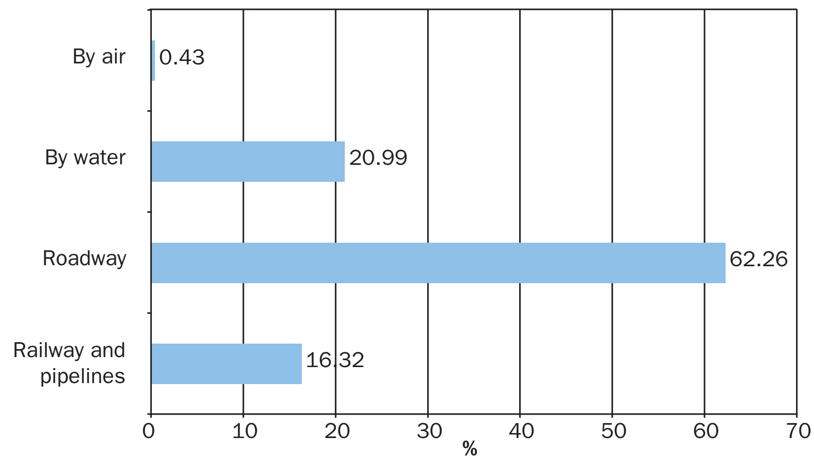


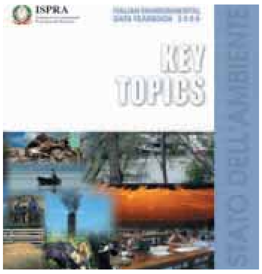
Figure II.7: Percentage of domestic freight traffic by transport mode (2008)[17]

In 2008, roadway transport once again proved to be the predominant mode, accounting for 62.3% of the km-tons transported.

Domestic passenger transport shows a fluctuating trend during the period 2004-2008, with growth of 6.5% in 2006, compared to 2005, followed by a decrease of -4.7% in 2008, as compared

Domestic passenger transport shows fluctuating trend for the period 2004-2008, with a decrease of 4.7% in 2008, compared to 2007.

[17] Source: CNT 2007-2008 data processed by ISPRA



to the previous year. Despite this fragmented trend, there was a slight overall increase of 1.6% between 2004 and 2008.

As in the case of freight transport, the roadway mode is clearly predominant, with 92.2% of the total. The percentages of the other modes remained virtually unchanged, with respective values of 5.8% for transport by railway and other fixed systems, 1.6% for air transport and only 0.4% for transport by sea (Figure II.8).

Looking at domestic passenger transport, roadway travel is virtually the only mode used (92.2%).

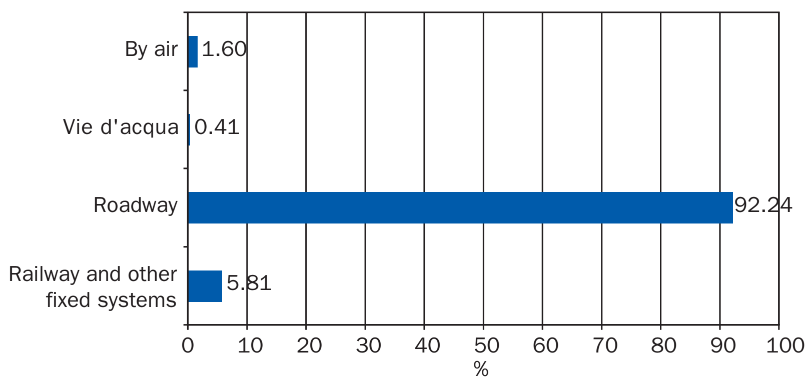
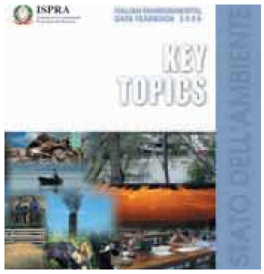


Figure II.8: Percentage of domestic passenger traffic by mode of transport (2008)[18]

Commercial air travel grows by 11.8% between 2004 and 2008.
Vehicle traffic registers a 60% increase in km travelled on Italian highways between 1990 and 2008.
Between 2004 and 2007, passenger transport on the railway network rises by 5.6%, while freight transport shows a 1.2% increase.

A more detailed analysis of traffic, broken down by the different modes of transport, highlight a variety of situations. The data on air traffic, based on the number of movements of commercial aircraft (domestic and international), though shows a growth of +11.8% between 2004 and 2008[19], they reduce of -4.3% during the last year. A long-term look at vehicle traffic (1990 – 2008) shows an approximately 60% increase in the kilometres travelled by light and heavy vehicles on Italian highways, while the result for last year (2007-2008) was a slight decrease in traffic (-0.8%)[20]. As for railway traffic 315 million train-km of passenger transport circulated in 2007 on the State Railway

[18] Source: CNT 2007-2008 data processed by ISPRA
[19] ENAC
[20] AISCAT



System (+5.6% compared to 2004), while approximately 63 million train-km of freight of traffic (-1.2% compared to 2004).

To better understand the potential pressures our country, it is necessary to examine the state of its transportat equipment and infrastructures.
As of 31 December 2007, the primary Italian roadway network (not including municipal roads) was 182,136 kilometres long, consisting of 6,588 km of motorways, 19,290 km of other roads of national importance and 156,258 km of regional and provincial roads, for an overall increase of 8.6% compared to 2000.

As of 31 December 2007, the primary Italian roadway network (not including municipal roads) shows an overall increase of approximately 8.6% compared to 2000.

Looking at the statistics on roadway traffic, the figures provided by the AISCAT (the Italian Association of Motorway and Tunnel Concessionaire Companies) on the volumes of traffic recorded on the motorway network operated under government concessions (5,485.9 km as of 31 December 2008), shows that the daily average theoretical vehicles in circulation in 2008 numbered more than 41 million (almost a million less than in 2007), consisting of 31.5 million light vehicles (76.2%) and 9.9 million heavy vehicles (23.8%).

As for the railway network, its total track length as of 2007 was approximately 20,035 km, or 771 km more than in 2000. More significant increases are registered in the lengths of the electrified network and of the two-track network, which grew by respective figures of 8.6% and 17.6%.

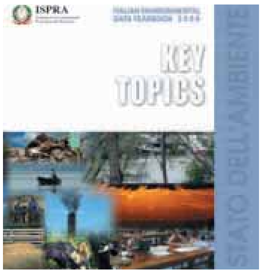
Between 2000 and 2007 the railway network grew by 771 km.

The available statistics also point to a significant quantity of port infrastructures in Italian territory. As of 31 December 2007, there were 263 ports, with total dock length of slightly more than 401 kilometres, making for an average of approximately 263 metres per berth and more than 1.5 kilometres per port.
Maritime transport registered an increase of 36.1% in 2007, as compared to 2001, with a total of 1,523 dockings.

Maritime transport registered an increase of 36.1% in 2007, compared to 2001.

Examining airport infrastructures in Italy, there were 100 airports distributed throughout Italian territory in 2007, one less than in 2006, while the airport grounds covered a surface area of approx-

Domestic airports covered a total surface area of 150 km^2 in 2007, and overall



runway length was approximately 202 km.

imately 150.6 km² and runway length totalled approximately 202 km.

An overview of the urbanised surface area set aside for infrastructures and the transport network is provided by Figure II.9, which illustrates the percentage of the total surface area found in for each region. The region with the highest infrastructure density is Lombardy, with a percentage of more than 12.3%, followed by set of regions in the range of 8-10%: Veneto (9.7%), Campania (8.9%), Friuli Venezia Giulia (8.3%) and Lazio (8.2%).

The region with the highest density of infrastructures is Lombardy, with more than 12.3% of the total, followed by regions falling in a range of 8-10%: Veneto (9.7%), Campania (8.9%), Friuli Venezia Giulia (8.3%) and Lazio (8.2%).

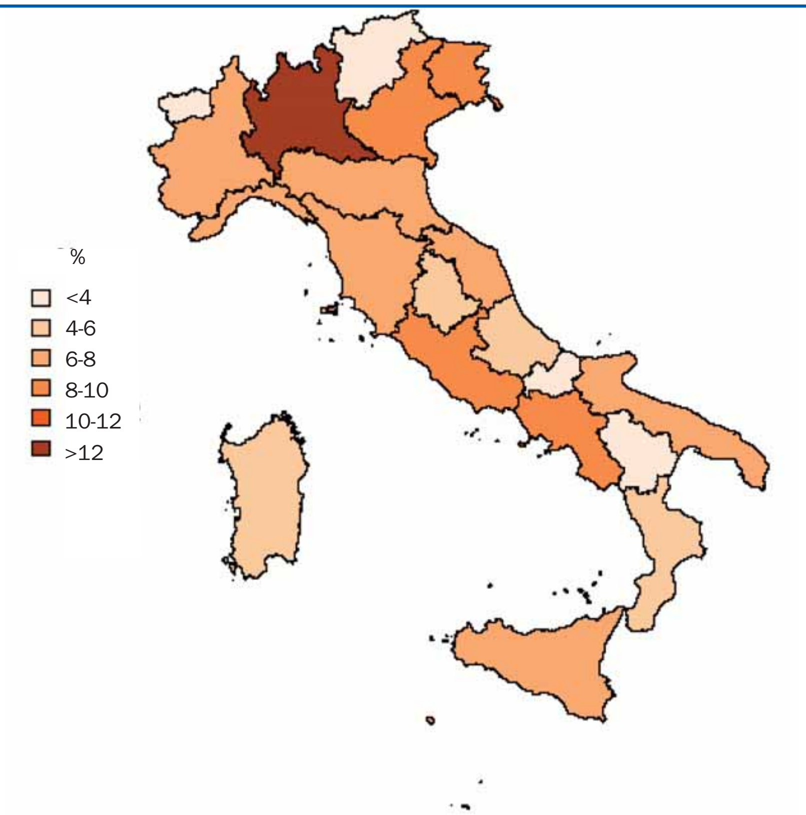
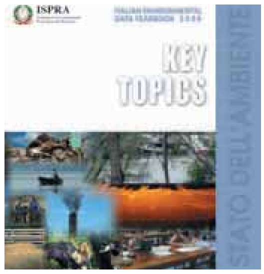


Figure II.9: Percentage of urbanised areas set aside for infrastructures and the transport network, out of total regional surface areas (2005)[21]

[21] Source: Ministry of Infrastructures and Transport and ISTAT and APAT-CLC 2000 (urbanised) data processed by ISPRA



Tourism

It is impossible to address the subject of tourism without making reference to the environment, given the reciprocal interests and dynamics, based on social, historical and cultural factors, between the two sectors. There is a special tie between tourism and the environment, because tourist activities utilise environmental resources, in the broadest sense of the term, as an indispensable asset for their development, while, at the same time, the environment benefits from the resources brought into play by tourist activities, assuming such operations are compatible with the environment.

Tourism and the environment are closely connected.

Internationally, arrivals rose by 2% in 2008, compared to 2007. Though Europe is still the most frequently visited destination (53.1% of all international arrivals), the number of arrivals remained essentially stagnant in 2008, rising by only 0.3%, due primarily to growth of 3.1% in the central-eastern European market.

Europe received 53.1% of international arrivals.

In 2008, tourist arrivals and overnight stays in all of Italy's hospitality structures registered an overall decrease (respective figures of -0.6% and -0.8%). The average stay (3.9 days) remained unvaried from the previous year, in line with the trend of recent years towards more frequent trips but for shorter periods.

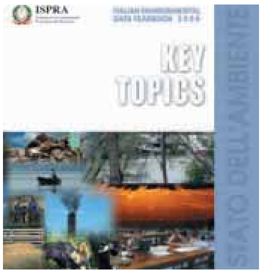
Tourist arrivals and overnight stays in Italy fell by respective figures of -0.6% and -0.8%.

Climate is one of the main driving factors behind the seasonal structure of tourist demand, determining its length and quality playing a key role in the choice of the destination and decisions on how much to spend. In 2008 the peak season for tourist flows remained the third quarter (with 49% of overnight stays).

The climate is one of the key driving factors behind the seasonal structure of tourist activity.
In 2008, 49% of the overnight stays again occurred in the third quarter.

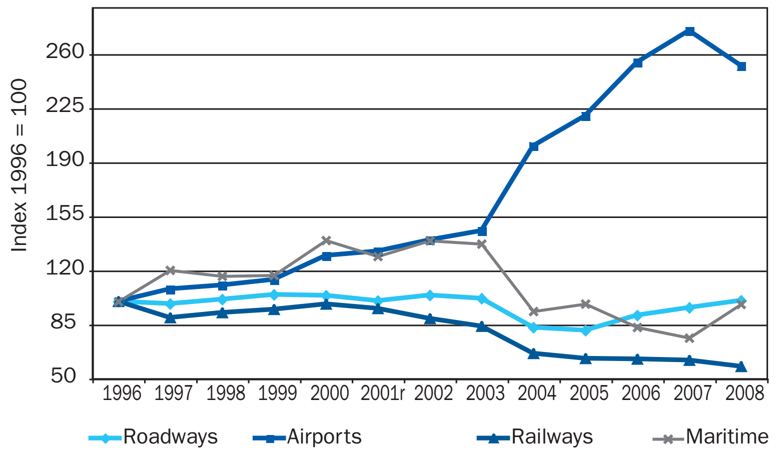
Of the total number of trips taken by Italians (roughly 122 million), 63.6% are taken in cars. The tendency of Italians to travel by air is on the rise (15.6% of the trips), due in part to the increasingly economical and widespread services (low cost/low fare), together with the trend towards "short breaks". As for the modes of transport used by foreign tourists who come to Italy, the car continues to be favoured, registering an increase (+4.7%) between 2007

The favourite Italian mode of transport for trips is the car (63.6%).



and 2008. In contrast, air travel as the mode of transport used by foreign tourists to reach Italy showed a decrease (-8.1%) on an annual basis for the first time since 1996, primarily to the advantage of cruise ships, which registered a significant growth (+28.5%) (Figure II.10).

The car continued to be the preferred modes of transport for foreign tourists to Italy, growing by 4.7% between 2007 and 2008.



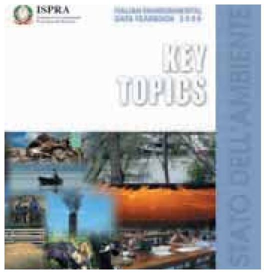
r: The 2001 data relating to border entry points by road and air have been revised, following the introduction of more sophisticated survey methodologies

Figure II.10: Variations in the number of foreign tourists at Italian border entry points[22]

Tourism places a variety of environmental pressures.

Tourism inevitably brings change with it; the yearning for environmental and cultural values, together with the desire for new experiences, can create disturbances in the balance of socio-environmental factors. Environmental pressures on the environment have a wide variety of effects, though a number of constants can be observed: elevated number of tourists, seasonal concentrations, use of the most polluting modes of transport etc.. A characteristic typical of big cities is the fact that the problems normally caused by residents have been compounded by the role of the cities as extremely popular tourist destinations.

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



It should be noted that tourist flows significantly alter the residential density of certain Italian provinces. Under normal conditions (taking into account only the resident population), Florence, Venice, Rimini and Rome present respective population densities of 278, 342, 559, 755 inhabitants/km², while the arrival of tourists pushes these figures considerably higher. Rimini goes from 559 inhabitants/km² to 6,087 inhabitants/km² (population + tourist arrivals), making it the country's most densely populated province. The same type of jump takes place in Florence, whose resident population density is on a par with provinces such as Livorno, Lodi or Pescara, while the addition of the tourists raises the density (1,440 inhabitants/km²) to a level almost twice that of the resident population density of Rome (Figure II.11).

Tourist flows radically modify population density, as in the cases of Rimini and Florence, whose densities reach noteworthy levels with the addition of the tourists.

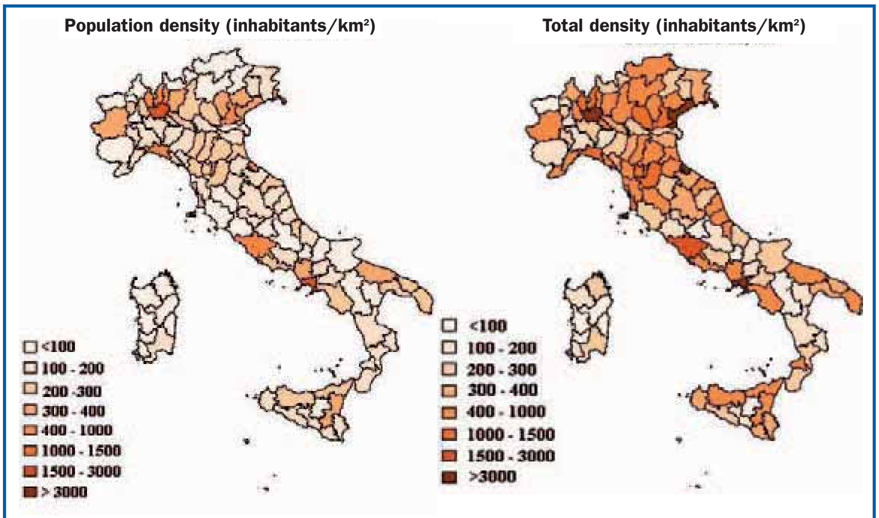


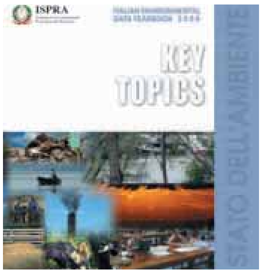
Figure II.11: Variation in the population densities of Italian provinces taking into account tourist flows (2007)[23]

The map on the left, showing the "Population density", groups the Italian provinces into eight population density classes; the map on the right showing the "Total density", groups the provinces into the same eight density classes, but also takes into account the total density, i.e. Resident (Population + Arrivals)/surface area in km².

II.3 Potential developments

Though the ramifications of the current global economic crisis must be dealt with, one of the priorities of Italian policy is to move towards a sustainable environmental economy, enacting forms of environmental governance in order to respond in the most effective manner possible to the increasing challenge of efficiently and

[23] Source: ISTAT data processed by ISPRA



effectively managing water resources, use of the territory, biodiversity and energy, which also constitute the “cornerstones” of policies and measures for mitigation, and adaptation to climate change.

Italy’s priority environmental policies.

The priority environmental policies, outlined by the Ministry of the Environment, Land and Sea and calling for measures of urgent intervention, are:
1. efficient management of water resources;
2. land reclamation;
3. reduction of waste generation;
4. protection of biodiversity and ecosystems;
5. clean energy and better air quality.

The fight against climate change is the chief challenge for the coming decades, though it will also serve as an opportunity to lessen current environmental pressures caused by unsustainable models of production and consumption that result in emissions of polluting substances, increased waste generation, a shortage of natural resources and a loss of biodiversity and ecosystems.

CHAPTER 1

CLIMATE CHANGE

In 2009 growing expectations were placed on the 15th Conference of the Parties (COP-15), held to determine the elements of a new agreement meant to go into effect in the period following that (2008-2012) covered by the Kyoto Protocol.

At the G8 summit in Aquila in July of 2009, there was a unanimous consensus on the importance of keeping the increase in the average global temperature below 2°C, as well as on the need to set a global objective for a noteworthy, long-term reduction in emissions.

Introduction

In 2009, the issue of climate change was a focal point of attention on the part of both the general public and national and international institutions, with growing expectations placed on the results of the 15th Conference of the Parties (COP-15 Copenhagen 2009), held with the objective of determining the elements of the new agreement meant to go into effect in the period following that (2008-2012) covered by the Kyoto Protocol.
In terms of public opinion as a whole, there was noteworthy awareness of this issue on the occasion of the awarding of the Nobel Peace Prize to US President Barack Obama (which came in the wake of the Nobel Prize awarded in 2007 to the to IPCC and to Al Gore, former Vice President of the United States, for his film "*The Inconvenient Truth*"). Indeed, one of the stated motives for the award of the 2009 Nobel Prize to Barack Obama was the efforts of the US President to give his country "a more constructive role in meeting the great climatic challenges the world is confronting"[1].
In terms of discussions between the different governments in preparation for the COP-15, during the G8 summit held in Aquila in July of 2009, the world leaders confirmed their intent to deal with the subject urgently and effectively, in an effort to arrive at an agreement in Copenhagen.
In the G8 forum, the leaders of industrialised countries have agreed on the need to keep global warming below 2°C compared to pre-industrial levels, as has long been requested by the European Union. Agreement was also reached on the objective of reducing global emissions by 50% by the year 2050, with a reduction of 80% by the developed countries, in order to keep global warming below 2°C (though the reductions will not be calculated from the year 1990). At the same time, the developing countries were also asked to reduce their current growth trends in emissions. And there was also a general consensus on the need to set medium-term objectives in keeping with the long-term goals and to reach a peak in global emissions as soon as possible. The active involvement of all the leading emitting countries, through quantified mitigation initiatives, is held to be an indispen-

[1] http://nobelprize.org/nobel_prizes/peace/laureates/2009/press.html

sable prerequisite for successfully dealing with climate change. The leaders have acknowledged the crucial role of technological development and know how in carrying out mitigation and adaptation initiatives in developing countries and in achieving economic growth with low levels of carbon dioxide emissions. With this in mind, and seeing that the mobilisation of adequate financial resources will be a key factor in arriving at an ambitious and widely endorsed agreement in Copenhagen, the world leaders have confirmed their intention to contribute to a joint effort for the procurement of the necessary funds (both public and private), through national initiatives and international instruments, including financial assistance. In the same period as the summit in Aquila, a meeting of the Major Economies Forum, or MEF, was held in the presence of the General Secretary of the United Nations, attended by all the leading countries in terms of emissions, meaning, in addition to the G8 nations, Australia, Brazil, Canada, China, South Korea, the European Union, India, Indonesia, Mexico and South Africa, in order to reach an agreement as wide ranging and relevant as possible on the key issues at the Copenhagen Conference.

Here too there was acknowledgement of the importance of limiting the average global temperature increase to 2°C, though, contrary to the G8, no agreement was reached on either the reductions to be achieved on a global level nor the level of funding to be made available. The leaders of the countries responsible for the most emissions, on the other hand, have decided to work together in the months leading up to the COP-15, in order to set a long-term global objective for reducing emissions by 2050. The leaders have agreed that all the countries must undertake suitable initiatives on the national level: the developed countries shall enact timely reductions of significant entity in the middle-term, while the developing countries shall undertake actions designed to guarantee a significant departure of emissions levels from the “business as usual” scenario.

The key role of the larger economies in promoting innovation was stressed, and the leaders proposed a global partnership as a way of accelerating efforts. Agreement was reached on the need for a noteworthy increase in public investment in research and devel-

opment, with the goal of doubling the level by the end of 2015. The leaders pledged that they would work to eliminate obstacles to the marketing of low-carbon-emission technologies while creating incentives to accelerate their development, spread and transfer, with an emphasis on the role of the private sector and international cooperation. There was also a broad consensus on the need to increase financing for the climate, from both public and private sources, as well as through carbon markets.

Basic climate trends

Globally

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

The warming of the global climate system currently stands as an undisputed fact, as shown by the increases observed in the average global 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 covering of snow) and the rise in the average level of the oceans. The increase in the average temperature observed in recent decades, both globally and in Europe, is unusual in terms of both its extent and its rate of variation.

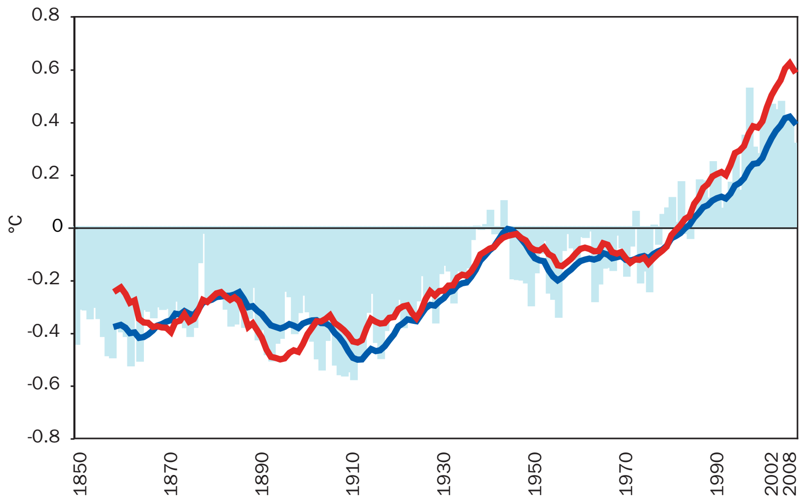
As of 2008, the overall increase in average global temperature (the land-ocean system) was 0.7°C compared to the pre-industrial level.

Based on the Fourth Assessment Report of the IPCC *(Intergovernmental Panel on Climate Change)*, the overall increase in average global temperature (the land-ocean system[2]) as of 2008 was 0.7°C compared to the pre-industrial level. The rate of warming, equal to 0.1°C per decade during the last 100 years, rose at 0.16°C per decade during the last 50 years. During the last century (1905-2005), the average temperature of the planet rose by 0.74°C, at increasingly higher rates: in the decades before 1950, the average rate of the rise was less than 0.06°C per decade, while, over the last 50 years, it increased to 0.13°C per decade, and more recently (the last few decades), it reached approximately 0.25°C per decade.
Analyses carried out by the East Anglia University, including figures

[2] 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 seas, while the phrase “land only” means that the reading refers only to the temperature of the air on dry land

for 2008, show that, of the fourteen highest annual temperature levels registered from 1850, the first year for which instrumental temperature readings were recorded, thirteen fall within the period of the last fourteen years, between 1995 and 2008[3] (Figure 1.1).

Of the fourteen highest annual temperature levels starting from 1850, the year in which instrumental measurement of temperatures began, thirteen fall within the last fourteen years, between 1995 and 2008.

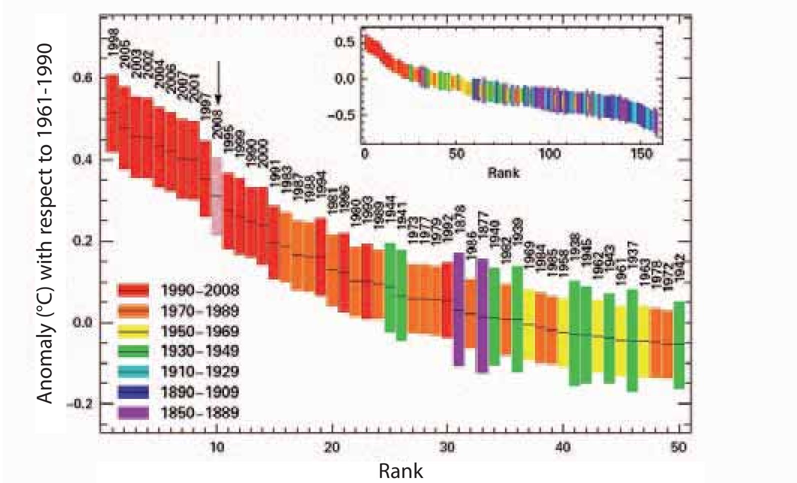


Legend: The lines represent the mobile averages over 10 years, calculated, respectively, for the "land-ocean" system (blue) and for the "land alone" system (red).

Figure 1.1: Series of the annual anomalies[4] in the average global temperature (land-ocean system) between 1850 and 2008[5]

Based on the estimates of the National Climatic Data Centre of the NOAA, the year 2008, together with 2001, was the eighth warmest year of the series starting from 1880, with an average global land-ocean temperature that was 0.49 °C higher than the average for the twentieth century.
The ranking of the 50 highest years in terms of average global surface temperature, as illustrated in figure 1.2 and published by the World Meteorological Organisation, shows the year 2008 in tenth place; as a rule, the ranking of the most recent years, between 1990 and 2008, in the leading positions is confirmed. Projections based on the six emissions scenarios of the IPCC for the

[3] EEA, http://themes.eea.europa.eu/IMS/ISpecs/ISpecification20041006175027 / IAssessment1202733436537/view_content
[4] Anomalies calculated for the reference period 1961-1990
[5] Source: Climatic Research Unit of the East Anglia University



Legend: The insert shows the ranking of the average global surface temperatures starting from 1850. The dimensions of the bars point to an interval of confidence of 95%

Figure 1.2: Ranking of the average global surface temperatures for the 50 warmest years[6]

end of the 21st century forecast an increase of from 1.8 to 4.0 °C in global temperature by the period 2090-2099, as compared to the period 1980-1999[7]. As for trends in precipitation between 1900 and 2005, noteworthy increases were registered in the eastern portions of North and South America, in Northern Europe and in Northern and Central Asia, while there was reduced precipitation in the Sahel region, in the Mediterranean, in Southern Africa and in 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. The frequency of intense precipitation events has risen in most portions of the earth's surface above water, in parallel with the warming trend and the heightened amount of water vapour in the atmosphere. The surface temperature of the seas, on a global level, rose by 0.038±0.011 °C per decade during the period 1850-2005, according to an estimate based on the HadSST2 dataset of the Hadley Centre. If policies of mitigation are not implemented, then, in all probability, there will be an increase in the frequency of heat waves and intense precipitation on our planet, together with a rise in the intensity of tropi-

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

[6] World Meteorological Organization (2009): WMO statement on the status of global climate in 2008. Report WMO, n. 1039, Geneva 2009

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

cal cyclones, as well as a decrease in available water supplies in many semi-arid areas, such as the Mediterranean Basin, with noteworthy repercussions in terms of the environment, society and economics.

Europe

As of 2008, the temperature of the land-ocean system in Europe had increased by approximately 1.0 °C, and the temperature of dry land by 1.3 °C, over the pre-industrial levels, a greater rise than the global increase[8]. Projections point to an average temperature increase of between 1.0 and 5.5 °C by the end of this century. Based on the A1B scenario[9], for example, global climatic models estimate an average increase in temperatures between the periods 1980-1999 and 2080-2099 in a range of 2.3 to 5.3 °C in Northern Europe, while an increase of between 2.2 and 5.1 °C would be registered in Southern Europe and the Mediterranean regions[10]. Naturally, when different emissions scenarios are employed, the estimated intervals for temperature increase vary considerably. The greatest warming in Northern Europe is forecast for the Winter season, while the highest increases for the Mediterranean are expected in summer (Figure 1.3).

As of 2008, the temperature of the land-ocean system in Europe had increased by approximately 1,0 °C, and the temperature of dry land by 1.3°C, over the pre-industrial levels, a greater rise than the global increase.

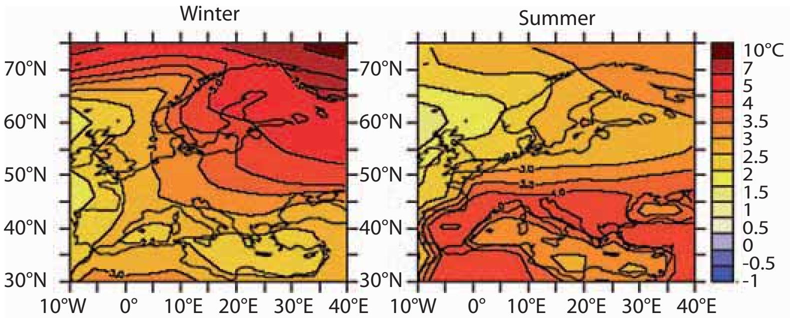


Figura 1.3: Variation in the average temperature in Europe between 1980-1999 and 2080-2099, estimated on the basis of the A1B emissions scenario[11]

Based on the A1B scenario, global climatic models estimate an average temperature increase, between the periods 1980-1999 and 2080-2099, in a range of 2.3 and 5.3 °C in Northern Europe and a range of 2.2 and 5.1 °C in Southern Europe and the regions of the Mediterranean.

[8] EEA, http://themes.eea.europa.eu/IMS/ISpecs/ISpecification20041006175027 / IAssessment-1202733436537/view_content

[9] Scenario characterised by extremely rapid economic growth, a global population that peaks around the middle of the 21st century, and then begins to decline, the rapid introduction of new and more efficient technology and a balanced distribution of the different sources of energy (IPCC, *Special Report on Emission Scenarios*, 2000)

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

[11] Source: IPCC, *Fourth Assessment Report*

Over the last 50 years, changes have been observed in the distribution of extreme temperatures, with an increase in the frequency and intensity of extremely hot events and a decrease in episodes distinguished by low temperatures. Projections point to a continuation of this trend in the future as well. In terms of precipitation in Europe, an increase of between 10% and 40% was observed in the northern regions during the 20th century, together with a decrease of up to 20% in certain parts of Southern Europe[12].

During the 20th century, precipitation in creased between 10% and 40% in the regions of Northern Europe, while it decreased by as much as 20% in certain parts of Southern Europe.

Based on the A1B scenario, global climate models estimate an increase between 0% and 16% in cumulated annual precipitation between the periods 1980-1999 and 2080-2099 for Northern Europe, with a decrease of between 4 and 27% in Southern Europe and the Mediterranean regions, showing peak levels in the Summer season[13] (Figure 1.4). It should be kept in mind that projections of precipitation, unlike those of temperature, which are distributed fairly uniformly over space, can differ significantly even within relatively small horizontal distances, especially in regions where the lay of the land is complex. It has also been estimated that the frequency and intensity of extreme precipitation events shall increase, especially in the northern regions, while there will be a rise in periods of drought, especially in Southern Europe.

Based on the A1B scenario, the global climate models estimate an increase in the range of 0% to 16% in cumulated annual precipitation between the periods 1980-1999 and 2080-2099 in Northern Europe, while a decrease of between 4% and 27% is forecast for Southern Europe and the Mediterranean regions, especially during the Summer season.

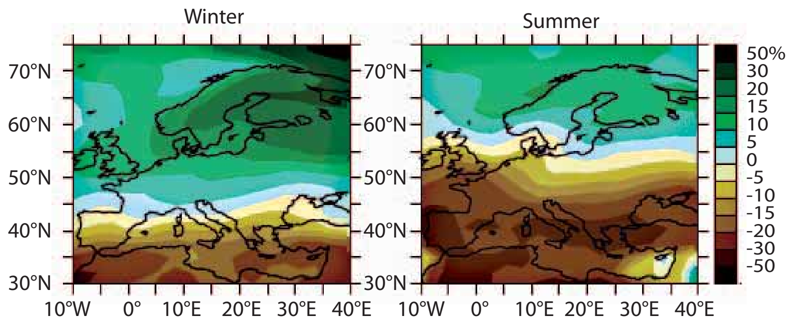


Figure 1.4: Percentage variation in cumulated precipitation in Europe between the periods 1980-1999 and 2080-2099, estimated on the basis of the A1B emissions scenario[14]

[12] EEA, 2008, *Impacts of Europe's changing climate – 2008 indicator-based assessment. EEA Report* n. 4/2008

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

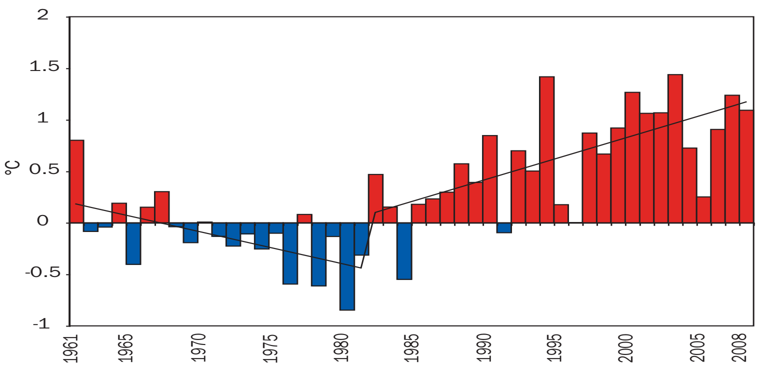
[14] Source: IPCC, *Fourth Assessment Report*

Finally, the surface temperature of Europe's seas is increasing more rapidly than the rates observed in the rest of the globe, with the highest rates recorded in the seas of Northern Europe rather than the Mediterranean. Over the last 25 years (1982-2006), the rate at which the temperature of Europe's seas has risen has been roughly 10 times greater than the figure registered for the period 1871 to 2006[15].

Italy

Based on the CNR-ISAC studies (summarised in last year's "Key Topics"), the average annual temperatures in Italy have risen by 1.7°C over the past two centuries (working out to more than 0.8°C per century), though the most significant portion of this increase has occurred over the last 50 years, during which the increase has been approximately 1.4°C (making for a rate of approximately 2.8°C per century). Temperature trends in Italy are updated annually by ISPRA by establishing uniform criteria for the series of results recorded in the period 1961-2008 and applying statistical models, including non-linear ones, to identify and estimate trends. It is estimated that the average temperature in Italy fell between 1961 and 1981, at which point it rise through 2008, for an overall increase of approximately 1.0 °C (Figure 1.5)

Estimates of trends in average annual temperatures in Italy for the period 1961-2008 point to a decrease in the average temperature between 1961 and 1981, followed by an increase through 2008, for an overall rise of approximately 1.0 °C.



Legend: The staggered line represents the trend estimated with a "*sloped steps*" statistical model[16]

Figure 1.5: Anomalies in the average temperature in Italy[17]

Average annual anomalies in the average temperature between 1961 and 2008, as compared to the normal value calculated for the period 1961-1990, point to a decrease in the average temperature in Italy between 1961 and 1981, followed by an increase through 2008, for an overall rise of approximately 1.0 °C.

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[15] EEA, 2008, *Impacts of Europe's changing climate – 2008 indicator-based assessment. EEA Report* n. 4/2008

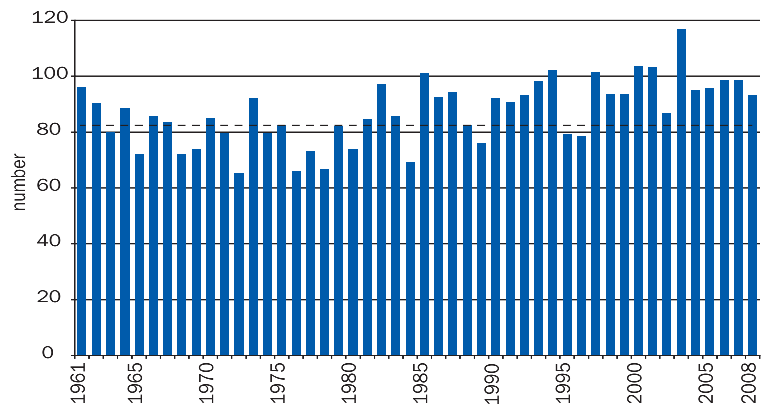
[16] Toreti A. and Desiato F., 2008, *Temperature trend over Italy from 1961 to 2004*, *Theor. Appl. Climatology*, doi 10.1007/s00704-006-0289-6

[17] Source: Italian Air Force data processed by ISPRA

The increase in the average temperature registered in Italy in recent decades is higher than the global average.

The increase in the average temperature registered in Italy in recent decades is greater than the global average. In the years 2007 and 2008 the anomalies compared to the thirty-year period 1961-1990 were, respectively, +1.24 and +1.09 °C, in contrast to a global average of 0.67 and 0.53 °C. The year 2008 was the seventeenth consecutive year to register a positive anomaly, and the anomaly was the fifth largest since 1961[18]. A detailed seasonal analysis of the trends for northern, central and southern Italy shows that the increase in average temperature was noteworthy throughout the country in Autumn starting from 1970 and in summer from 1980, while, during the entire period 1961-2006, there were significant increases in the north in Winter and in the central-southern regions in Spring[19]. The warming trend can also be observed in an analysis of extreme temperature levels. A trend analysis of the period 1961-2008 points to an estimated 12% average increase in "summer days"[20] (Figure 1.6), plus an average 42% in "tropical nights", compared to the climatological average[21] (Figure 1.7).

There was an estimated average increase of 12% in the number of "summer days" during the period 1961-2008, meaning days with a maximum air temperature of more than 25 °C.



Legend: The dotted line indicates the average normal value calculated for the period 1961-1990

Figure 1.6: Annual average number of summer days between 1961 and 2008[22]

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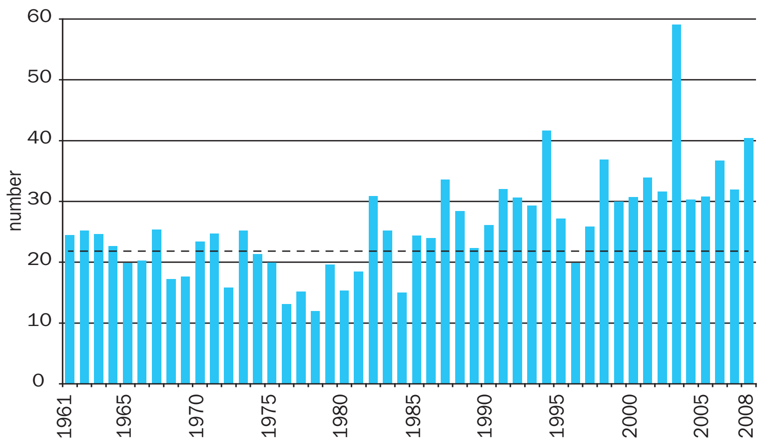
[18] ISPRA, *Gli indicatori del clima in Italia nel 2008*, Report from the State of the Environment Series, no. 12/2009, Year IV

[19] 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

[20] Number of days with a maximum air temperature of more than 25 °C

[21] Number of days with a minimum air temperature of more than 20 °C

[22] Source: Stations of the network of the Italian Air Force data processed by ISPRA



Legend: The dotted line indicates the average normal value calculated for the period 1961-1990

Figure 1.7: Average annual number of tropical nights between 1961 and 2008 [23]

There was an estimated annual increase of 42% in the number of "tropical nights" during the period 1961-2008, meaning nights with a minimum air temperature of more than 20 °C.

In terms of long-term trends in precipitation, studies of the CNR[24] indicate that, "As a rule, the trends are negative, though only to a slight extent and often without much statistical significance. The magnitude of the reduction in precipitation is on the order of 5% per century; it would appear to be traceable primarily to Spring, the season for which a reduction of nearly 10% per century in precipitation was recorded"[25].

In analysing the most recent period, ISPRA has examined the annual and seasonal precipitation series for northern, central and southern Italy[26]. The annual series do not point to statistically meaningful trends, while the Winter series in northern Italy shows an average decrease of 1.47 mm/year in precipitation between 1961 and 2006 (Figure 1.8).

The precipitation series for Northern Italy shows an average decrease in precipitation of 1.47 mm/year between 1961 to 2006.

[23] Source: Stations of the network of the Italian Air Force data processed by ISPRA
[24] 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
[25] Nanni T. and Prodi F., 2008, Energia, no.1, 2008, pp. 66-71
[26] Toreti A., Desiato F., Fioravanti G. and Perconti W. 2009, *Annual and seasonal precipitation over Italy from 1961 to 2006, International Journal of Climatology*, doi 10.1002/joc. 1840

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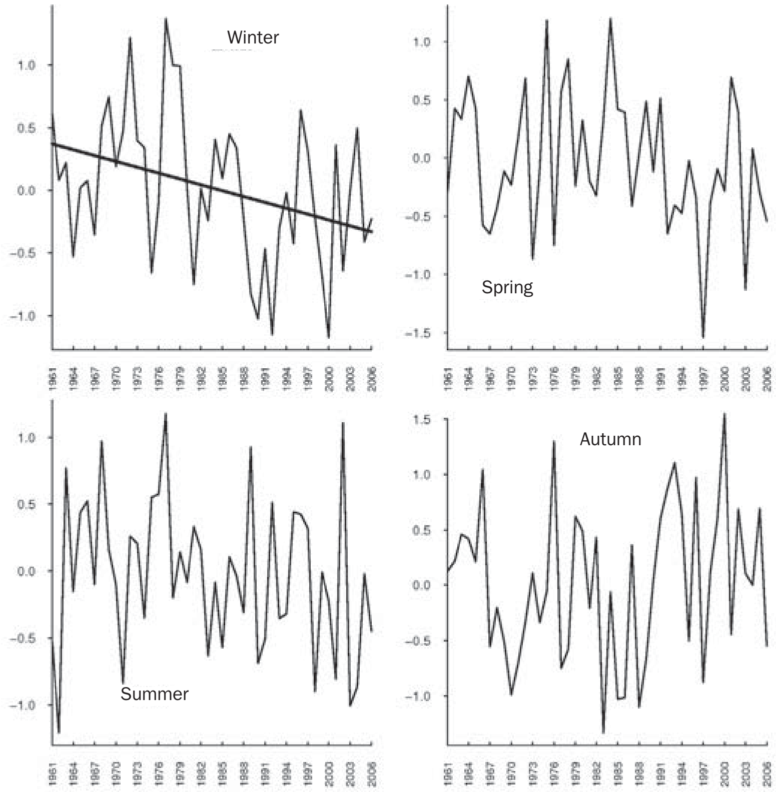

Legend: On the Winter graph, the vertical axis stands for the estimated linear trend

Figure 1.8: Series of standardised anomalies of seasonal precipitation in Northern Italy[27]

In order to determine whether there were any trends involving extreme precipitation events, the following indicators were analysed: "consecutive dry days" (CDD) index, meaning the maximum consecutive number of days with precipitation of less than 1 mm; "very wet days" (R95p) and the "extremely wet days" (R99p) indexes, meaning the number of days in the year when there is precipitation in excess of the 95th (99th) percentile of the climatological distribution of daily precipitation between 1961 and 1990; and the "simple

[27] Source: Toreti A., Desiato F., Fioravanti G. and Perconti W. 2009, *Annual and seasonal precipitation over Italy from 1961 to 2006, International Journal of Climatology*, doi 10.1002/joc.1840

daily intensity" index (SDII), meaning the annual precipitation divided by the number of days with precipitation greater than or equal to 1 mm. The CDD is pertinent to the duration of periods of drought, while the other indicators (R95p, R99p and SDII) provide statistical analyses of events of intense precipitation.
A preliminary analysis of these indexes on a sample group of approximately 50 stations shows no statistically significant trend between 1950 and 2006. However, the limited number of sufficiently continuous times series of controlled quality, plus the fact that they are distributed unevenly within the territory, make it impossible, for the moment, to determine whether or not there are significant trends concerning extreme precipitation events in Italy.

Impacts and vulnerabilities

Observations made on dry land and on the oceans show – as is illustrated by the Fourth Assessment Report of the IPCC - that many natural systems have been affected by regional climate change, and especially by increases in temperature.
On the global level, in keeping with the warming trend observed, most of the components of the cryosphere are undergoing a generalised reduction in their extension, and at an increasingly rapid pace in recent decades.
The level of the sea rose at a rate of approximately 1.7-1.8 mm a year during the last century, with increase of up to 3 mm a year during the last decade, and the consequences are being felt in many coastal regions. In marine and aquatic ecosystems, many changes in phenology and biogeography, meaning the phases of the development of organisms and the distribution of species, are tied to increases in water temperature, as well as to changes in salinity, levels of oxygen and circulation. Studies of land biological systems point to impacts of global warming over the last 30-50 years, such as the earlier occurrence of Spring and Summer phenological phase and the extension of the growth season in the medium and high latitudes, as well as increased vulnerability of certain species, with cases of extinction on the local level.
In recent years, repeated large-scale forest fires have been associated with drought episodes in the Mediterranean area and in North Africa, as well as in North America.

Observations on both dry land ad oceans show that many natural systems have been affected by regional climate changes, and especially by increased temperatures.

Climate change affects not only physical and biological systems, but also socio-economic sectors that depend on climate conditions, and which are already undergoing the consequences, such as farming, fishing, tourism, energy and health, as well as financial services and insurance.
Still, additional efforts are indispensable for reinforcing the basic knowledge on climate change and on the related impact on natural systems and socio-economic sectors, so as to be able to formulate suitable adaptation measures.
This is the direction taken by the initiatives of the IPCC, which recently stressed the need to improve the level of knowledge on impacts, vulnerability and adaptation by pursuing the regional analyses at greater depth. These evaluations shall be included in a specific section of the contribution of Working Group II to the Fifth Assessment Report, expected to be published in the early months of 2014.
In Europe as well, as shown by the latest report of the European Environment Agency on the impacts of climate change[28], many natural systems, plus a large number of socio-economic sectors, have already undergone the consequences of climate change, namely loss of biodiversity, reduced quantities and quality of water resources, risks to human health, damage to farming and forestry activities, to tourism and to the energy and transport sectors. The most vulnerable areas of Europe are mountainous zones, the Mediterranean area, coastal regions and the Arctic, and this will increasingly be the case unless, in addition to a noteworthy reduction in global emissions of greenhouse gases, the measures needed to adapt to the impact of the instances of climate change already underway, and to moderate them, are taken[29].
In the decades to come, overall national water resources shall tend to decrease, on account of lower levels of precipitation and higher levels of evapo-transpiration, as well as the procurement of water supplies. The situation shall prove most critical in Southern Italy, were water supply is already under stress and have far-reaching

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[28] EEA, 2008. *Impacts of Europe's changing climate – 2008 indicator-based assessment*. EEA *Report* no. 4/2008
[29] For more in-depth information, see the 2008 edition: Key Topics 2008 – Yearbook of Environmental Data. ISPRA, 2009

implications for farming, tourism, health, industrial production, urbanisation and, last but not least, the insurance sector.
The climate trends underway, and those forecast under the IPCC scenarios, shall shift to higher latitudes climatic and environmental conditions typical of the Mediterranean area. This means that the ecological and forestry systems, and the natural environments, of the Mediterranean shall tend to "migrate" towards western and northern central Europe. However, the pace of the climate change underway is far more rapid that the rate at which the vegetable species are able to colonise the new spaces, especially in the case of the dominant forest species: what can be expected, therefore, is a gradual "breaking up" of many ecosystems, resulting in modifications in the landscape, with noteworthy influences on the agriculture, tourism and leisure sectors, as well as on residential housing.
Even a limited increase in sea-level, along with an intensification of extreme events, such as exceptionally high surges, will aggravate to a noteworthy extent existing problems in coastal environments. A number of low-lying coastal plains (there are roughly thirty major ones, making for a total of approximately 1400 km of linear extension) could be flooded, in addition to which all the low-lying, sandy coastal areas (totalling approximately 4000 km) could be vulnerable to problems of acute coastal erosion, infiltration of salt water in coastal fresh-water tables and damage to the biodiversity of coastal wetlands, especially if their altitude already places such areas below sea level (as in the case of the entire upper Adriatic coastal zone). This problem could have significant effects not only in terms of a loss of biodiversity, with serious consequences for production activities in coastal zones, but, to an even greater extent, and recreational and tourist activities, even reaching the point of threatening historic, artistic and cultural resources, as in the case of Venice.
In addition to possible damage to natural resources, the environment, the surrounding territory and economic activities, there could also be impacts, secondary but worthy of note nonetheless, in terms of work and employment, and as regards social and medical wellbeing, especially for the part of the population most vulnerable to climate change.

This year the European Environment Agency has focussed particu-

The Alpine environment is one of the most vulnerable in Europe.

lar attention on the Alpine environment, one of the most vulnerable, and on the impact that climate change can have on water resources and on the socio-economic sectors that depend on such environments and resources[30].

The effects of climate change are already plainly visible from the observation of certain glaciers and the variations they have undergone. Like the majority of the glaciers on the European continent, the mass of the Alpine glaciers is decreasing (Figure 1.9).

The majority of the glaciers on the European continent are losing mass.

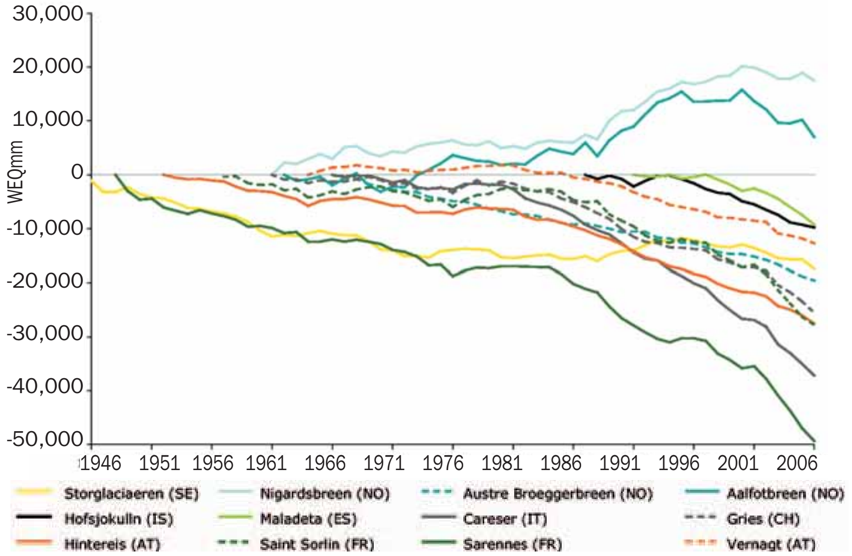


Figure 1.9: Balance of the cumulative net mass of European glaciers between 1946 and 2006[31]

Between 1850 and the end of the 1970's, the Alpine glaciers lost a third of their surface area and half of their volume. Starting in 1985, the trend was found to be accelerating, with 25% of the remaining glacial mass lost by the year 2000. During the exceptionally hot season of 2003, a further

Between 1850 and the end of the 1970's, the Alpine glaciers lost a third of their surface area and half of their volume. Starting in 1985, the trend was found to be accelerating, with 25% of the remaining glacial mass lost by the year 2000. During the exceptionally hot season of 2003, a further reduction of 5-10% was

[30] EEA, 2009, *Regional climate change and adaptation – The Alps facing the challenge of changing water resources*, EEA Report No 8/2009

[31] Source: EEA, 2008, *Impacts of Europe's changing climate — 2008 indicator based assessment.* EEA Report 4/2008, JRC Reference Report JRC47756. Joint EEA–JRC–WHO report

registered, making for a loss equal to roughly two-thirds of the glacial mass as of 1850.
The Norwegian coastal glaciers, which expanded up through the 1990's, have initiated a phase of retreat, due to lower levels of Winter precipitation and increased Summer melting.
The glaciers of the Svalbard Islands are losing mass at lower altitudes, while the glacial fronts of almost all glaciers are in retreat. Estimates for the Svalbard Islands as a whole show an overall negative balance, with unmistakable signs of accelerated melting, especially in the western area.
Recent studies point to a clear-cut rise in the annual reduction in average global glacial thickness, starting from the new millennium (0.5 m), as compared to the period 1980-1999 (0.3 m). The centuries-long retreat of Europe's glaciers can be traced primarily to increased temperatures in Summer.
In the case of the Alpine region, a noteworthy increase in temperature was registered during the last century: approximately 2 °C, more than double the average rate of warming observed in the northern hemisphere. In addition, an upward trend in precipitation was observed in the northern Alpine zone, while precipitation decreased in the southern sector of the Alps[32].
With rising temperatures and changes in rates of rain and snow, therefore, global warming poses a serious threat to the Alpine hydrological system, as well as to the environmental, social and economic systems that depend on it[33].
A number of the effects of climate change observable both globally and in Europe can already be noted in Italy as well: erosion of coastal areas, desertification, melting of glaciers, scarcity of water, slope instability and risks to health are only some of the examples[34].
Give its sensitivity to increased temperatures and its limited adaptive capacity, the Alpine environment proves to be one of the most vulnerable in our country as well, in keeping with what

reduction of 5-10% was registered, making for a loss equal to roughly two thirds of the glacial mass as of 1850.

The centuries-long retreat of Europe's glaciers can be traced primarily to increased Summer temperatures.

In Italy, the Alpine environment is considered to be one of the most vulnerable to climate change.

[32] EEA, 2009, *Regional climate change and adaptation – The Alps facing the challenge of changing water resources*, EEA Report No 8/2009
[33] Convenzione delle Alpi, Segnali alpini – Edizione speciale 2, 2009. *L'acqua e la gestione delle risorse idriche – Relazione sullo Stato delle Alpi*
[34] For a more detailed description of the impact of climate change on the Italian territory, see the 2008 edition: Key Topics 2008 – Yearbook of Environmental Data. ISPRA, 2009

has been observed in the rest of Europe[35].
Starting from the second half of the 19th century, Italian glaciers have undergone a phase of intensive contraction, resulting in the loss of 40% of their surface area: many minor glaciers have disappeared, while larger ones have broken down into smaller units[36].
Measurements of the glacial mass balance, indicating the algebraic sum of the mass of accumulated ice, the result of the snow precipitation, and the mass lost during the melting period, provides direct, pertinent information on the effect of the climate on glaciers, though the scope is limited, due to the reduced availability of adequate data from the past, except in the case of the Caresèr glacier (Figure 1.10).

The five glacial bodies considered show a general trend towards deglaciation and melting, developments common to much of the planet's glaciers.

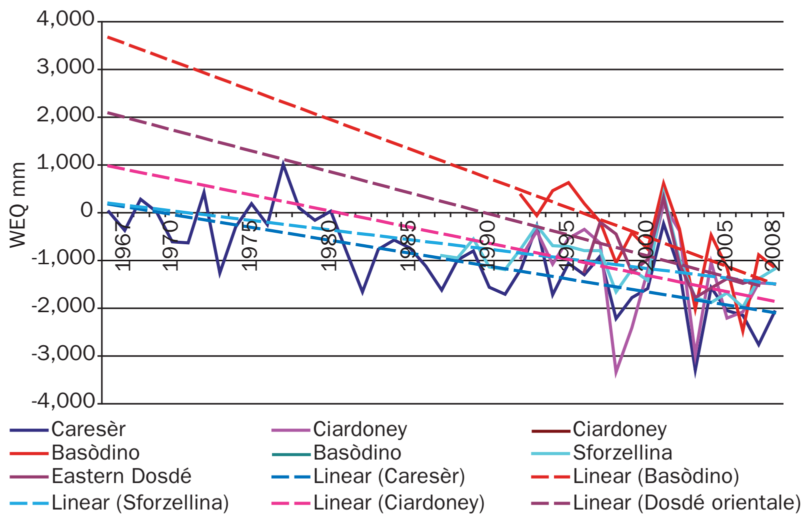


Figure 1.10: Net mass balance of the glaciers Caresèr, Ciardoney, Basòdino, eastern Dosdé and the Sforzellina, plus the related trend lines[37]

[35] APAT, Ministry of the Environment, Land and Sea, 2007. *Gli eventi preparatori della Conferenza – Sintesi dei lavori*
[36] Source: The Italian Glaciology Committee http://www.disat.unimib.it/comiglacio/comitatoglaciologico.htm
[37] Sources: Italian Glaciology Committee – Trent SAT Glaciology Committee, in collaboration with the Autonomous Province of Trent, Department of Civil Engineering and the Environment of the University of Trent, Tridentino Museum of Natural Science (Caresèr); Italian Meteorological Society (Ciardoney); Swiss Weather Service (Basòdino); Italian Glaciology Committee (Sforzellina and eastern Dosdè)

Figure 1.10 illustrates the changes that have occurred in 5 glacial bodies representing different climate sectors: the Basòdino glacier in the northwestern Alps, the Caresèr in the central Alps, the eastern Dosdè of the Piazzi-Campo chain in Lombardy, the Sforzellina on the Lombardy side of the Ortles-Cevedale and, finally, in the western Alps, the Ciardoney glacier. As is the case for most of the planet's glaciers, all the glacial bodies observed show a general tendency towards deglaciation, with an especially evident example being the trend for the Caresèr glacier, which has been consistently negative since back in 1981.
Figures 1.11, 1.12 and 1.13 illustrate the changes in the average minimum altitude of the fronts of a number of glacial units. At first, data was considered (starting from 1958) for a set of 1,028 individual glacial units (329 in the western Alps, 545 in the central Alps and 96 in the eastern Alps) while later, the focus was narrowed to a subset held to be significant, and open to variation from year to year. All the glaciers for which data were recorded have a surface area of more than 12 acres. Each glacier has distinctive characteristics (altitude, substrate, exposure, morphology etc.): depending on the type of glacial unit involved, an effective retreat does not always correspond to an evident increase in the minimum altitude of the front.

The rise in the minimum altitude in the western Alps is hard to ignore.

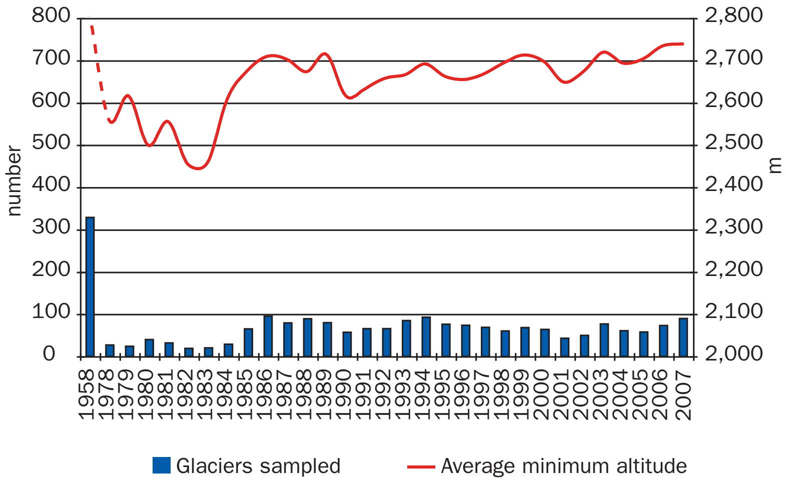


Figure 1.11: Changes in the average minimum altitude of the glacial fronts in the western Alps[38]

[38] Source: Italian Glaciology Committee data processed by ISPRA

In the central Alps, the tendency of the glaciers to retreat is confirmed by the overall trend, though with a number of discrepancies.

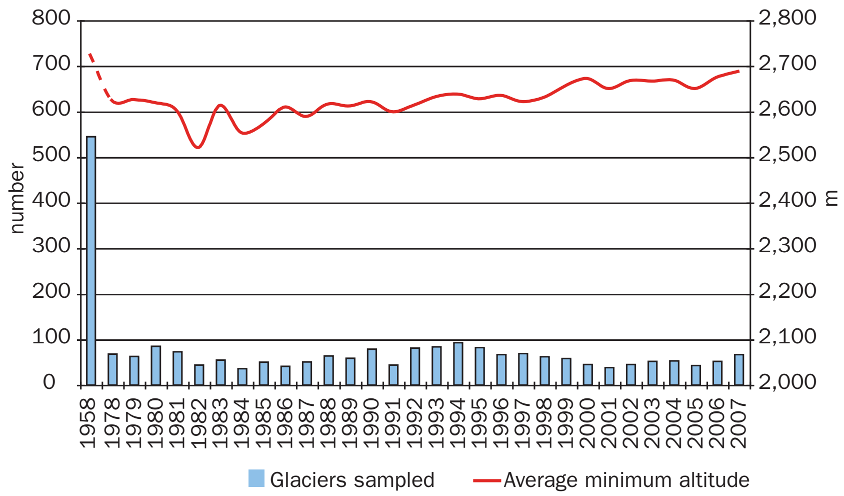


Figure 1.12: Changes in the average minimum altitude of the glacial fronts in the central Alps[39]

In the eastern Alps, the tendency of the glaciers to retreat is confirmed by the overall trend, though with a number of discrepancies.

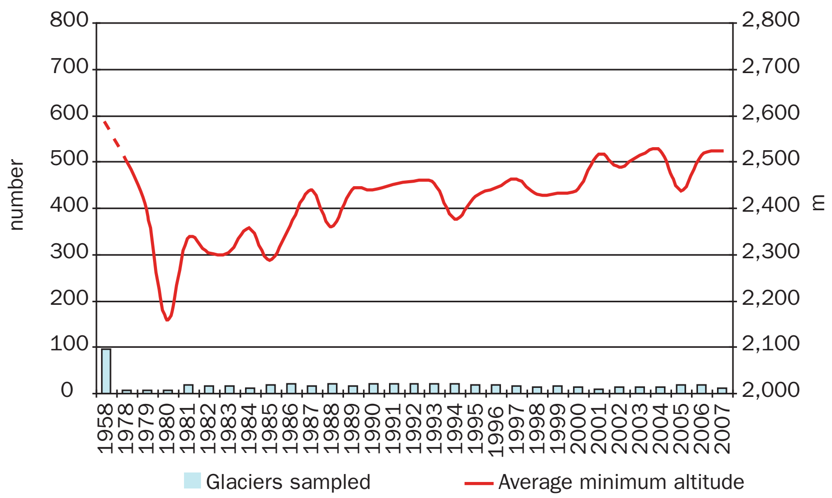


Figure 1.13: Changes in the average minimum altitude of the glacial fronts in the eastern Alps[40]

[39] Source: Italian Glaciology Committee data processed by ISPRA
[40] Source: Italian Glaciology Committee data processed by ISPRA

Changes in the glacial fronts point to an overall declining trend, meaning a rise in the average minimum altitude of the fronts.
The most recent changes show different trends in the three Alpine sectors: in the western Alps, the rise in the minimum altitude is fairly notable, while, in the central and eastern Alps, the withdrawal is demonstrated by the overall trend, though with a number of discrepancies[41].
Further scientific observation demonstrates, beyond any reasonable doubt, the impact of climate variations on the cryosphere and on the Alpine hydrological cycle, in the form of a reduction in the snow covering, a rise in the snow line and thawing of the permafrost, as well as variations in the outflow of watersheds and a decrease in available water resources.
These variations will have a particularly significant effect, and increasingly so in the future, on slope stability, biodiversity and the economic sectors that depend on water, especially tourism, energy generation and agriculture.
Winter tourism in the Alps is probably the economic sector that will suffer the heaviest losses on account of climate change, due to the reduced availability of snow in quantities sufficient for skiing. At present, the LAN, or Snow Reliability Line, meaning the average altitude above which precipitation in the form of snow, together with the temperature, guarantee at least 100 days a year when there are 30 cm of snow, is found at approximately 1,500 metres above sea level[42]. Of the 251 ski complexes in operation today in Italy, only 167, meaning 66%, have at least half of their surface located above the LAN, and can therefore be considered reliable in terms of the presence of snow (Table 1.1).

Climate variations have an impact on the cryosphere and on the Alpine hydrological cycle, reducing the snow covering, raising the snow line and thawing the permafrost, in addition to causing variations in the outflow of watersheds an d a decrease in available water resources.

In the Alps, winter tourism is probably the economic sector that will suffer the largest losses on account of climate change, due to the reduced availability of sufficient quantities of snow for skiing.

[41] ISPRA, 2009, Yearbook of Environmental Data 2009
[42] FEEM, 2008. *Cambiamenti climatici e strategie di adattamento in Italia – Una valutazione economica*

Table 1.1: Reliability of snow in Alpine ski resorts[43]

Region	Reliable ski resorts (with at least half their surface located above the LAN) no.	Total ski complexes no.
Aosta Valley	22	25
Piedmont	30	54
Lombardy	21	33
Veneto	14	46
Trentino	25	34
Alto Adige	54	54
Friuli Venezia Giulia	1	5
ITALY	**167**	**251**

Under the various scenarios for temperature increases, and resulting rises in the LAN[44], a large part of the ski resorts could gradually lose reliable snow covering, leading to massive economic losses.

Looking at the energy sector, the impact of climate change on Alpine water resources plays a key role in the production of hydroelectric energy.

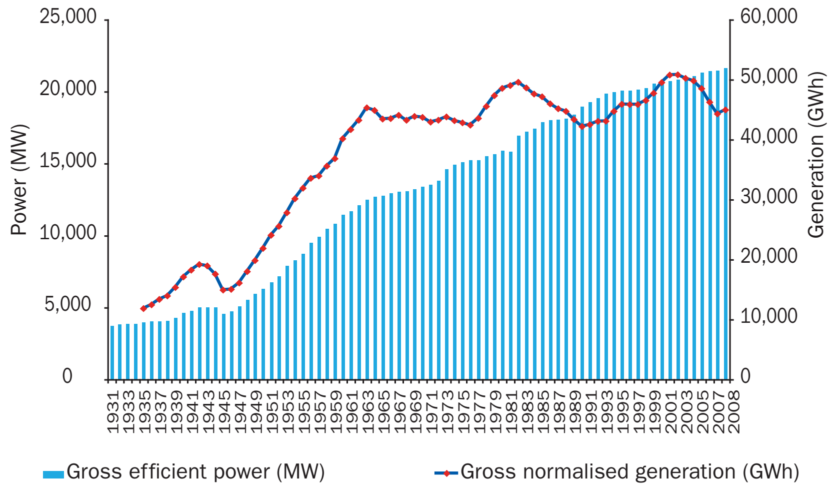
Looking at the energy sector, the impact of climate change on Alpine water resources plays a key role in terms of hydroelectricity generation, a fundamental economic resource for the entire area and a major factor in Italy's national energy balance, seeing that the presence of the glaciers in the Alps makes possible intensive use of water as a source of energy.

However, while in the past hydroelectricity was long Italy's main energy source, today it covers approximately 15-18% of the national demand for energy. At the same time, available hydroelectric capacity has risen significantly in absolute terms (Figure 1.14).

[43] Source: Ministry of the Environment, Land and Sea and the European Academy of Bolzano-EURAC, 2007. *Data and elaboration on the Italian Alpine and Pre-Alpine Ski Stations, Ski Facilities and Artificial Snowmaking*

[44] It is estimated that both the snow line and the line of snow reliability (LAN) can rise by 150 m for each °C of temperature increase. Assuming a constant upward trend, this would result in an increase of from 300 m to 600 m in the LAN altitude, due to an increase of from 2°C to 4°C in temperature

Hydroelectricity was long Italy's main source of energy, but today it covers approximately 15-18% of the national energy demand. In absolute terms, however, available hydroelectric capacity has risen significantly.



Legend: Hydroelectricity generation has been normalised to attenuate annual fluctuations[45]

Figure 1.14: Gross hydroelectricity generation and installed capacity in Italy through 2008[46]

The trend in hydroelectricity generation can provide noteworthy indications regarding variations in the hydrological cycle as a result of changing climate conditions, especially if consideration is also given to the development over time of the installed capacity for electricity generation. Installed capacity shows a constant increase, while electricity generation followed a parallel trend during the period 1931-1963, but later showed periodic fluctuations around an average level; the slightly upward trend did not appear to be precisely correlated to the available capacity.

In the short term, it is foreseeable that the melting of the glaciers will send much more water to the power plant turbines. But over the medium-long term, the gradual reduction and loss of the glaciers will pose a threat to an important source of renewable energy.

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[45] Hydroelectricity generation was normalised under the criteria found in Directive 2009/28/EC (Annex II). Gross production, which includes the energy for pumping, reflects the production average for a period of five years

[46] Source: TERNA S.p.A. data processed by ISPRA

The increase in extreme events and hydrogeological risk could pose a threat to certain crops found in unstable, exposed areas, while higher temperatures and reduced water supply of water could have long-term negative consequences on Alpine crops.

With regard to agriculture, there is still little documentation on the impact of the climate change underway in the Alpine area. In the short to medium term, an increase in productivity can actually be observed, due to the fertilising effect of CO_2. However, the increase in extreme events and hydrogeological risk may pose a threat to certain crops found in unstable, exposed areas. At the same time, higher temperatures and reduced water supply could have long-term negative consequences on Alpine crops, including feed crops and pasture areas, with related effects on livestock breeding.

Pressures on the climate system

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

Without meaning to overlook the effects of natural phenomena, such as the variability of the intensity of solar radiation, the vast majority of the scientific community is convinced that "There are new and even more meaningful elements" for holding that "most of the observed warming over the last 50 years is likely to have been due to human activity"[47]; 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 pointed to as the causes for this warming with a "very high confidence"[48].
With regard to CO_2, the main greenhouse gas, the average global atmospheric concentration of carbon dioxide has risen from 280 ppm during the period 1000-1750 to 385 ppm in 2008, corresponding to a growth in carbon dioxide emissions from roughly zero to 31.2 billion tons, taking into account solely emissions from the use of fossil fuels in combustion processes and in cement production[49]. 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 below the ground and burned, producing, in turn, approximately 1400 billion tons of carbon dioxide. Of this quantity, 57% was

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[47] IPCC, 2001, Climate Change 2001 – Synthesis Report
[48] IPCC, 2007, Climate Change 2007 – WG-I, WG-II, WG-III, Technical summary
[49] *Global Carbon Project* , 2008, *Recent carbon trends and the global carbon budget 2007*

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, nitrogen dioxide and the fluorocarbons, have shown similar patterns of growth, with an even higher rate.

Italy is not exempt from this growth trend of greenhouse gas emissions: the most recent figures for the national inventory of greenhouse gas emissions show that emissions in equivalent tons of CO_2 went from 516.32 million to 552.77 during the period 1990-2007, making for an increase of 7.06%, whereas, according to the Kyoto Protocol, Italy should have brought its emissions down, during the period 2008-2012, to levels 6.5% lower than emissions in 1990, meaning to 482.76 MtCO_2eq.

From 1990 to 2007 greenhouse gas emissions in Italy went from 516.3 to 552.8 Mt CO_2 eq, for an increase of 7.1%.
Under the Kyoto Protocol, Italy should have lowered its emissions, in the period 2008-2012, to levels 6.5% lower than emissions in 1990, meaning to 482.8 Mt CO_2eq.

Globally, Italy is responsible for no more than 1.51% of overall emissions generated by the use of fossil fuels in 2007, meaning that it ranks twelfth among the countries with the highest levels of greenhouse gas emissions[50].

Between 1990 and 2007, greenhouse gas emissions in Italy registered an overall growth of 36.45 million tons of carbon dioxide equivalent (Mt CO_2eq).

During this period, there were reductions in fugitive emissions, those due to accidental losses during the extraction and distribution of hydrocarbons (-3.51 Mt CO_2eq), as well as in emissions generated by manufacturing industries (-10.06 Mt CO_2eq), agriculture (-3.37 Mt CO_2eq), the use of solvents (-0.26 Mt CO_2eq) and industrial processes (-0.17 Mt CO_2eq), while there were increases in the emissions generated by waste (+0.52 Mt CO_2eq), the residential sector and services (+3.71 Mt CO_2eq.) and, to an even greater extent, those of the energy industries (+20.61 Mt CO_2eq) and the transportation sector (+25.47 Mt CO_2eq). The increasing trend has reversed starting from 2005: in 2006, a decrease of 1.87% in overall emissions

[50] IEA, 2009, *CO_2 emissions from fuel combustion. Highlights.* 1971-2007

Starting from 2005, a reduction in overall emissions was registered each year, for a decrease of 1.9% in 2006 and an additional reduction of 1.8% in 2007, compared to the previous year. Emissions from processes of combustion fell by 2.3%.

was registered, as compared to the previous year. In 2007, emissions showed an additional decrease compared to 2006 (-1.81%).

The reduction took place in almost all the sectors: energy industries (-1.04%; -1.75 Mt CO_2eq compared to the previous year), the residential sector and services (-6.94%; -6.07 Mt CO_2eq), waste (-1.32%; -0.25 Mt CO_2eq), fugitive emissions (-1.83%; -0.14 Mt CO_2eq), the manufacturing industry (-3.88%; -3.25 Mt CO_2eq) and the use of solvents (-0.64%; -0.01 Mt CO_2eq).

Only agriculture, transportation ad industrial processes moved in the opposite direction, showing growth in emissions compared to 2006 (agriculture: +1.59%; +0.58 Mt CO_2eq; transportation: +0.13%; +0.17 Mt CO_2eq; industrial processes: +1.06%; +0.38 Mt CO_2eq).

On the whole, total emissions fell by 10.21 Mt CO_2eq (-1.81%) in 2007, compared to the previous year, essentially on account of reduced emissions from combustion processes (-2.33%; -10.78 Mt CO_2eq) (Figure 1.15).

Between 1990 and 2007, there were increases in emissions from waste, the residential sector and services and, to an even greater extent, from the energy industries and transportation.

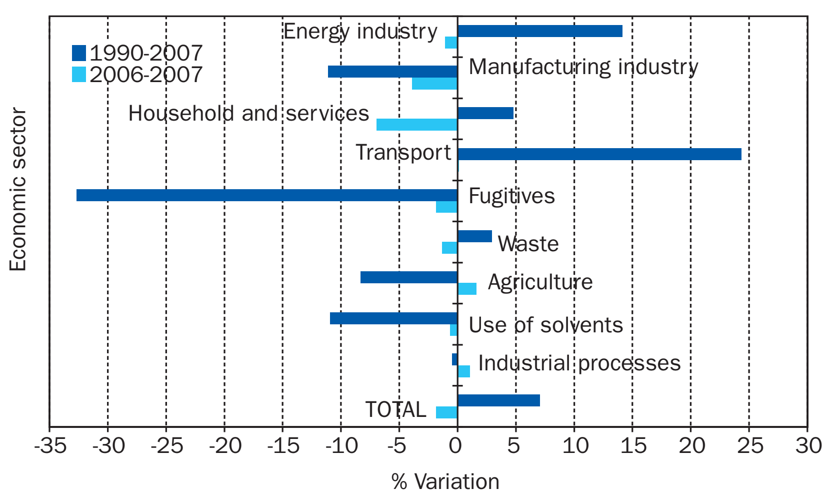


Figure 1.15: Percentage variation in emissions of greenhouse gases by economic sector for the year 2007, compared with the previous year and with 1990[51]

[51] Source: ISPRA

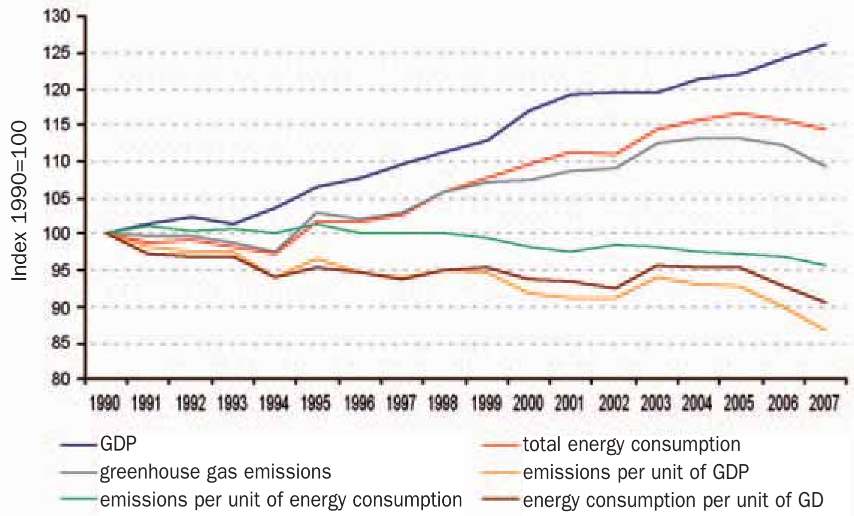


Figure 1.16: Trends of for the main economic, energy and emissions indicators[52]

A comparison of levels of greenhouse gas emissions with the figures for the main variables of economic growth show that, during the period 1990-2007, the growth in greenhouse gas emissions was generally slower than the growth of the economy, pointing to a relative decoupling of the two trends.

A comparison (Figure 1.16) between the levels of greenhouse gas emissions and of the main variables depicting economic growth (such as the GDP and value added) show that, for the period 1990-2007, growth in greenhouse emissions was generally slower than economic growth, pointing to a relative decoupling of the two trends[53].

In contrast, an analysis of levels of greenhouse gas emissions per total energy unit shows that emission levels in the 90's essentially followed those of energy consumption, with a decoupling arising only in recent years, due primarily to the use of natural gas in place of combustibles with higher carbon contents to produce electric energy and fuel industrial activities.

Greenhouse gas emission levels in the 90's essentially followed those of energy consumption, with a decoupling arising only in recent years, due primarily to the use of natural gas in place of fuels with higher carbon contents for electricity generation and industrial activities.

A decomposition analysis was carried out to determine the main

[52] Source: ISPRA

[53] If the economic variable shows positive growth while the growth rate of the environmental variable is less than or equal to zero, then it is said that an "absolute decoupling" has occurred. In contrast, when the growth rate of the environmental variable is positive, but lower than that of the economic variable, then a "relative decoupling" is at work (OECD, 2002)

factors underlying the variation in greenhouse gas emissions[54]. Specific consideration was given to the variation in greenhouse gas emissions for which economic activities were responsible in the period 1992-2006, with the use of three sets of data – environmental, energetic and economic – all collected on a consistent basis (meaning in accordance with the principles, definitions and classifications of national accounting)[55].

In breaking down the variation in greenhouse gas emissions in the period 1992-2006, the following factors were taken into consideration:

- the level of economic activity (to evaluate the effect of economic growth);
- the percentage weight of the different sectors of the economy (to assess the effect of changes in the production structure);
- the economic efficiency of fuel use (to assess the effect of changes in energy intensity per unit of product);
- the emission intensity of energy consumption (to assess the effects of changes in emission intensity).

The decomposition analysis indicates that the increase in emissions between 1992 and 2006, equal to approximately 24 million tons of CO_2 eq (Figure 1.17), is due exclusively to the "economic growth". And if the effects of economic growth had not been offset by those of the other components, the overall variation would have been approximately 30.8% instead of the actual 5.6%.

More specifically, the improvements in the two technological factors "emission intensity" and "energy intensity" should have led to a reduction of 20.7% in potential emissions. The factor "production structure" also played a significant role, though to a lesser extent, in reducing greenhouse gas emissions (-4.5%).

[54] Femia A. (ISTAT), Marra Campanale R. (ISPRA), *Production-related air emissions in Italy 1992-2006, a decomposition analysis*, in "*Environmental Efficiency, Innovation and Economic Performance*", edited by Anna Montini, Massimiliano Mazzanti, June 2010

[55] This type of analysis does not refer to the total emissions estimated by ISPRA using the IPCC methodology employed for the UNFCCC, but rather to a NAMEA type context (*National Accounting Matrix including Environmental Accounts*). The NAMEA classification method considers only emissions that can be traced to the production activities responsible for them, and it is consistent with the national economic statistics. As a result, no direct comparison can be established between the NAMEA data and the data used for UNFCCC

The decomposition analysis shows that the increase in emissions caused by economic activities, equal to 24 million tons of CO_2 eq between 1992 and 2006, was due exclusively to the "economic growth" factor.

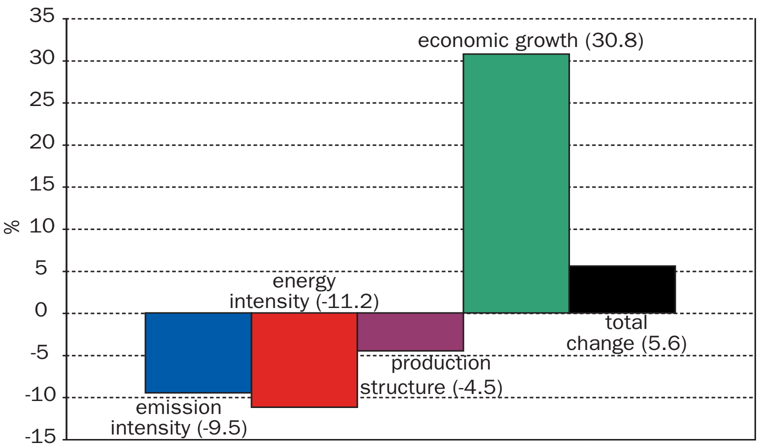


Figure 1.17: Variations between 1992 and 2006 in greenhouse gas emissions due to economic activities, broken down by determinants[56]

An analysis of the annual variations shows that the overall change for 1992-2006 (-9.5%) traceable to "emission intensity" was arrived at, for the most part, by accumulating small annual increases in efficiency during the period (though, in a number of years, the annual variation in intensity was positive). This demonstrates that there was indeed an improvement, though admittedly a slow one, in the environmental efficiency of Italian industry, thanks to a decrease in emissions not involving the use of fuels (but, for example, the use of solvents); the switch to less polluting combustible fuels; the use of technologies that improve production processes, such as integrated technologies; the installation of devices that reduce *end-of-the-pipe* emissions. In contrast, the effect of the "energy intensity" is characterised by an irregular, unpredictable pattern that often features major changes from one year to the next, such as the increase of 3.4% in 2003 and the upward variations of 2005 and 2006, all of which suggests that the use of energy has become less efficient in recent years. This factor takes into account the effects of a number of possible real improvements, such as the introduction of less fuel intensive techniques and the removal from operation of machines or plants that waste energy. However, both the overall importance of the factor and its volatility can be explained, at least in

[56] Source: Processing by Femia A. (ISTAT), Marra Campanale R. (ISPRA) of ISTAT-ISPRA data

part, by the delocalisation of Italian production activities. In effect, an increasing number intermediate and final products of Italian industrial concerns are manufactured abroad, with only the very last phases performed in Italy. This means that the output is achieved without having to use all the energy necessary for "production" in the sector (in reality, frequently acquired abroad, as intermediate input, in the form of goods that are almost finished and the resold following a small transformation). In 2007 greenhouse gas emissions exceeded the Kyoto objective by 70 Mt CO_2 eq. (+14.5%). The increase in emissions was due primarily to the energy industry and transportation sectors.

In 2007, greenhouse gas emissions in Italy exceeded the Kyoto objective by 70 Mt CO_2 eq.

Under the Kyoto Protocol, Italy should lower its emissions, during the period 2008-2012, to levels 6.5% below those of 1990, meaning to 482.76 Mt CO_2eq.
In 2007 greenhouse gas emissions exceeded the Kyoto target by 70 Mt (+14.5%).

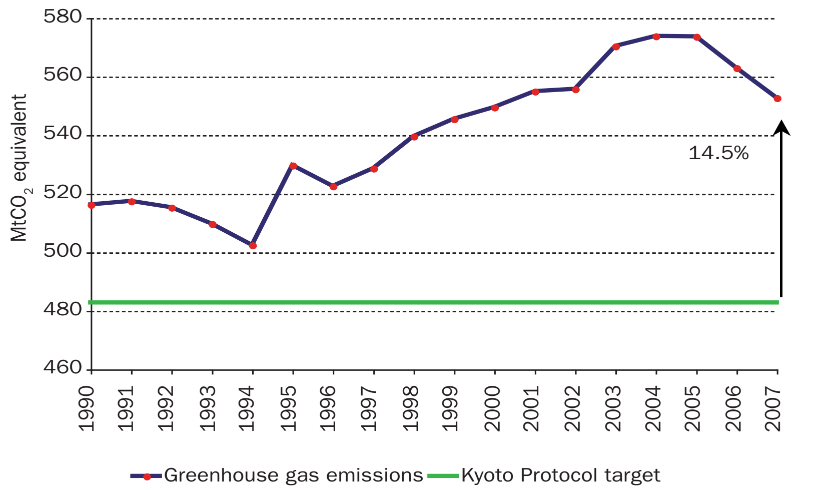
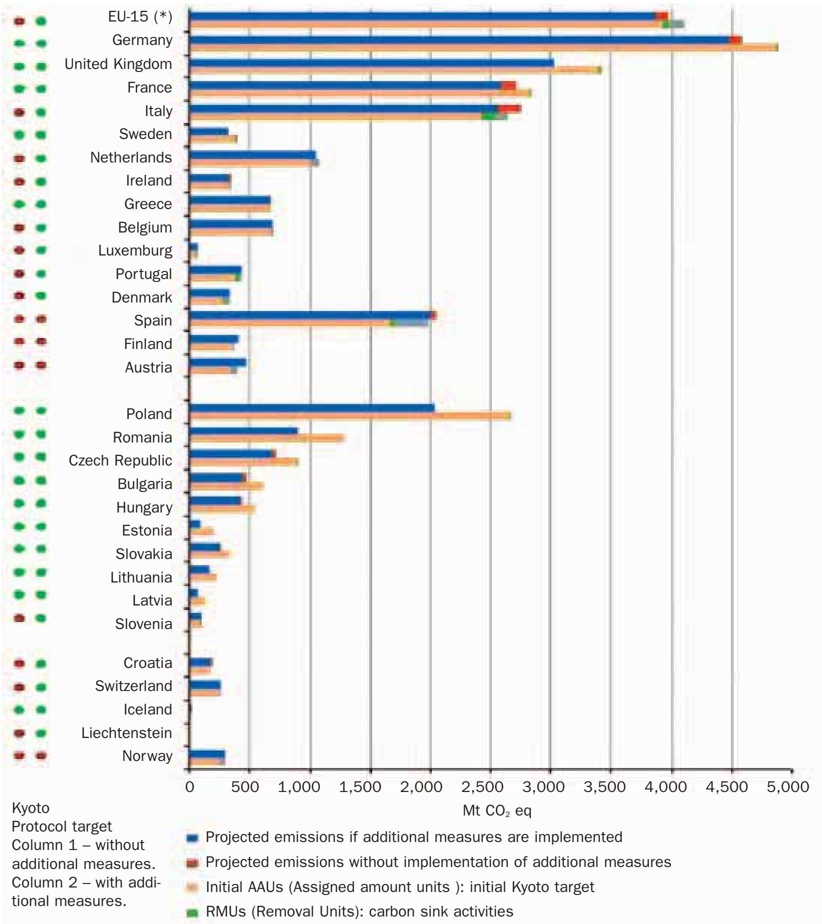


Figure 1.18: Total greenhouse gas emissions in Italy, compared with the Kyoto target[57]

According to the assessments in the report "*Greenhouse Gas Emission Trends and Projections in Europe* 2009 - *Tracking progress towards Kyoto targets*" of the European Environmental Agency, Italy will be able to reach the objectives set under the Kyoto Protocol only if, in addition to drawing on emission credits gained through LULUCF activities (*Land Use, Land Use Change and Forestry*) and acquiring quotas generated by the flexible mechanisms provided for under the Protocol, it implements additional measures to reduce emissions, above and beyond those already taken; such measures, however, must still be determined and enacted.

According to the assessments of the European Environment Agency, Italy will be able to reach its objectives under the Kyoto Protocol only if, in addition to drawing on emission credits gained through LULUCF activities and acquiring quotas generated by the flexible mechanisms provided for under the Protocol, it implements additional measures to reduce emissions, above and beyond those already taken.

[57] Source: ISPRA



Note: The countries are divided into the groups EU15, EU12 (with the exception of Malta and Cyprus, which do not have objectives under the Kyoto Protocol) and non-EU countries. Within these groupings, the countries are ranked in ascending order, based on the absolute interval between the emissions forecast for the period 2008-2012 and their respective objectives under the Kyoto Protocol. The first coloured dot to the left of each country indicates the difference between the projected greenhouse gas emissions and the Kyoto objectives with only the measures already taken (excluding sink activities and the Kyoto mechanisms: CDM, JI), while the second coloured dot indicates the difference between the projection of greenhouse gas emissions and the Kyoto objectives in the event that additional measures are taken. The green and red dots indicate that emissions fall, respectively, below or above the levels required under the Kyoto Protocol.
(*): annual average emissions for the EU15, while the projections for the individual countries regard total emissions for the period 2008-2012 and the Kyoto objectives.
The projections for the period 2008-2012 are communicated by the member states (Belgium, Bulgaria, Denmark, Ireland, Italy, Luxemburg and Portugal) or estimated by the European Environmental Agency on the basis of the emissions of 2007 and the projections for 2010 and 2015, as communicated by the countries.
For each country, the upper bar represents the quantity of emissions permitted for the period of 2008-2012 (the initial objective under the Kyoto Protocol, plus the emissions estimate resulting from the reduction of emissions through sink activities and through the purchase of credits under the flexible mechanisms provided for in the Protocol). lThe lower bar represents the emissions projection for the period 2008-2012.
A country can reach its objective when its emissions (the upper bar) do not exceed its Kyoto objective (lower bar).

Figure 1.19: Comparison between the emissions forecast for the European countries for the period 2008-2012 and their targets under the Kyoto Protocol[58]

According to the EEA, at present only three member states (Austria, Finland and Spain) hold that they will not be able to meet their Kyoto target without taking further measures.

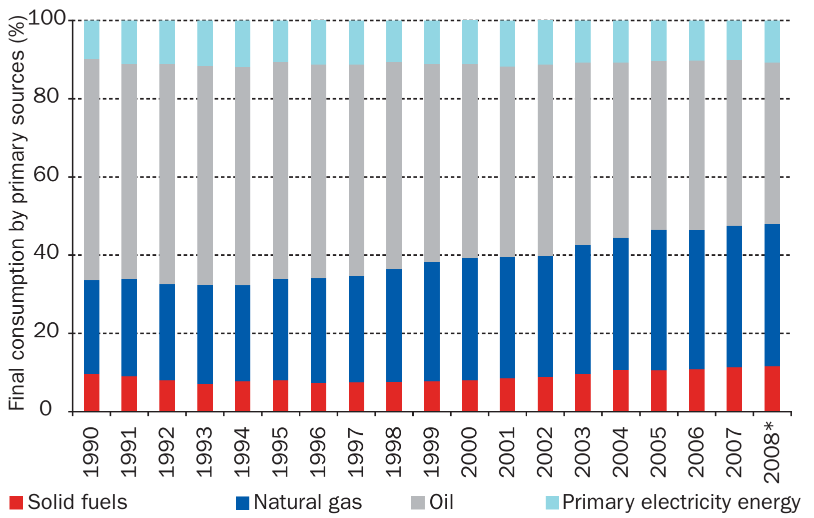
[58] Source: EEA, *Greenhouse Gas Emission Trends and Projections in Europe* 2009 - *Tracking progress towards Kyoto targets, forthcoming*

In terms of the goal of reducing green house gas emissions by at least 20% within 2020, compared to the levels of 1990, the EU is roughly halfway there, having registered, in the year 2007, a 9.3% reduction in emissions compared to 1990.

Energy prices fluctuations are one of the causes of the ongoing changes in the energy supply mix.

The energy sector is undergoing changes in the supply of primary sources, with growth in the consumption of natural gas, at the expense of oil products, and a contribution from renewable sources and cogeneration, plus, since 2001, consumption of solid fuels.

According to the European Environmental Agency, at present only three member states (Austria, Finland and Spain) feel that they will not be able to reach their Kyoto objective without taking further measures. In terms of the goal of reducing greenhouse gas emissions by at least 20% within 2020, as compared to the levels of 1990, assessments are still in the preliminary stage; taken as whole, the EU is roughly halfway there, having registered, in the year 2007, a 9.3% reduction in emissions compared to 1990.
Energy prices fluctuations are one of the causes of the ongoing changes in the energy supply mix, with natural gas playing an increasingly important role, at the expense of oil products, and with an upward trend in the contribution of renewable sources and cogeneration, plus, starting from 2001, renewed consumption of solid fuels, whose contribution to primary energy sources (including primary electric energy) went from 8.6% in 2001 to 11.5% in 2008.



Legend :* Provisional figures

Figure 1.20: Total consumption of energy by primary sources[59]

[59] Source: Ministry of Economic Development data processed by ENEA

Despite changes in the mix of primary energy sources, our country's energy dependence remains high, having risen from 82.8% in 1990 to 85.5% in 2008, for an increase of 2.7%. With the goal of limiting the vulnerability of our economic system on account of this supply structure, the current Government has presented legislative measures meant to select locations for new nuclear power plants.

Despite the modifications in the mix of primary energy sources, our country's energy dependence remains high.

Starting from 1990, there was a constant upward trend in total final energy consumption, with the peak reached in 2005 (+20.7% compared to 1990). A reversal in the trend was observed from 2006 on, with a 4.1% drop in final consumption registered in 2008, as compared to 2005. Final total consumption for 2008 amounted to a 15.7% increase over 1990.

Starting from 1990, there was a constant upward trend in final energy consumption, with the peak reached in 2005 (+20.7% compared to 1990). A reversal in the trend was observed from 2006 on, with a 4.1% drop in final consumption registered in 2008, as compared to 2005.

The main sectors that contribute to the overall trend have shown falling consumption in recent years. In particular:

- industry has registered a decrease of 8.6% in energy consumption since 2004;
- the household and services sector shows 3.5% lower consumption than in 2005, though the level rose last year (+4.8% compared to 2007);
- in contrast to the other sectors, consumption for transportation has increased constantly since 1990 (+29.6% in 2008), with the sole exceptions of drops in consumption in 2005 and 2008, compared to the preceding years. Based on provisional estimates, the decrease in 2008 was 1.7%;
- consumption in the agriculture and fishing sector has declined constantly since 2005 (-3.9%).

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 34.4% of consumption, followed by the transportation and industrial sectors, at 34.2% e 29% respectively. The agriculture and fishing sector accounts for the remaining 2.5% of final consumption. The decrease in Italy's total energy consumption in recent years, together with the limited growth of its GDP, explain the significant reduction in energy intensity between 2005 and 2008 (-5.3%), following a series of decidedly high values (around 159 toe per millions of Euro) registered between 2003 and 2005. In 2007, Italy was the G20 country with the lowest total energy intensity, with GDP corrected for purchasing power parity, rating below the worldwide average and that of the OECD.

The decrease in Italy's total energy consumption in recent years, together with the limited growth of its GDP, explains the significant reduction in energy intensity between 2005 and 2008 (-5.3%).

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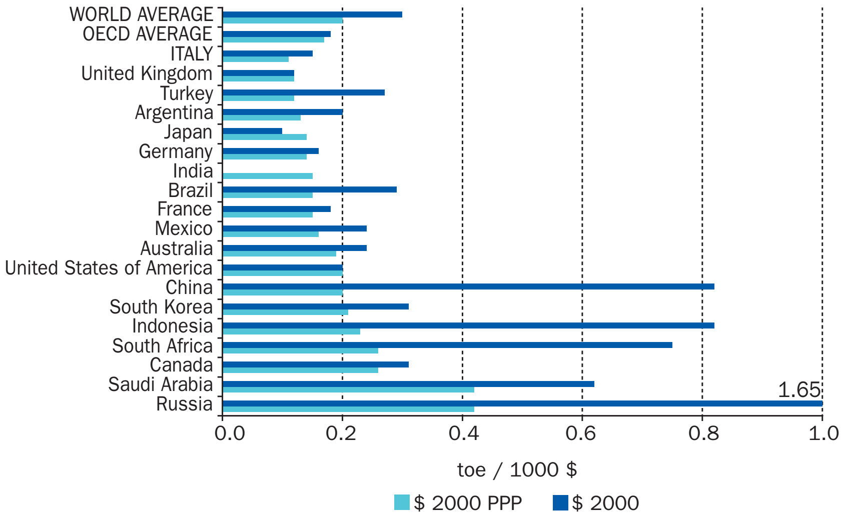

Figure 1.21: Total energy intensity of the G20 countries, with GDP measured in year-2000 dollars and corrected for purchasing power parity (PPP) (2007)[60]

Between 1994 and 2008 the electricity generation grew at a rate considerably higher than total energy consumption.
This result points to the growing role of electricity as a vector in the national energy system.

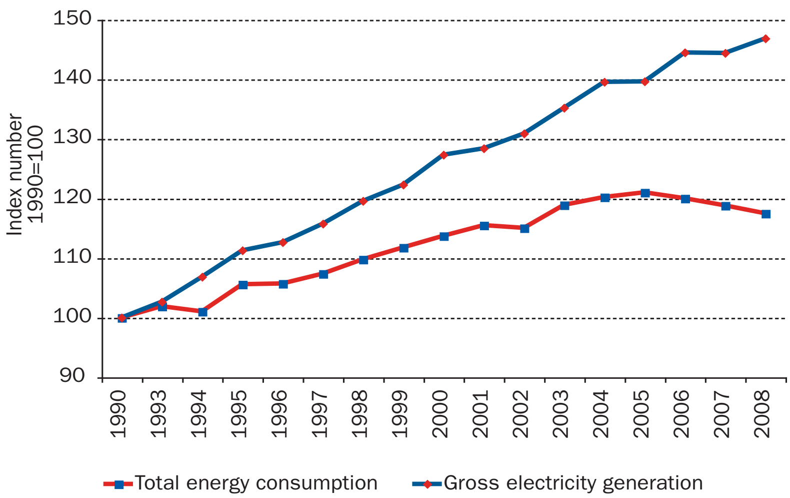

Figure 1.22: Total energy consumption and electricity generation (1990 = 100)[61]

[60] Source: International Energy Agency (IEA)
[61] Source: Ministry of Economic Development and TERNA S.p.A. data processed by ISPRA

Between 1994 and 2008, the rate of growth for electricity generation was considerably higher than that for total energy consumption. This result points to the growing role of electricity as an energy vector in the national energy system.
Looking at the regional break-down, final energy consumption varies considerably within the national territory. The figures for 2008 show that Lombardy consumes 21.6% of the national total, followed by Veneto at 10.1%, while Emilia Romagna and Piedmont account for respective levels of 9% and 8.4%, and other regions, such as Lazio, Tuscany, Apulia, Campania and Sicily find themselves in and around an average value of 6.1%. Taken as a whole, these nine regions consume 79.5% of the Italian total (Figure 1.23).

Between 1994 and 2008 electricity generation grew at a rate considerably higher than total energy consumption.

Regional final energy consumption reveals a highly varied structure within the national territory.

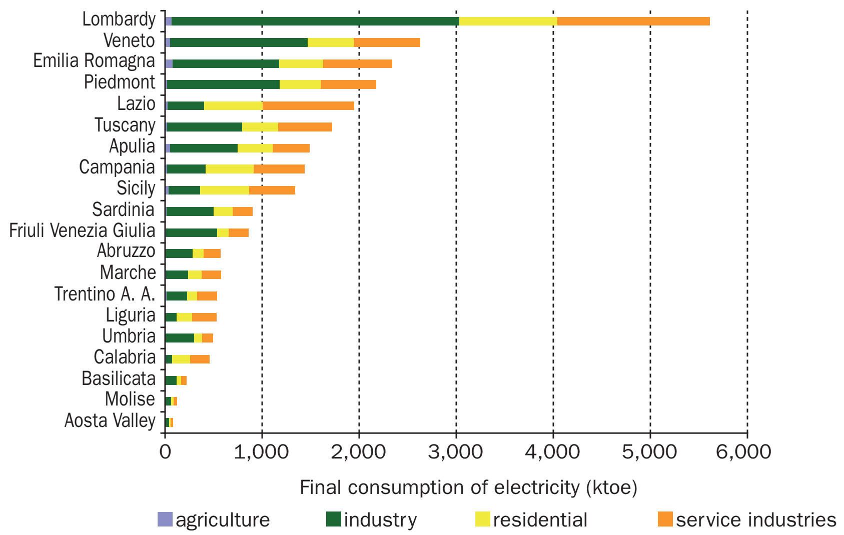

Figure 1.23: Final energy consumption by region and by economic sector (2008)[62]

Regional consumption of electricity reveals a highly varied structure within the national territory.
Lombardy consumes 21.6% of the national total.
Nine regions (Lombardy, Veneto, Emilia Romagna, Piedmont, Lazio, Tuscany, Apulia, Campania and Sicily) account for 79.5% of total Italian consumption.

The transportation system must respond to sharp rises in the demand for mobility. During the period 1990-2008, the demand for passenger transport increased by 34%, while the demand for domestic transport of cargo for distances of more than 50 km grew by 23.2% over the same period.

The transportation system must respond to sharp rises in the demand for mobility. During the period 1990-2008, the demand for passenger transport increased by 34%, while the demand for domestic transport of cargo for distances of more than 50 km grew by 23.2% over the same period.

[62] Source: ENEA data processed by ISPRA

Growth in passenger demand remained constant during the period 2000-2005, followed by increases over the following two years.
In 2008, there was a drop in the demand for transportation (-4.7% compared to 2007) (Figure 1.24).
The demand for passenger transportation continued to be met primarily by roadway transportation, the least efficient mode from an economic and environmental perspective. In 2008, automobiles, motorcycles and scooters covered 81.6% of passenger transportation demand.
Italy ranks second, after Luxembourg, in terms of the ratio of automobiles in circulation to the resident population, but it is first when motorcycles, scooters and commercial vehicles are taken into consideration; worldwide, only the USA has a higher rate of motorisation in terms of vehicles per inhabitant.

During the period 1990-2008, the demand for passenger transport increased by almost 34%. Roadway transportation (automobiles, motorcycles and scooters) covered 81.6% of the demand for passenger transport (automobiles alone 73.8%) in 2008.

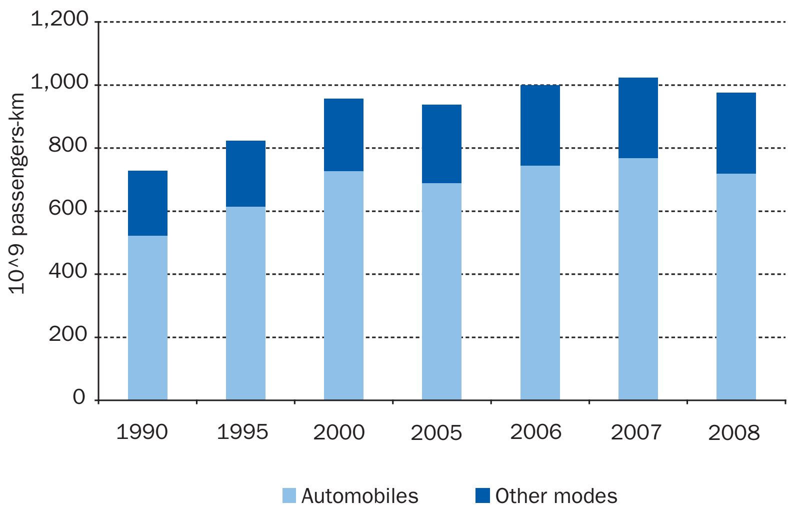

Figure 1.24: Demand for passenger transport[63]

The demand for passenger transport shows a growth trend from 1990 to the present (+23.2% in 2008, compared to 1990), being

[63] Source: Ministry of Infrastructures and Transport data processed by ISPRA

closely tied to the dynamics of economic development and the process of European integration (Figure 1.25).
Transportation of freight takes place primarily by truck, with the rate having remained fairly constant since 1990, at in and around 70% compared to the other modes of transport (68.2% in 2008). In 2008, domestic freight transport by sea and by railway accounted for respective percentages of 17.7% and 9.5, while air transport represented a marginal 0.4% of total transport.
The demand for freight transport showed noteworthy growth during the period 2000-2005, following by decreases in subsequent years. Roadway transport has increased by 0.9% compared to 2000. Under the category “other modes”, cargo transported by sea showed a significant increase (+43.8%) from 2000 on, while more modest growth was registered by railway transport (+3.9%). The increases for air transport and transport by pipeline were, respectively, 17.8% and 18.6%, compared to the year 2000.

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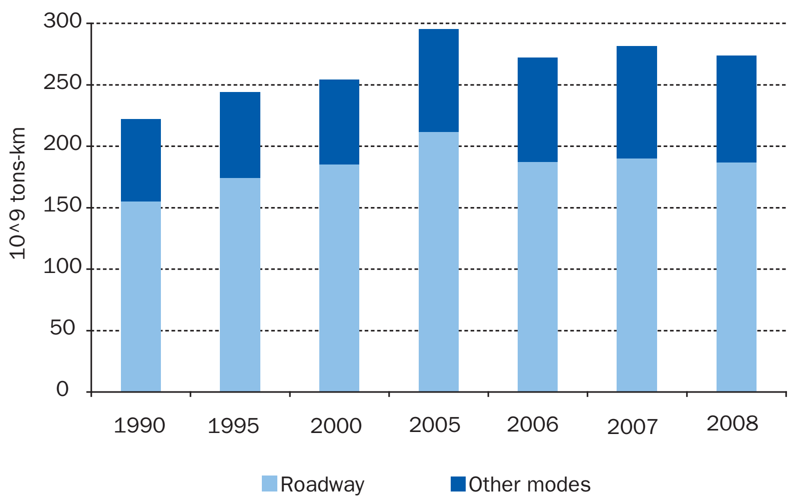


Figure 1.25: Demand for freight transport[64]

The demand for transport showed growth of 23.2% between 1990 and 2008. Furthermore, estimates for 2008 show that freight transport within the national territory occurs primarily by roadway travel (68.2%) while other modes, such as the transport of freight by sea and by rail, account for respective shares of 17.7% and 9.5% of total transport.

[64] Source: Past series recalculated by ISPRA under uniform criteria, using data of the Ministry of Infrastructures and Transport (National Accounting of Infrastructures and Transportation); the past series on freight transport is affected by variations in the data-collection methodology employed by the ISTAT

The main response measures involve mitigation (reducing greenhouse gas emissions) and adaptation to climate change underway.

The year 2009 saw publication in the Official Journal of the European Communities of all the legislative documents in the "Energy – Climate Change" package that was the subject of the historic agreement known as "20-20-20".

Response measures

The main measures of response to climate change involve mitigation, which means reducing greenhouse gas emissions, as well as adaptation, whose objective is to minimise the potential negative consequences of climate change and prevent related damage. Such measures are complementary.
As concerns mitigation measures, it is important to note that the year 2009 saw publication in the Official Journal of the European Communities of all the legislative documents in the "Energy – Climate Change" package that was the subject of the historic agreement known as "20-20-20", reached in the European Council on 18 December 2008; specifically:

- Directive 2009/28/EC on the promotion of renewable energy, which sets the binding objective for the EU of bringing the percentage contribution of renewable sources as a percentage of total energy consumption to 20% by 2020, with the effort distributed among the Member States; Italy's assigned objective is 17%;
- Decision 406/2009 on effort sharing, which sets the binding objective for the EU of reducing by 10% compared to the Community levels for 2005 greenhouse gas emissions in the sectors not regulated by 2003/87/EC; the burden of the effort is distributed among the Member States, with Italy assigned an objective of 13%;
- Directive 2009/29/EC on the revision and strengthening on the European emissions trading system, setting for the EU the binding objective of reducing greenhouse gas emissions by 21% compared to the levels of 2005 for the sectors governed by Directive 2003/87/EC;
- Directive 2009/31/CE on carbon capture and storage, a measure that establishes a legal framework for the geological storage of carbon dioxide, so as to ensure permanent containment of this substance and reduction to a minimum of possible risks to the environment and to human health.

On the subject of adaptation, 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[65].

The document lays out guidelines for action, structured around the following points:

- consolidation of basic knowledge regarding the risks and consequences of climate change;
- consideration on the impact of climate change on the main EU policies;
- integration of the different policy measures to obtain the best possible effect (for example, new forms of financing, including market-based programs, could be utilised to facilitate adaptation,);
- support of more wide-ranging international adaptation efforts;
- implementation of activities in collaboration with national, regional and local government bodies.

In operating terms, the White Paper states that:

- access to a wider range of data on the impact on the climate could facilitate decision-making processes;
- by 2011 a clearinghouse mechanism should be established for the exchange of information, making it easier to gain access to multiple sources of information on the consequences of climate change, on areas at risk and on successful practices;
- consideration of adaptation in formulating the primary policies of the EU.

By the end of 2011, the European Commission and the European Environment Agency plan to develop a series of instruments in support of adaptation policies, including:

- guidelines for the formulation of regional strategies of adjustment to climate change;
- sets of indexes of impact, vulnerability and adjustment;
- economic assessments of the costs and benefits of adjustment.

On the European level, in April 2009 the European Commission presented a white paper: "Adapting to climate change: Towards a European framework for action", with the goal of making the EU less vulnerable to the impact.

[65] Commission of the European Communities, 2009, *White Paper: "Adapting to climate change: Towards a European framework for action"*, COM(2009) 147 definitive, Brussels, 01/04/2009

In the countries of the European Union, a central role in strategies of mitigation has been given to implementation of the European emissions trading system established under Directive 2003/87/EC.

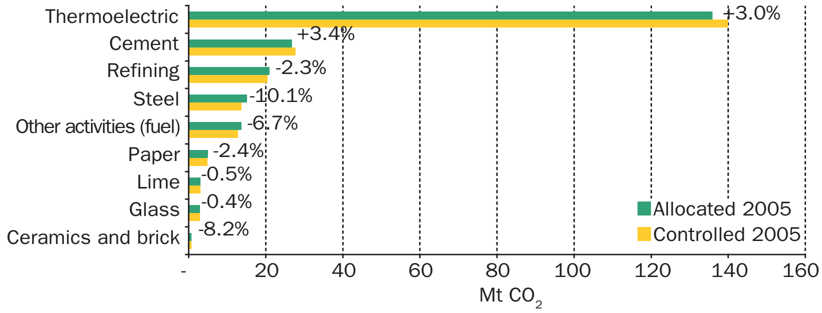
Mitigation

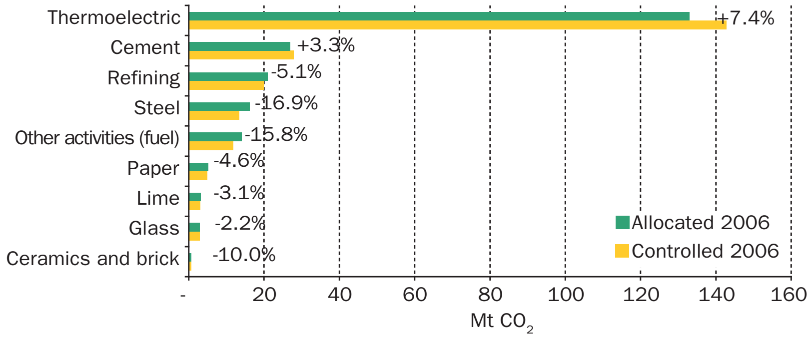
In the countries of the European Union, a central role in strategies of mitigation (meaning prevention of climate change by reducing emissions of greenhouse gas emissions and increasing absorption of carbon dioxide removals) has been given to implementation of the European emissions trading system established 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 into the air 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 that leads to a reduction in emissions by industrial plants. Furthermore, 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.

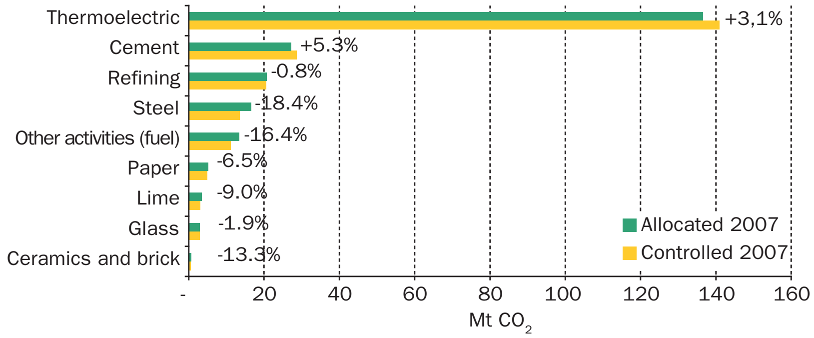
The initial period of implementation of the emissions trading system (ETS) began on 1 January 2005 and concluded on 31 December 2007. In Italy, the quotas for the first period were assigned under the decree DEC/RAS/74/2006 of the Ministry of the Environment, Land and Sea. More recently, the National 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, passed a ruling of 20 February 2008 assigning the quotas for the second period (2008-2012).

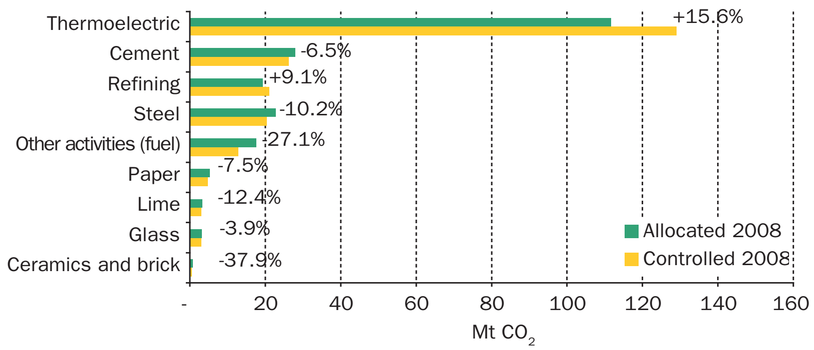
The final figures on greenhouse gas emissions are available for the years 2005 to 2008.

During the three-year period 2005-2007 (Figure 1.26), power stations and cement plants registered emissions levels higher than their respective allocations, while the levels observed for the remaining sectors were lower than the threshold set under the allocation plan. It can also be seen that, in a number of sectors (steel, other combustion activities, paper, lime, ceramics and









Legend:
The percentage figure represents the variation in CO_2 emissions, as compared to the assigned quotas.
"Allocated": CO_2 emissions quotas assigned to the plants.
"Controlled": quantities of CO_2 actually emitted by the plants.

Figure 1.26: Comparison of emissions allocated to emissions controlled for the three years of the first period 2005-2007, and for 2008, in the different industrial sectors[66]

Considering the sum total of the quotas assigned and issued in the three-year period 2005-2007, the differential for greenhouse gas emissions by plants participating in the ETS system was +5.7 Mt CO_2 above the maximum threshold.

In the first year of the second period (2008-2012), total emissions of CO_2 exceeded the assigned quotas by 9 Mt CO_2.

[66] Source: ISPRA

Considering the sum total of the quotas assigned and issued during the three-year period of 2005-2007, the differential for greenhouse gas emissions from the plants participating in the ETS system was +5,7 Mt CO_2 above the maximum threshold.

In the first year of the second period, (2008-2012), total emissions of CO2 exceeded the assign ed quotas by 9 Mt CO_2.

bricks), the reduction, in terms of the allocation, gradually increased over the three years. Total emissions were higher than the national allocation for the first two years (+0.8% in 2005 and +1.9% in 2006), while the quantity of emissions registered in the last year was slightly lower than the allocation (-0.2%).
Considered overall, meaning in terms of the sum total of the quotas assigned and issued during the three-year period of 2005-2007, the differential for greenhouse gas emissions from the plants participating in the ETS system was +5,7 Mt CO_2 above the maximum threshold.
With regard to the first year of the second period (2008-2012), total CO_2 emissions exceeded the assigned quotas by 9 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 reductions of between 3.9% and 37.9%, as compared to their assigned thresholds.
Working from the emissions data declared by the plants taking part in the European emissions trading system, a number of assessments were run in an attempt to determine the environmental effectiveness of the system by estimating the reduction in CO_2 emissions that can be credited to its operations. Obviously there are no proven methods or past references for calculating this reduction: the estimates must take into account the past emission trend (baseline), as well as the actual parameters of the main economic and energy parameters for the period to which the emissions refer.
This type of assessment points to a total reduction of approximately 70 $MtCO_2$ in CO_2 emissions in Europe, for the year 2005, as a result of the operations of the ETS, an amount that corresponds to roughly 3% of the emissions recorded in Europe[67]. Using the same method, which essentially consists of a comparison between the actual emissions and the forecasts, with respect to benchmark year, ISPRA analysed the figures for the Italian plants

[67] Ellerman A.D., Buchner B.K., *The European Union Emissions Trading Scheme: Origins, Allocation, and Early Results, Review of Environmental Economics and Policy*, Volume 1, Number 1, Winter 2007

participating in the ETS during the first period (2005-2007)[68]. Three scenarios for annual growth in CO_2 emissions, starting from the base year, were used as references (0.5%, 1.0% and 1.5%). The estimates show that the trading of CO_2 emissions quotas by the production sectors that are part of the ETS system has a positive impact. In the specific case of the scenario considered most probable (annual emissions growth of 1.0%), it was estimated that emissions would be reduced by 9.1 Mt CO_2 in 2005, 10.0 Mt CO_2 in 2006 and 13.4 Mt CO_2 in 2007 (respectively 4.0%, 4.4% and 5.9% of the controlled emissions).

It is estimated that the operations of the ETS were responsible for a total reduction of approximately circa 70 MtCO_2 in CO_2 emissions in 2005 in Europe, corresponding to roughly 3% of the controlled emissions throughout Europe.

Worthy of note nationally is the growing role played by cogeneration, which makes it possible to increase the efficiency of the conversion of the energy available from primary sources. Since 1997, the net amount of electricity from thermal power stations produced through cogeneration has followed a trend parallel to that for total thermoelectric production: between 1997 and 2008 the average annual increase was approximately 5,424 GWh/year for electricity generated through thermal cogeneration, while the overall average increase in total electricity generated by thermal power plants was 5,487 GWh/year. The figures for the production of electricity alone remained almost constant during the period considered, with an average annual increase, between 1997 and 2008, of 64 GWh/year. These figures show that, since 1997, the need for new electricity generation from thermal power plants has been completely met through cogeneration (Figure 1.27).

Worthy of note nationally is the growing role played by cogeneration, which makes it possible to increase the 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 influence on the trend in greenhouse gas emissions. This is due not only to the low emissions factor of natural gas compared to other primary sources, but also to the greater efficiency of combined cycles fuelled by natural gas, as opposed to traditional steam cycles.

The growing role of natural gas in thermoelectric production has a positive influence on trends in greenhouse gas emissions.

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[68] 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/

The average annual increase in electricity generation between 1997 and 2008 was approximately 5,424 GWh/year for thermal electricity generation with cogeneration and 5,487 GWh/year for total thermal electricity generation, while the generation of electricity alone remained almost constant during the period considered.
These figures show that, since 1997, the need for new electricity from thermal power plants has been met entirely through cogeneration.

During the period 1996-2008, the specific average consumption of all fuels used for net electricity generation fell by 12.8% (-1.4% between 2007 and 2008).

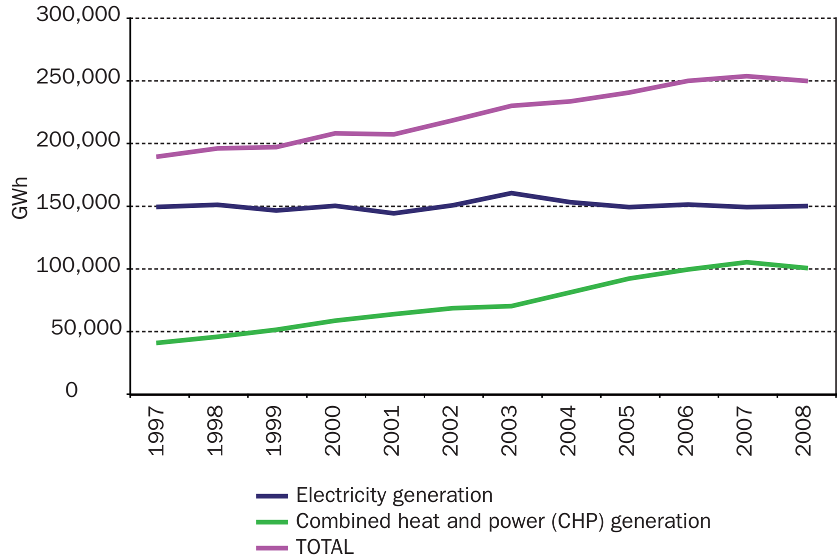


Figure 1.27: Net thermal electricity generation[69]

During the period 1996-2008 a decrease of 20.1% was registered in the specific average consumption of natural gas for net electricity generation. Derivative gases also showed a significant drop in specific consumption in 2008, for a decrease of 19.1% compared to 1996. Taking into consideration all the fuels used for electricity generation, specific average consumption fell by 12.8% (-1.4% between 2007 and 2008). Specific average consumption of all fuels for electricity generation was influenced by the use of oil products and solid fuel, which are less efficient than gas fuels. In fact, during the period considered, average specific consumption of oil products and solid fuel rose by respective figures of 11.1% and 10.4% (Figure 1.28).

[69] Source: TERNA S.p.A. data processed by ISPRA

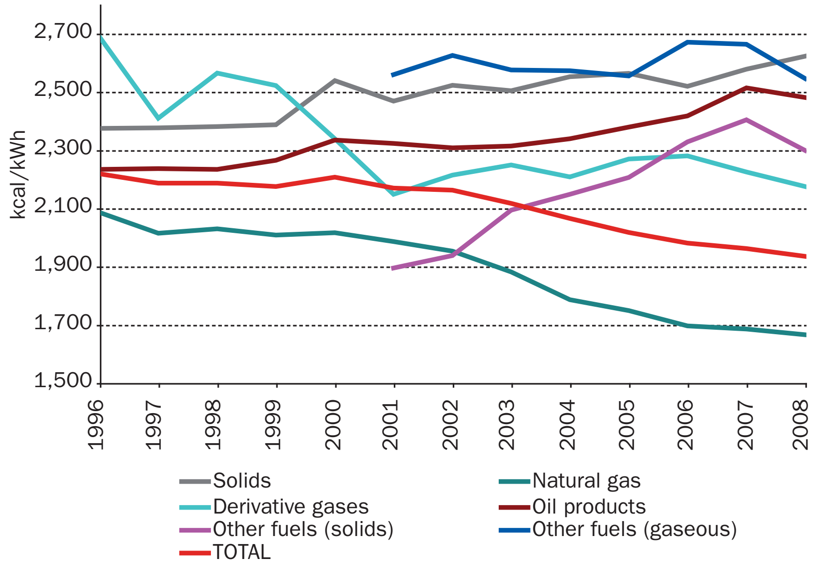


Figure 1.28: Average specific fuel consumption in the net electricity generation from fossil sources[70]

During the period 1996-2008 there was a decrease of 20.1% in the average specific consumption of natural gas, and a decrease of 19.1% in consumption of derivative gases. In terms of electricity generation in general, average specific consumption fell by 12.8%, while oil products and solid fuel rose by respective figures of 11.1% and 10.4%.

In terms of end-uses energy efficiency, Directive 2006/32/EC sets objectives for Member States regarding the efficiency of the end-uses of energy and energy services. The general national objective for energy savings is 9% within the ninth year of the implementation of the directive (2016). Under the provisions of art. 4, Member States must enact effective measures to achieve this objective; the Action Plan for Energy Efficiency, presented by Italy in July 2007, in fulfilment of art. 14 of the Directive, identifies a series of actions that will make possible energy savings of 9.6% in 2016, as compared to average energy consumption between 2001 and 2005.

Under Directive 2006/32/EC, the general national objective for energy savings is 9% by 2016.

Of the measures referred to above, a key role is played by the system of white certificates, contemplated under art. 6 of Directive 2006/32/EC, and which Italy was the second country to implement, right after the United Kingdom, doing so through the Ministerial Decrees of 20 July 2004. The objective of the decrees, subsequently supplemented by a Ministerial Decree of 21 December 2007, is to achieve energy savings that are to increase

The objective of the Ministerial decrees of 20 July 2004 and 21 December is to achieve energy savings that keep increasing, until they reach, in 2012, a level of 6 Mtoe a year.

[70] TERNA S.p.A. data processed by ISPRA

During the first four years of operation of the white certificate system, the certified energy savings were equivalent to the sum of the annual energy savings objectives set under the decree.

year after year, until they reach, by 2012, a level of 6 Mtoe a year through the introduction of obligatory quantities of energy savings for distributors of electricity and natural gas.

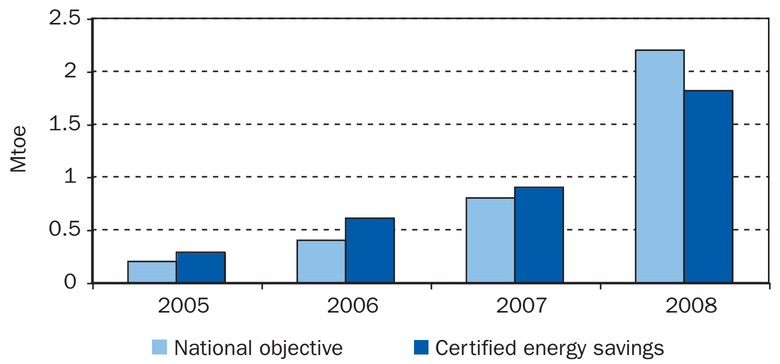
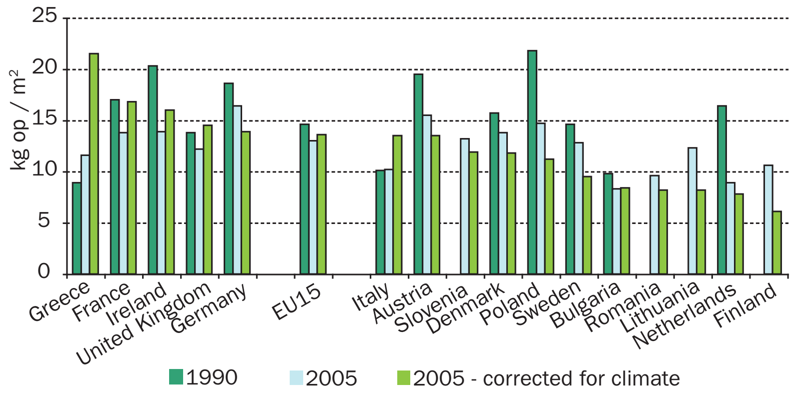


Figure 1.29: Comparison between national energy savings objectives and certified energy savings[71]

Figure 1.29 highlights the fact that, in the first four years of the system's operation, the certified energy savings were equivalent to the sum of the annual energy savings objectives set under the decrees referred to above, confirming that the system works. The majority of the measures for improving energy efficiency contemplated under the Action Plan for Energy Efficiency regard the residential sector, and specifically the energy needs of buildings (for hearting and cooling), as well as consumption by devices that are final energy users.
The potential for the first type of initiative is made clear by the data from 2005 on the energy consumption per surface area of EU15 buildings adjusted for climatic conditions. The data place Italy among the leading countries in terms of consumption per m^2, together with Germany, the United Kingdom Ireland, France and Greece. Other countries of the EU15, such as Austria, Denmark, Sweden, the Netherlands and Finland present levels of energy consumption lower than those registered for our country (Figure 1.30).

[71] Source: Italian Authority for Electricity and Gas, "*The Mechanism of Energy Efficiency Certificates from 1 January to 31 May 2009, Second Intermediate Statistical Report on the Obligatory Year 2008, drawn up in accordance with article 8, paragraph 1, of the Ministerial Decree of 21 December 2007*"



Note: The data for 1990 and 2005 were corrected to attenuate the effects of long-term climate variations in the individual countries. The year 2005 was also corrected for the average climate of the European Union, to take into consideration the temperatures in the different countries.

Figure 1.30: Energy consumption per m² in buildings[72]

In 2005, the data for energy consumption per m², adjusted for climatic conditions, showed that Italy ranks among the leading countries in terms of consumption.

In our country, the legislative process concerning energy certification of buildings is very lengthy. The principle was introduced in Italy under Law no. 10 of 9 January 1991, which addresses the various aspects of energy certification for buildings, but this law was never enacted.

In 1998, Legislative Decree no. 112 of 31 March 1998 transferred the administrative authority for the energy certification of buildings to the regional governments. Directive 2002/91/EC was transposed into Italian law with Legislative Decree no. 192 of 19 August 2005, recently revised and supplemented by Legislative Decree no. 311 of 29 December 2006.

On 10 July 2009 the Ministry of Economic Development published a decree containing guidelines for the energy certification of buildings. Starting from 25 July 2009, the regions that have not yet drawn up a regional law must follow the national guidelines. At present, only a few regions have established rules for the issue of energy certification. The decree defines the national guidelines for the energy certification of buildings, together with instruments of liaison, concerted effort and cooperation between the national government and regional governments, some of which

On 10 July 2009 the Ministry of Economic Development published a decree containing guidelines for the energy certification of buildings. Starting from 25 July 2009, the regions that have not yet drawn up a regional law must follow the national guidelines.

[72] Source: EEA/ODYSSEE data processed by ISPRA

have already established their own certification procedures, which shall be integrated with the national measure, respecting the distinctive characteristics of each regional law. The measure comes in the wake of Decree no. 59 of 2 April of 2009, issued by the President of the Republic to set the minimum energy requirements for new buildings and for the restructuring of existing ones.

An additional measure is expected to establish the professional profile of energy certifiers authorised to issue certificates.

Since 2006, there has been a noteworthy in Italy in the installed capacity for all renewable energy sources.

Electricity generation from renewable sources, nationwide, accounts for 18.8% of all the electricity generated.

Starting from 2006, a noteworthy increase was observed in the installed capacity for all renewable energy sources. In 2008, the gross efficient operating capacity was equal to 23,859 MW, making for an average annual growth rate of 6%. The increase in the capacity in 2008, compared to the previous year, was 1,552 MW. In 2008 electricity generation from renewable sources stood at around 59.7 TWh out of total electricity generation of 318.2 TWh, meaning that renewable sources account for 18.8% of total electricity generation. The break-down of overall production was characterised by annual fluctuations in the contribution by hydroelectricity, a result of meteorological conditions, as well as the growing contribution of non-traditional sources (wind power, geothermal energy, biomasses and waste). In 2008, hydroelectricity accounted for 69.7% of the electricity generated from renewable sources. In recent years, there has been a noticeable increase in the electricity generated from wind (from 117.8 to 4,861.3 GWh during the period 1997-2008) and from biomasses/waste (from 820.3 to 7,522.5 GWh). Electricity produced from geothermal sources also increased from 3,905.2 to 5,520.3 GWh during the period 1997-2008, though production from this source has remained essentially unchanged over the last three years. The contribution of photovoltaic systems remains negligible (193.0 GWh in 2008), though last year the quantity of electricity generated from that source increased by 395%.

Directive 2001/77/EC set a recommended objective of 22% as the portion of gross domestic consumption of electricity that should be generated from renewable sources (equal to approximately 75 TWh when gross domestic consumption stands at 340 TWh). Though this directive has since been rendered obsolete by

Directive 2009/28/EC, it still represents the only benchmark for assessing the generation of electricity from renewable sources. In calculating the target figure, electricity produced from renewable sources but imported from other European countries must also be considered. Based on the data provided by the GSE, in 2008 gross generation from renewable sources, including imports from abroad, amounted to 24% of the gross domestic consumption of electricity[73].

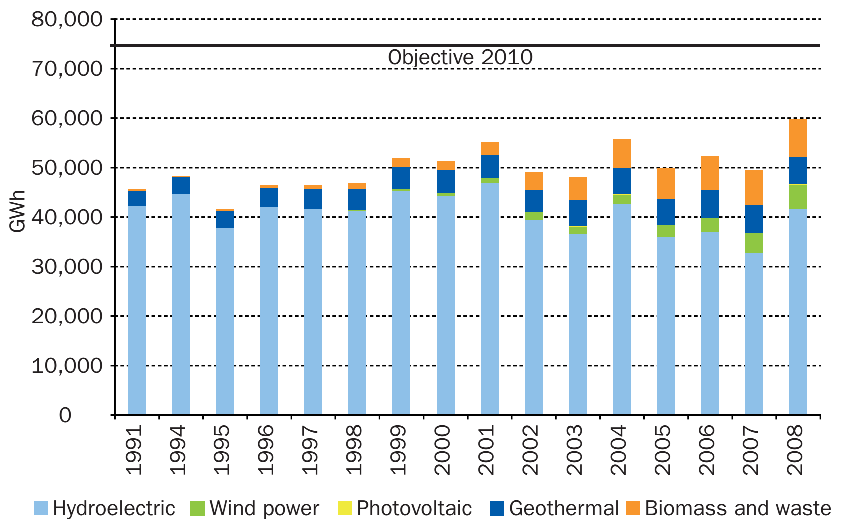


Figure 1.31: Gross domestic electricity generation from renewable sources[74]

On a national scale, electricity generation from renewable sources accounts for 18.8% of all electricity generated. Between '97 and 2008 there was a noticeable increase in the electricity generated from wind (from 117.8 to 4,861.3 GWh), as well as from biomasses/waste (from 820.3 to 7,522.5 GWh), and even, though to a lesser extent, from geothermal sources (from 3,905.2 to 5,520.3 GWh).

Based on the GSE data, imported electricity generated produced from renewable sources accounted for an average of 8% of gross domestic consumption of electricity between 2002 and 2008, while the contribution of electricity produced domestically from renewable sources averaged 14.7%.

[73] GSE, 2009, Statistics on renewable sources in Italy. Year 2008
[74] Source: TERNA S.p.A. data processed by ISPRA

In 2008 gross electricity generation from renewable sources, including electricity imported from abroad but produced from renewable sources, accounted for 24% of gross domestic consumption of electric energy.

Table 1.2: Electricity generated from renewable sources compared to gross domestic electricity consumption in Italy[75]

Year	G.D.C.[(1)]	Gross generation from RES[(2)]		Foreign from RES	Gross generation Renewable + Foreign from RES	
	TWh	TWh	% of G.D.C.	TWh	TWh	% of G.D.C.
2002	327.3	48.3	14.8	24.6	72.9	22.3
2003	337.2	47.1	14.0	26.5	73.6	21.8
2004	341.4	54.1	15.9	34.9	89.0	26.1
2005	346.0	48.6	14.1	9.7	58.3	16.9
2006	352.6	50.8	14.4	35.0	85.8	24.3
2007	354.5	47.9	13.5	38.2	86.1	24.3
2008	353.6	58.2	16.5	26.7*	84.9	24.0

Legend: (1) Gross Domestic Consumption: Gross national production – Pumping production + foreign balance
(2) Renewable Energy Sources
* Provisional figure

Hydroelectricity, concentrated in the regions of the Alpine arc, accounts for almost 69.7% of the electricity generated from renewable sources.

A regional analysis points to noteworthy differences in the energy sources used. Hydroelectricity, found primarily in the regions of the Alpine arc, accounts for 69.7% of the electric energy generated by renewable sources. Geothermal electricity generation, found only in the Tuscany region, represents 9.2% of the electricity produced from renewable sources. Biomasses account for 12.6% of the total, while wind and photovoltaic power registered a share of 8.5% of the electricity produced from renewable sources, though almost all of this last type of production takes place in the southern regions and on the major islands (98.4%). The increase of approximately 1,550 MW in installed power registered between 2007 and 2008 was due primarily to the development of wind power (823 MW) and photovoltaic power (345 MW), followed by biomasses and water power, at respective figures of 218 MW and 164 MW.

[75] Source: GSE data processed by ISPRA

Regionally, noteworthy differences can be observed in the renewable energy sources used. The primary renewable source used to produce electricity is hydroelectricity, concentrated in the Alpine arc, while production from wind and photovoltaic systems takes place in the southern regions and the main islands (98.4%).

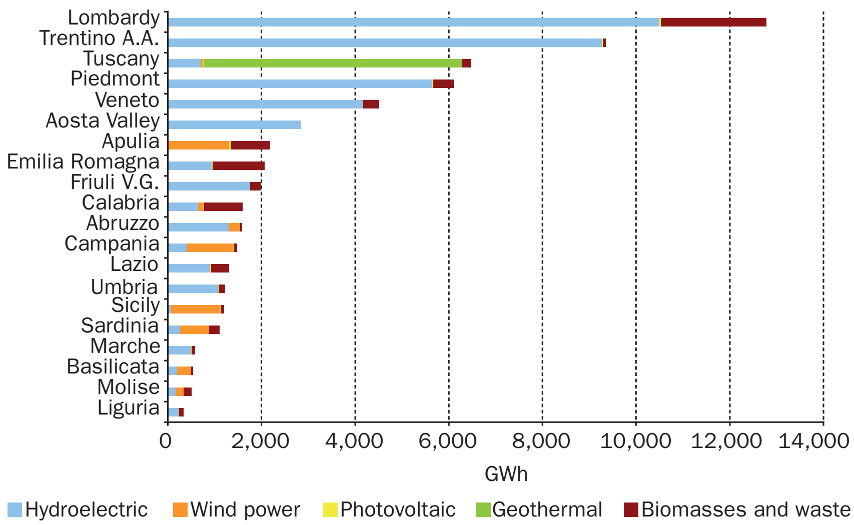


Figure 1.32: Regional analysis of gross electricity generation from renewable energy sources (2008)[76]

Directive 2009/28/EC stipulates what portion of final domestic energy consumption is to be produced from renewable energy sources by each country of the European Union as of 2020; these quotas include not only energy from renewable sources consumed for the production of electricity, but also renewable energy used for heating and transport. The Directive also makes it possible the statistical transfer from one Member State to another of a certain quantity of energy from renewable sources, as well as cooperation between the countries, or with non-EU countries, in the production of energy from renewable sources. The renewable–energy consumption objective assigned to Italy is 17% of final domestic consumption. In 2007, total renewable energy as a percentage of final consumption was equal to 6.9% (Figure 1.33).

Directive 2009/28/EC stipulates what portion of final domestic energy consumption is to produced from renewable energy sources by each country of the European Union as of 2020.

[76] Source: TERNA S.p.A. data processed by ISPRA

The renewable energy consumption objective assigned to Italy (Directive 2009/28/EC) is 17% of gross final consumption. In 2007 overall renewable energy as a percentage of final consumption was equal to 6.9%.

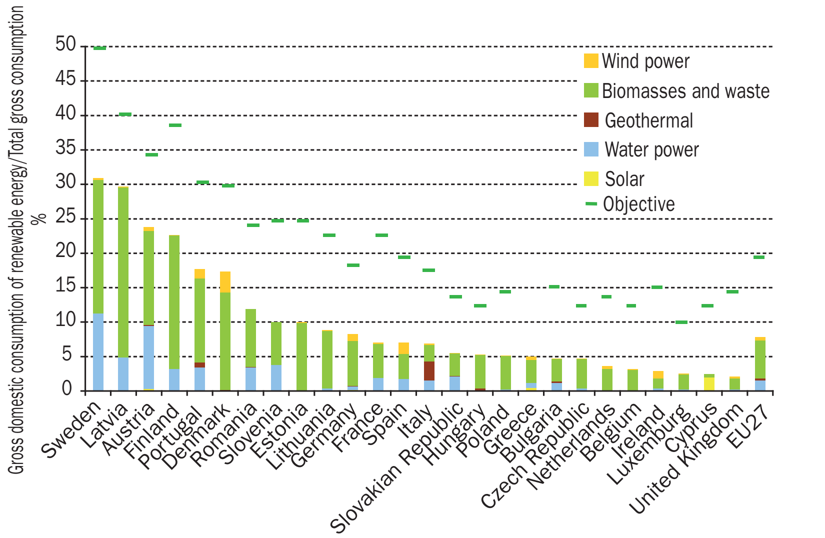


Figure 1.33: Energy consumption from renewable sources as a percentage of final consumption in the European countries (2007)[77]

Looking at the transportation sector, there was a constant increase in fuel consumption between 1990 and 2007 (+25.3% compared to 1990), with the only decrease registered between 2004 and 2005. Consumption levels appear to be characterised by brief periods of stabilisation, followed by resumption of the upward trend. The percentage of fuels with 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 6.1% in 1995. Since 2000, consumption of these fuels has dropped by 13.8%.

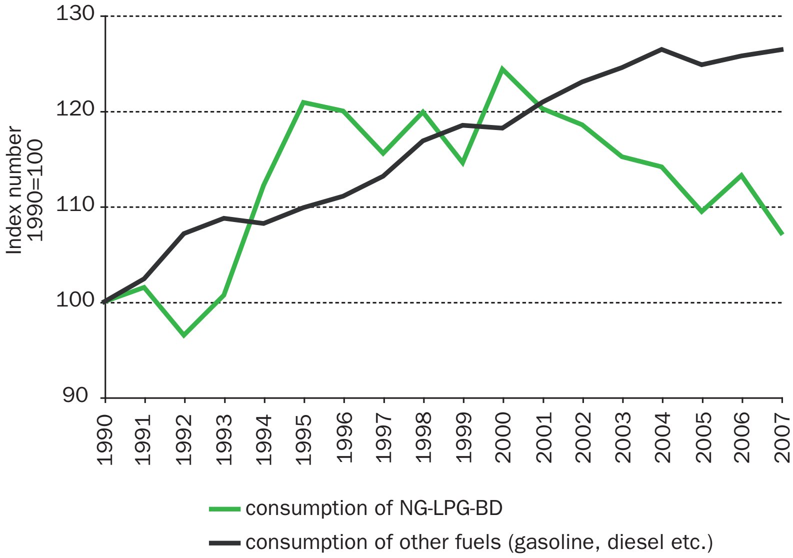
Variations in the percentages of the fuels consumed show that, while the classic fuels (gasoline, diesel fuel etc.) have increased constantly, levels of natural gas, LPG and bio-diesel have clearly been on the decline since 2000, apart from a few sporadic increases. As of 2007, the overall increase in the consumption of low-impact fuels, compared to 1990, was only 7.2%.

Based on the available data, it is clear that the progress made in

[77] Source: EUROSTAT data processed by ISPRA

the transportation sector through the implementation of technological measures involving engine efficiency are offset - and to a greater extent in Italy than in the other European counties, by growth in the demand for transportation, and especially the roadway mode, meaning that the environmental impact of the transportation 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, as demonstrated by the fact that, between 2000 and 2005 there was a constant decrease in the share of total fuels represented by low-impact fuels, followed by only a slight increase between 2005 and 2006.

The effects of technological measures are offset by the growth in the demand for transportation and especially the roadway mode.



Legend:
NG: natural gas;
LPG: liquefied petroleum gas;
BD: biodiesel

Figure 1.34: Consumption of fuels for transportation (1990=100)[78]

The use of low-impact fuels is subject to noteworthy irregularities: between 2000 and 2005 there was a constant decrease in their share of total fuel consumption.

[78] Source: Ministry of Economic Development data processed by ISPRA

In 2007, the LULUCF sector was responsible for the capture of 70.9 Mt di CO_2 eq in Italy. Much of the absorption was due to forests.

In contrast to the increase in emissions of greenhouse gases resulting from various production activities and processes of deforestation, a noteworthy quantity of carbon dioxide has been removed from the atmosphere by the LULUCF sector, for quantities on 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 globally[79]. 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 67.5 million tons of carbon in 1990 and 70.9 million tons of carbon in 2007. However, only the portion removed from managed forests can be include in the accounting for the Kyoto Protocol, as stipulated under articles 3.3 (forestation, reforestation and deforestation) and 3.4 (forest management[80]).

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[79] IPCC, 2000, *Land-use, Land-use change and forestry*, IPCC *Special Report*
[80] 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

CHAPTER 2

BIODIVERSITY AND NATURAL, AGRICULTURAL AND FOREST AREAS

Biodiversity is the richness of life on the Earth and a source of goods, resources and services indispensable to the survival of man.

Introduction

Biodiversity can be defined as the richness of life on the Earth: the millions of plants, animals and micro-organisms, the genes that they contain and the complex ecosystems of which they are the component parts in the biosphere. The *Convention on Biological Diversity* (CBD), whose provisions were set during the world summit held in Rio de Janeiro in 1992, defines biodiversity as the variety and variability of living organisms and of the ecological systems in which they live, stressing that the diversity in question involves genes, individuals and ecosystems as a whole.

Biodiversity consists not only of the range of different forms and structures of living beings, but also of their diversity in terms of abundance, distribution and interactions among the different components of biodiversity itself. Biodiversity also includes variety in human culture, though this is another area subject to the same negative repercussions that affect, as we shall see, the biodiversity of the gene pool, of species and of the ecosystem as a whole.

Biodiversity, apart from its intrinsic value, is a source of goods, resources and services (ecosystems services) that are indispensable to man's survival. These services (classified by specialists under the categories of *provisioning*, *regulating*, *cultural* and *supporting*) provide both direct and indirect benefits to all the planet's human, animal and plant communities, in addition to playing a key role in constructing the economies of the world's nations.

For example, plant biodiversity, in the form of both cultivated and wild plants, provides the underpinnings of agriculture, making possible the production of food while contributing to the health and nourishment of the global population. In the past, genetic resources have been used to improve species of cultivated plants and bred animals , and they shall continue to serve this function in the future. Genetic variety can also be drawn on to respond to ongoing developments on markets for agricultural products and to adapt to climate change and changing environmental conditions.

The priority objectives of the CBD are the preservation of biodiversity and the sustainable and durable use of its components, in addition to a just and equitable distribution of the benefits it provides. In 2003, on the occasion of the sixth session of the Conference of the Parties to the CBD, 123 nations committed

themselves to reduce significantly loss in biodiversity at local, national and regional level by 2010. Unfortunately, as even the international conservation agencies admit, there is no hope of achieving this objective. The decline of biodiversity moves forward with unprecedented speed: species are becoming extinct at a rate 100 greater than that registered in the pre-human era.

Italy is considered one of the planet's key "hot spots" of biodiversity.

The variety of bio-geographic, geo-morphological and climatic conditions that characterise continental Europe and the Mediterranean basin make Italy a nation with an extraordinary concentration of species, habitats and areas with bountiful natural resources. Major centres of biodiversity have been identified in Italy, such as the Tyrrhenian islands and the Maritime and Ligurian Alps, to say nothing of the high rate of endemic species that characterises many areas, such as, to name just one, the Apennine chain. On the global level, Italy is considered one of the "hot spots" of biodiversity[1], being recognised as a priority eco region[2].

Many critical problems pose either indirect or direct threats to Italy's national heritage.

This massive natural heritage is threatened by a series of critical problems traceable to the general course of economic development, both global and national, such as the destruction and fragmentation of habitats due to urban development and agricultural practices, the deterioration of habitats on account of unsustainable management, plus the serious threat to diversity posed by the introduction of alien species and the unsustainable use of resources and species, as well as the effects of climate change. In addition to these general critical threats, there are other factors that place more direct pressure on natural systems, such as water, air and soil pollution, the increasing transformation of watersheds into artificial systems, the intensification of the grid of infrastructures, the spread of genetically modified organisms whose effects on natural dynamics are not always clearly identified and the growing presence of natural risks.

National and international instruments, both indirect and direct, are meant to fight the loss of biodiversity.

The loss of biodiversity is countered, on the national and international levels, through the use of both indirect and direct instruments. The first category includes all the initiatives taken to reduce the sources of pressure, such as controls on the levels of emissions of polluting substances and defence of the quality of waters. The second category consists of direct efforts to preserve species and ecosys-

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[1] *http://www.biodiversityhotspots.org/xp/Hotspots/hotspotsScience*
[2] *http://www.worldwildlife.org/science/ecoregions/ecoregion-conservation.htlm*

tems. A noteworthy regulatory framework supports policies of conservation, making it possible both to take increasingly effective measures at the various levels of territorial jurisdiction and to establish forms of coordination between increasingly focussed and effective initiatives involving safeguards, territorial planning and general programming. Still, the regulatory sphere needs further reinforcement, in particular through increased and more widespread application of controls, higher levels of funding and adjustment of the regulations to address newly emerging problems, such as the spread of alien species and global climate change.
Starting from the information provided by the indicators found in the ISPRA Yearbook of Environmental Data, this chapter provides an overview of biodiversity in Italy, briefly outlining the state of the country's natural environments, the most important threats to biodiversity and, finally, the primary actions of defence undertaken.

The state of the natural and semi-natural environments

Italy is one of Europe's richest countries in terms of biodiversity, possessing half of the European plant species and a third of the animal species.

Italy is one of Europe's richest countries in terms of biodiversity, essentially on account of its favourable geographic position, as well as its extensive geo-morphological, microclimatic and vegetative variety, plus the additional influence of factors of history and culture. Italy possesses roughly half of all the plant species found in European territory, and it is the leading nation on the continent for number of species in absolute terms; as for animal species, Italy holds approximately a third of those currently found in Europe: certain groups, including a number of families of Invertebrates, are present at two or three times the concentration, if not higher, than in other European countries. All the above reflects what is known as the "latitude gradient" of richness of species, or the fact that diversity falls as latitude rises.

Italy has the highest number of animal species in Europe (more than 58,000), with a high incidence of endemic species, including more than 9% of the terrestrial fauna.

Based on the studies carried out to date, as well as the recent *European Fauna,* Italy has the highest number of animal species in Europe, with a noteworthy incidence of endemic species. Italian fauna are estimated to include more than 58,000 species, of which approximately 55,000 are Invertebrate species and 1,812 are species of Protozoa. Taken together, these categories account for roughly 98% of the total number of species, in addition to which there are 1,258 Vertebrate species (2%). The most abundant

phylum is that of the Arthropods, with more than 46,000 species, of which approximately 65% belong to the Insect class[3].
Approximately 42,000 species of terrestrial fauna have been identified to date in Italy, of which over 9% are of particular importance, being endemic species. The number of species found in freshwater habitats (not including Protozoa) is estimated at 5,500, meaning approximately 10% of all Italian fauna. The checklist of Italy's marine fauna holds more than 9,000 species, and, given the country's geographic position, these probably account for the majority of the species in the Mediterranean.
Italian bryological flora, including Mosses and Hepaticae, are among the most abundant in Europe, consisting of 1,130 species, of which 851 are Mosses and 279 are Hepaticae[4]. It should also be remembered that knowledge of the number of these groups is continuously being updated, thanks to further exploration of little known areas of the national territory, together with the ongoing development of techniques of genetic research. Italy can also be counted among the European countries presenting the largest variety of Lichens, with 2,323 *taxa* recorded[5].

Italy's bryological and lichen flora are among the most abundant in Europe.

Italy's vascular flora consist of 6,711 species, breaking down into 144 species of Pteridophytes, 39 Gymnosperms and 6,528 Angiosperms[6], with endemic species accounting for 15.6% of the total. The greatest number of flora is found in the regions with the most extensive environmental variations and the largest territories, such as Piedmont (3,304 species), Tuscany (3,249), Veneto (3,111), Friuli Venezia Giulia (3,094), Lazio (3,041) and Abruzzo (2,989). Looking at the flora species that are most rare, and found in small areas, the regions that possess the greatest number of endemic species and exclusive species, meaning those

Of Italy's more than 6,700 species of vascular plants, 15.6% are endemic species.

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[3] Source: *GIS NATURA II GIS delle conoscenze naturalistiche in Italia*, Ministry of Environment and Defence of the Land, Department for the Protection of Nature, Milan Polytechnic, 2005; *Stato della Biodiversità in Italia*, Blasi *et al.*, 2005
[4] *Check-list and red-list of liverworts (Marchantiophyta) and hornworts (Anthocerotophyta) of Italy,* Aleffi & Schumacker, 1995; *Check-list of the Mosses of Italy,* Cortini Pedrotti, 1992; *New Check-list of the Mosses of Italy,* Cortini Pedrotti, 2001
[5] *ITALIC, the information system on Italian lichens*, Nimis & Martellos, 2002; *Licheni*, Nimis & Martellos, 2005, in: *Stato della biodiversità in Italia. Contributo alla strategia nazionale per la biodiversità*, Blasi *et al.*, 2005
[6] *An annotated checklist of the Italian vascular flora*, Conti *et al.*, 2005

found in that region alone, are Sicily (322 endemic species and 344 exclusive ones) and Sardinia (256 endemic species and 277 exclusive ones).

The national forest area index is 22,8%, and it is constantly growing.

Italy also possesses an especially rich stock of forests, whose quantity, depending on the type of specifications adopted for the statistics, can be estimated at approximately 6,860,000 hectares[7] and 8,760,000 hectares[8], in addition to which there are 1,710,000 hectares of sparse or low forest formations, as well as bushes and shrubs (CFS-INFC, 2005). Taking the most restrictive approach, the national forest area index is equal to 22.8%, a figure that is increasing in a gradual but constant manner (Figure 2.1). The CFS-INFC also reports that a significant portion of the new forests is recently planted and in the growing phase. These last results, together with the dynamics in the change of the cover and land use, as shown by a comparison of the *Corine Land Cover 1990* and the *Corine Land Cover 2000* (the two European projects for surveying and monitoring the characteristics of cover and land use), point to an expansion of national forest resources estimated at approximately 5,500 hectares per year[9]. From the time there have been precise statistics on the land uses in our country, this is the largest recorded extension of forest area. The trend, which involves not only Italy, but the rest of Europe as well, has been underway for a number of decades and is destined to continue in the future. It is caused not only by policies and measures for the preservation of existing resources, combined with forestation and reforestation activities, but also, and to an even greater extent, by natural forest expansion in abandoned farming areas found in hilly and mountainous zones.

[7] ISTAT data 2006 processed by ISPRA
[8] *CFS-INFC, 2005*
[9] *La realizzazione in Italia del progetto europeo Corine Land Cover*, APAT, 2005

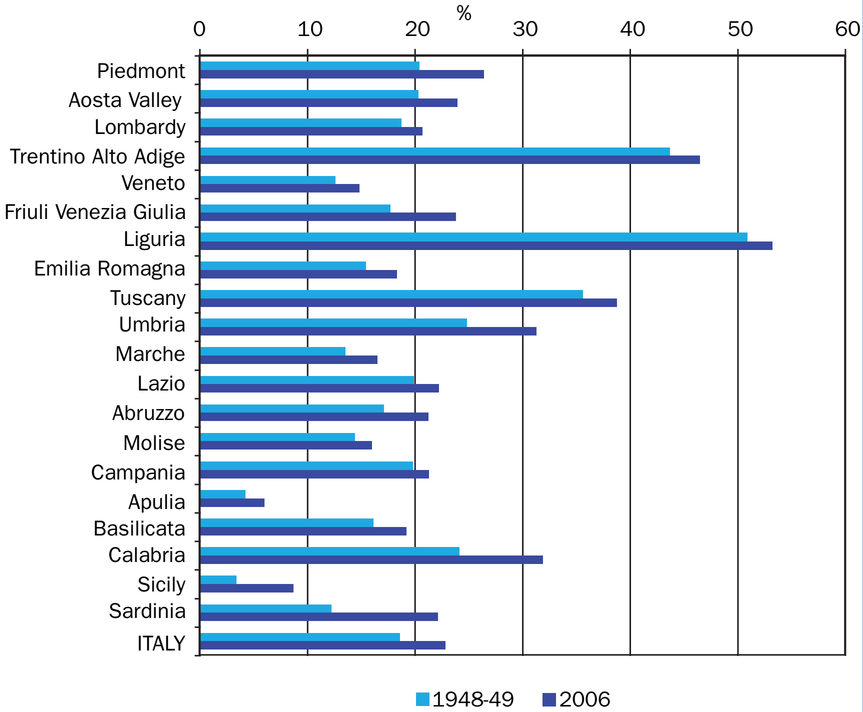

Figure 2.1: Regional forest area index[10]

Italy has an especially rich stock of forests, and its forest area index is constantly on the rise, thanks to activities of forestation and reforestation, plus the natural expansion of forests.

In addition to natural and semi-natural environments in the strict sense of the terms, Italy also possesses urban green areas that constitutes an important component of its natural assets, in light of the increasing expansion of urban areas. Green areas within cities serve a variety of functions: in addition to improving appearances and setting the stage for recreational activities, they also mitigate pollution in the different environmental matrices (air, water, soil), in addition to improving the micro-climate and contributing to the preservation and enrichment of biodiversity. But despite the importance of urban green areas, there is still a shortage of data, both on account of a lack of shared data-banks and due to the failure to arrive at a universally accepted definition of "urban green areas". In cities that are provincial seats, the quantity of urban greenery managed (directly or indirectly) by government entities (municipalities, provinces, regions, the central govern-

The quantity of urban greenery in provincial seats followed a positive trend between 2000 and 2008, in terms of both density and per capita availability.

[10] Source: ISTAT data processed by ISPRA

The percentage of Vertebrate species at risk fluctuates, depending on the author consulted, from 47.5 % to 68.4%.

Of the threatened species, a third of the fish, a sixth of the Reptiles and no less than 66% of the Amphibian species are endemic.

ment) showed a positive trend between 2000 and 2008, in terms of both density (percentage of the total municipal surface area) and per capita availability (ISTAT, 2008). The average density of urban greenery in these cities went from 7,8% in 2000 to 8.3% in 2008, while the average per capita availability went from 88.40 square metres per inhabitant in 2000 to 93.60 square metres per inhabitant in 2008.
The wealth of biodiversity illustrated up to this point, however, is seriously threatened and risks being lost forever. The outlook in terms of threats to animal species within the national territory has been illustrated by a number of different authors in specific Red Lists, especially with regard to autochthonous Vertebrate species. In evaluating the different categories and levels of threats, the authors make reference to the IUCN categories[11]. An analysis shows that the percentage of Vertebrate species at risk fluctuates, depending on which author is consulted, from 47.5 % to 68.4%[12] (Figure 2.2). In the specific cases of Cyclostomes and Fishes in inland waters, more than 40% of the threatened species were found to be in an especially critical condition (the IUCN categories of CR – *critically endangered* and EN – *endangered*), while, with regard to Birds and Mammals, respective percentages of 23% and 15% of the threatened species were in serious danger of extinction. A further analysis, carried out on endemic and sub-endemic species, confirmed the overview just formulated. A third of the threatened Fishes species, and a sixth of the Reptiles species at risk, are endemic. But the most critical situation is that of the Amphibians, which show the highest percentage of all for endemic species in danger, at more than 66%. As of today, for obvious reasons, there exists no similar evaluation for the levels of threat faced by Invertebrates. Nevertheless, considering the elevated number of species, plus the fact that the percentage of endemic species is higher than in the case of Vertebrates, being equal to more than 10% of the total, as well as the elevated niche specialisation and the limited areas of distribution of many species, it can reasonably be assumed that, when faced with the same conditions as the Vertebrates, in terms of threats,

[11] *The World Conservation Union*, 1994
[12] *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

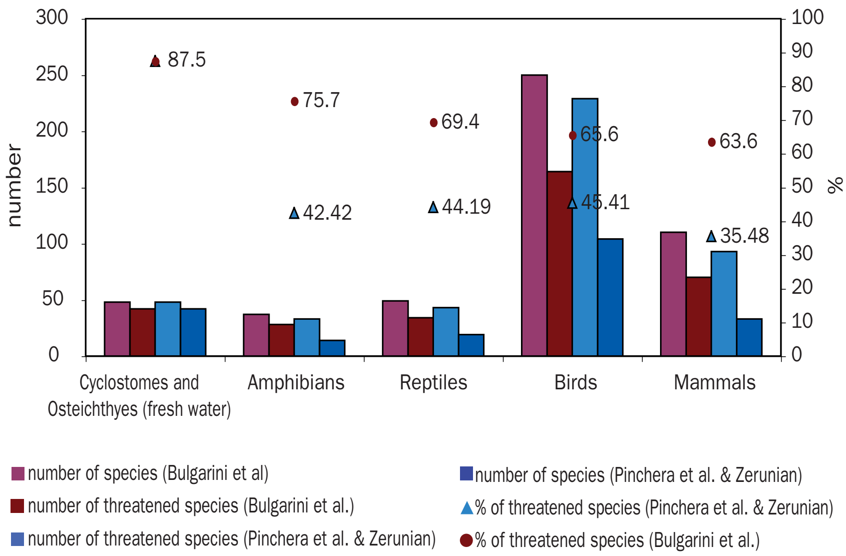

Figure 2.2: Vertebrate species found in Italy and placed on Red Lists[13]

The percentage of Vertebrate species at risk fluctuates, depending on the author consulted, from 47.5 % to 68.4%. The situation is especially critical for freshwater Fishes, Amphibians and Reptiles.

the level of danger for the Invertebrates, and thus the threat of extinction, will prove decidedly higher. The statistics on the threat faced by plant species in Italy are also taken from Red Lists published by specialists. In 1992 the number held to be in risk of extinction was 458[14], a figure that rose to 1,011 in 1997, with publication of the Regional Red Lists on Plants in Italy[15], to which the IUCN categories of threat (version 2.3) were applied. This list was subsequently revised and combined with the Atlas of Species at Risk of Extinction[16], resulting in the identification of 1,020 specie, whose precise distribution is also indicated. At present, therefore, 15.2% of Italy's vascular flora are threatened with extinction, a situation that proves even more acute for lower plants, approximately 40% of which, out of all the known species, were found to be in danger (Figure 2.3).

15% of the higher plants are at risk and 40% of the lower plants.

[13] Source: ISPRA processing of data taken 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

[14] *Libro Rosso delle Piante d'Italia*, Conti *et al.*, 1992

[15] Conti *et al.*, 1997

[16] Scoppola & Spampinato, 2005

15% of the vascular flora in Italy are threatened with extinction, while the situation is even more critical for the lower plants, with approximately 40% of all known species found to be in danger.
In detail, the Italian plants at risk include 772 species of Hepaticae, Mosses and Lichens, plus 1,020 vascular plants.

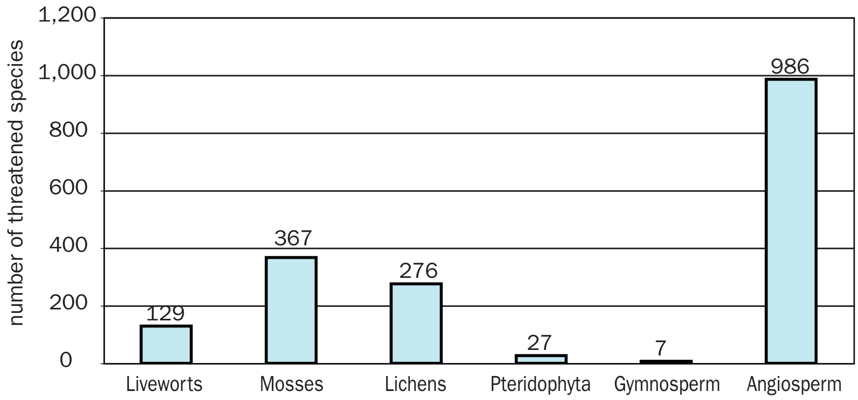

Figure 2.3: Threatened plant species in Italy, distributed by system groups[17]

Current knowledge of Italian vegetal units at risk is far from complete, and so the state of preservation of the *taxa* of Italian flora should be evaluated according to the most recent criteria, published by the IUCN in 2001, in order to draw up a New Red List for Italy. To this end, the Italian Botanical Society undertook the "Italian Initiative for the Implementation of the IUCN Categories and Criteria (2001) for Formulation of new Red Lists" in 2006. In 2008 the experts involved in this initiative published the initial results of application of the IUCN criteria to 40 target species of Italian flora[18]. The experts' assessment work continues, as new reports are currently being prepared for publication on other Italian plant species at risk.

Based on the Habitat Directive, over 50% of the European habitats to be protected are found in Italy.

Closely connected with the state of preservation of the different species is the state of preservation of habitats. As we shall see further on, in applying the "Habitat Directive" (92/43/EEC), which constitutes one of the most important regulatory instruments for preserving habitats and biodiversity, Italy plays a role of noteworthy importance. In fact, the country's geographic characteristics place

[17] Source: *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
[18] *Informatore Botanico Italiano*, vol. 40, suppl. 1, 2008

it within three different bio-geographic zones (Alpine, Continental and Mediterranean), while, according to the directive, over 50% of the habitats to be protected are found in Italy.

Our country holds 130 of the habitats in annex I to the Habitat Directive, as well as a total of 455 of the species founds in annexes II, IV and V[19]. In Italy there are 212 animal species, including 7 species of cetaceans and sea turtles, whose presence in our seas is held to be occasional, plus 113 plant species, when the species of 3 different genera of lower plants are considered in a joint evaluation.

Of the habitats listed in annex I to the Habitat Directive, no fewer than 24, of which 13 are given top priority, are found only in Italy within their bio-geographic region of reference[20]. Nevertheless, the "Italian Manual for Interpretation of Directive 92/43/EEC", recently published by the Ministry of Environment, Land and Sea, together with the Italian Botanical Society, points to the need to update the directive annexes to include 15 new habitats found in our country and worthy of being listed, in addition to reviewing the "priority" status attributed to certain habitats. As a rule, the habitats at risk in Italy are uniformly distributed throughout the national territory, with this being true for the quantities of the different types of habitats as well[21]. Worthy of separate mention are the 9 marine habitats protected under the directive, of which only the Prairie of Posidonia is a marine habitat in the strict sense of the term. Regarding the latter, it should be noted that the European Commission does not hold the network of sites proposed to date by Italy for the Nature Network 2000 to be complete.[22]

24 habitats listed in the Habitat Directive as requiring protection, off which 13 are given top priority, are found only in Italy within their bio-geographic region of reference.

The state of conservation within Italian territory of the habitats and species of Community interest included in the annexes of the Directive was illustrated in the 2nd National Report, which Italy drew up and sent to the European Commission in 2007, in accordance with the provisions of art. 17 the same Directive. This Report,

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[19] *Attuazione della Direttiva Habitat e stato di conservazione di habitat e specie in Italia.* Ministry of Environment, Land and Sea, 2008

[20] *Reference list of habitat type, EU Commission and EEA*, 2009

[21] *Libro rosso degli Habitat d'Italia. Petrella S. et al., 2005, WWF Italia Onlus Roma*

[22] *Ruling of the Commission approving the list of SCI for the Mediterranean region*, 2006

The Italian habitats in the worse state of conservation are those of the dunes, followed by freshwater and rocky habitats.

covering the period 2001-2006, provides a benchmark for comparisons with the results to be presented by subsequent national reports, which, as stipulated under art. 17, are to be drawn up every six years. The current results show that the habitats in the worst state of conservation are those consisting of dunes, followed by freshwater and rocky habitats. It was also found that the available data are not sufficient for forecasting the future prospects of much of the habitats, meaning that their fate will depend, in large part, on the management strategies followed, inside and outside the Nature 2000 Network.

In addition to natural environments, agricultural areas also play an important role when it comes to biodiversity and other environmental factors. Not only do they support the production of food and fibres, but they are closely tied to the environment, giving rise to extremely complex relations, at times in contradiction the one with the other. In demonstration of the importance of agriculture with regard to natural resources, it should be remembered that roughly 42% of the national territory is earmarked for agriculture (ISTAT, 2007), and that a portion of this area, the equivalent of approximately 21% of the UAA (Utilised Agricultural Area), presents characteristics of noteworthy naturalistic value in terms of genetic and species biodiversity, as well as that of the landscape, also serving as zones of connection with natural spaces. Italy, together with Spain, Greece, northern Great Britain and Scandinavia, preserves an elevated percentage of agricultural areas of significant natural worth, such as Alpine meadows and pastures.

Roughly 42% of the national territory is devoted to agricultural activity, and approximately 21% of the UAA (Utilised Agricultural Area) presents characteristics of noteworthy naturalistic value.

The decrease in UAA frequently corresponds to an operational abandonment of agricultural soil, following which processes of vegetative renewal are possible, though also processes of soil deterioration, erosion and desertification.

In recent decades, running parallel to the stagnation in demographic growth and in the demand for agricultural products, as well as to the exodus from rural areas and the rise in productivity per unit of surface area, Italy has registered a noteworthy decrease in the number of farming enterprises and in the UAA. This last measure fell by 2.3 million hectares between 1990 and 2007, meaning a loss of more than 15% (ISTAT). It is important to note, however, that this decrease has been accompanied by a gradual rise in the UAA of the average enterprise, which went from 6.1 hectares in 2000 to a figure of 7.6 hectares in 2007, making for an increase of 25.1%. The reduction in the overall UAA frequently corresponds to an operational abandonment of farmlands, which can then undergo

processes of renewed colonisation on the part of tree, bush and herbal vegetation (re-vegetation), though they can also be subject to processes of soil deterioration, erosion and desertification. The process of vegetative renewal can be sharply limited by a loss of natural qualities caused by agricultural activities, with the extent of the loss depending on the characteristics of the agricultural activities and their duration. The fertility of the soil in abandoned farmland always proves to be impoverished, while the composition of the original seed bank of the soil is totally compromised. These factors, together with the situations of deterioration and fragmentation typical of the agricultural areas of industrialised countries, block or slow the natural dynamics of vegetative succession.

In Italy, as in many other countries of the Western world, the process of agricultural specialisation and intensification underway between the 1950's and the early nineties, together with the globalisation of the agricultural economy, have resulted in a serious loss in biodiversity. At present, almost half of the 12.7 million hectares of UAA are dominated by only five crops: wheat, corn, rice, olives and grapes. And even these crops are subject to a worrisome level of genetic erosion.

At the same time, it should be noted that the set-aside policies promoted under the 1992 reform of Common Agricultural Policy, calling for subsidies to be paid to farmers to put to rest 10% of the cultivated surface area, has facilitated the restoration of habitats that had almost disappeared, such as wetlands, meadow areas alternating with shrubs and flooded meadows, with the result that meadows and pastureland (currently 27.1% of the UAA), together with fallow land and other crops (currently 4.1% of the UAA), have registered growth over the last ten years.

Confirming the loss of agricultural biodiversity is a study carried out by *BirdLife International*, *European Bird Census Council* and the *Royal Society for the Protection of Birds*, showing that, of the 124 species of birds most widespread in Europe, 54 have decreased over the last 40 years. Of these species, no fewer than 33 are typical of agricultural environments, and their numbers have been nearly halved in 25 years' time. The decrease in agricultural species is even more pronounced in Italy, specifically affecting the Swallows, Martins, Warblers, Stonechats, Larks, Shrikes, the White Wagtail, the Italian Sparrow and the Tree Sparrow.

The specialisation and intensification of agriculture, as well as the globalisation of the agricultural economy, have resulted in a serious loss in biodiversity, even though set-aside policies have facilitated the restoration of habitats that had almost disappeared, such as wetlands, meadow areas alternating with shrubs and flooded meadows.

In recent decades, there has been a noteworthy decrease in ornithological species tied to agricultural environments.

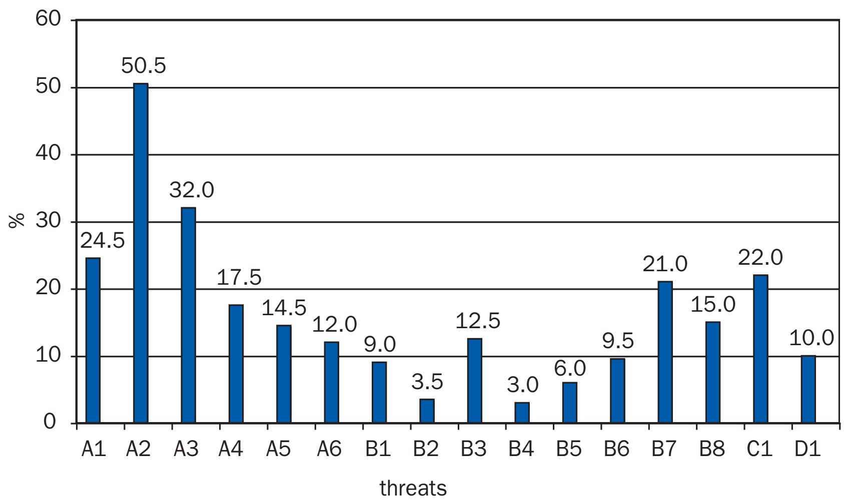
The primary threats to biodiversity are human activities and the growing demand for natural resources and ecosystem services.

The transformation and modification of habitats threatens 50.5% of the Vertebrate animal species.

The main causes of threats to biodiversity

The main threats to the natural heritage are tied to the impact of human activities and to the growing demand for natural resources and ecosystem services, which proves increasingly incompatible with the preservation of those resources and services in a state able to guarantee their survival and transmission to future generations. In Western and Central Europe, and throughout the Mediterranean basin, the presence of man from ancient times has led to alterations in the natural ecosystems and habitats, which today, in the majority of cases, appear fragmented and subject to various types of disturbances. Five main causes for the loss of biodiversity are particularly worthy of note[23]: the deterioration and destruction of habitats, fragmentation, the introduction of alien species and the excessive exploitation of resources and species. This last factor is traceable, first and foremost, to a lack of adequate regulation for governing, according to ecological criteria, the procurement of supplies of resources, plus, as a secondary consideration, the collection and sale of wild species. These threats lead to a reduction in biodiversity, as a result of the deterioration and impoverishment of ecosystems, together with the local extinction of many species, primarily the most sensitive, the endemic species, the rare ones and those that prove most vulnerable. At times there is a turnover involving different types of species, with the often irreversible disappearance of many species typical of a natural habitat being accompanied by the entry of species that are exotic, competitive, generalist, ruderal or connected to human phenomena. With respect to Vertebrate animal species, Figure 2.4 shows the overall outlook for the various factors of risk and their relative incidence on the state of preservation, determined on the basis of the Red Lists published to date on the different categories of threats by the IUCN. Generally speaking, the analysis shows that the most frequent threat (50.5% of the species at risk) of all the indirect influences of human origin consists of the transformation and modification of natural habitats (A2), while poaching and illegal fishing (B7) constitute the predominant threat among direct influences of human origin.[24]

[23] *Conservazione della natura*, Primack & Carotenuto, 2007
[24] *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



Legend:
Indirect influences of human origin:
A1: Reclamation of wetlands
A2: Modifications and transformations of habitats (construction, buildings, roads, ports, lining of riverbanks with concrete, variations in climate tied to influences of human origin, barriers blocking water ways, intakes of water supplies, modifications of flow)
A3: Use of pesticides and water pollution
A4: Fires and cutting of forests
A5: Changes in farming, livestock and fishing activities
A6: Leisure time activities (tourism, bathing, excursions, nautical sports, sport fishing, photographic hunting, mountaineering or free climbing)
Direct influences of human origin:
B1: Hunting
B2: Suppression of pests
B3: Harvesting of eggs, chicks, larva and adults for the purpose of sale or collection
B4: Vandalism
B5: Genetic pollution
B6: Excessive fishing
B7: Poaching and illegal fishing
B8: Competition or predatory behaviour on the part of outside species and/or populations
C1: Natural causes
D1: Unknown causes
The figure refers only to threatened species for which confirmed chorological information is available.
It should be noted that the categories of threats indicated in the reference source were later modified by the IUCN, and so do not correspond to those currently in use (ver. 3.0).

Figure 2.4: Incidence of the risk factors for Vertebrates out of the total species threatened[25]

In Italy the primary threats to biodiversity are human activities and the growing demand for natural resources. Of all the indirect threats of human origin, the most frequent involve the transformation or modification of natural habitats, while poaching and illegal fishing constitute the primary threats among the direct influences of human origin.

Though difficult to quantity, poaching represents a very serious threat to Birds and Mammals in Italy. In many regions the illegal capture of wild animals with traps, snares and jaw traps is still widespread, as is the killing of animals with poison and firearms. These practices are especially common in certain critical areas, such as the Brescia and Bergamo valleys, the Tyrrhenian Islands and the Strait of Messina[26].

[25] Source: ISPRA processing of data taken 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
[26] *Bracconaggio e trappolaggio. Todaro G., 2006, Perdisa Ed., Bologna*

Worth mentioning among the causes of impact are those tied to hunting, which can be practiced in more than 62% of the national territory, though hunting pressure differs from one region to the next.

Moving on to a more detailed analysis of the causes of impact, mention can be made of those tied to hunting, an activity that, it should be noted, can be practiced in more than 62% of the national territory (ISTAT, 2007). Pressure from hunting is not uniformly distributed throughout the country: in certain regions, such as Liguria, Umbria, Tuscany and Lazio, the level is definitely higher than in others. The greatest levels of pressure are to be found both in large-size regions (Tuscany, Lazio, Lombardy, Campania) and in those of limited extension (Umbria and Liguria). Assuming that the number of hunters constitutes the primary factor of hunting pressure within a given territory, a decrease in this pressure was observed between 2000 and 2007, due to a drop of 6.2 percent in the number of hunters on the national level. Looking at the different regions, no fewer than eleven showed percentage reductions in the number of hunters higher than the decrease for Italy as a whole. Only five regions (Trentino Alto Adige, Lazio, Calabria, Sardinia and Molise) showed increased numbers of hunters.

Fishing is an important factor of impact in marine environments. Italy accounts for approximately 5% of the total European catch, but, as do the other countries of the Union, it takes part in efforts pursued by the EU for some time now to limit fishing.

As far as fishing is concerned, it has a major impact on the marine environment. Italy accounts for approximately 5% of the total European catch, though, together with the other countries of the Union, it takes part in the efforts to limit the impact of fishing pursued for some time now by the EU and forcefully confirmed in the new Common Fisheries Policy (CFP), which went into effect on 1 January 2003. The year 2008 registered a continuation of the trend begun in 2000, with the size of the fishing fleet falling in terms of both ships and overall engine power, while the figure for the total tonnage of the national fleet, which had reversed its downward trend in 2007, increasing by 20% over 2006, once again showed a decrease, though a slight one, in 2008. The primary fishing indexes (fishing effort and CPUE - *Catch Per Unit of Effort*) moved in the same direction, as both figures, though their results had differed in previous years, showed decreases in 2008[27].

As a rule, the Italian fishing fleet consists of modest and medium-size vessels, with non-industrial-scale fishing in many regions accounting for 80% of the entire fleet (Ministry of Agricultural, Food and Forestry Policies-IREPA, 2008). Naturally, the situation varies throughout the national territory: in 2008 more than 55% of the vessels

[27] Ministry of Agricultural, Food and Forestry Policies-IREPA, 2008

of the national fishing fleet were registered in Sicily (24%), Apulia (13%), Sardinia (9%) and Campania (9%), while the highest figures for average days of fishing were recorded in Apulia, Campania, Marche and Molise. The most frequently used fishing systems are bottom and mid-water trawling, together with small-scale coastal fishing, confirming the general tendency of the Mediterranean to favour non-industrial modes of fishing. In the case of small-scale coastal fishing, it is common for different systems to be used in different periods of the year. In 2008, 37.3% of the total catch in Italy was made by trawling, with the boats of Sicily and Apulia responsible for 44% of the overall figure[28]. Even though the vessels are generally small in size, and fishing activities have been successfully limited in recent years, more than 50% of the vessels still operate exclusively along the coast (MIPAAF, 2008), subjecting this zone, in which a large part of the resources of the entire marine system are located, to greater pressure.

The biodiversity of forest ecosystems is also subject to a variety of threats, though, as noted earlier, the trend in total forest surface area in Italy has been positive for a number of years now. This increase largely reflects decisions made in other economic sectors rather than being the result of deliberate forestry or environmental defence policies, as demonstrated by the growing wooded area is increasingly subject to abandonment and the accompanying deterioration, first and foremost in the form of fire. An especially critical period for forest fires was recorded in the mid 80's, followed by years in which the level remained high, on the whole, with a gradual falling off up to 2006, then a sharp rise in 2007, followed by another lessening of the level in the year 2008, during which slightly less than 6,500 events occurred, involving approximately 66,000 hectares, of which 30,000 can be classified as forest area in the strict sense of the term (CFS, 2008).

The expansion of Italy's forest area is accompanied by a rise in the volume of roundwood and large branches (the latter figure, equal to 1.269 billion cubic metres, for an average of 145 cubic metres per hectare), making for a current total increase in forests of roughly 36 million cubic metres (4.1 cubic metres per hectare)[29].

The biodiversity of forest ecosystems is also subject to a variety of threats, despite the positive trend.

After a sharp revival in the number of forest fires in 2007, the level dropped once again in 2008.

The increase in wood volume is limited by the harvesting of supplies, fires, plant disease and mortality.

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[28] Source: Ministry of Agricultural, Food and Forestry Policies-IREPA data processed by ISPRA

[29] CFS-INFC, 2005

Use of forests appears extremely limited, following a downward trend since 2005, especially as regards firewood.

The rate of harvesting gradually fell between 1999 and 2002, registering constant annual values in the years that followed.

Harvesting of a number of non-wood products decreased in 2007, as compared to 2000, though with certain exceptions.

This last statistic is limited by the harvesting of wood supplies, by fires, by plant disease and by mortality.
Wood harvesting, as registered by ISTAT (though numerous independent studies hold the figure to be significantly underestimated), appears very limited, and on the decrease since 2005, especially in terms of the harvesting of firewood. This last activity fell from 5.2 million cubic metres in 2005 to 5.0 million cubic metres in 2007. Total supplies harvested in 2007 were equal to 8.5 million cubic metres (7.5 million cubic metres, not counting wood outside of forests), of which 66.8% was firewood. In recent years, the trend in the harvesting of wood has been downward, accompanied by a noteworthy reduction in the average surface area cut.
In terms of the harvesting rate (the ratio between the cubic metres harvested and the forest area), it fell gradually between 1999 (the year when it reached the level of 1.3 cubic metres per hectare) and 2002 (0.8 cubic metres per hectare), after which a constant annual figure of 0.9 m^3/ha was registered in the years that followed. This decrease was especially pronounced for firewood (-40% compared to 2000), which still constitutes more than 60% of overall wood production.
A decrease in the harvesting of some non-wood products was registered in 2007 as compared to 2000 (ISTAT, 2008), with the noteworthy exceptions of mushrooms and pine seeds with shells, while the year 2005 also registered a significant truffle harvest. In all likelihood the downward trends were tied to processes of urban development, with the resulting difficulty of recruiting labour, not to mention the loss of local traditions, while the growth exceptions involve niche and/or industrial products with a market. As a rule, these trends can be interpreted as a lessening of pressure on forest ecosystems, though consideration should also be given to the fact that a renewal of production activities, if properly managed, can end the state of abandonment of forests and improve the manner in which they are managed, with positive fallout in terms of conservation as well.
The introduction of potentially invasive allochtonous species – or alien, exotic or non-native ones - constitutes another threat to biodiversity. Their presence in Nature can essentially be traced to three modes of introduction: intentional (through raising, culti-

vation, as a hobby etc.), accidental or secondary (i.e. through the transport of cargo, ballast water in ships, fouling etc, or *taxa* originally introduced in areas outside Italy's borders, only to enter our country, at a later point in time, on their own) and unknown. Based on the available data for the presence of alien animal or plant species introduced in Italy since 1500, the year used as the benchmark for species introduced into Europe, the current overall number of documented alien species is 2,029[30-31]. It is important to stress, however, that this figure underestimates the true extent of the situation, both on account of the limited number of specific studies and focussed monitoring efforts available and due to the delay with which the species, once they are identified, are placed on the lists or databases.

An analysis of the percentage break-down of the alien species into the various taxonomic/environmental groups (Figure 2.5), based on the taxonomic categories of the DAISIE, shows that, of the 2,029 documented alien species in Italy, plants account

The introduction of potentially invasive allochtonous species constitutes another threat to biodiversity. The number of alien animal and plant species in Italy currently stands at 2,029.

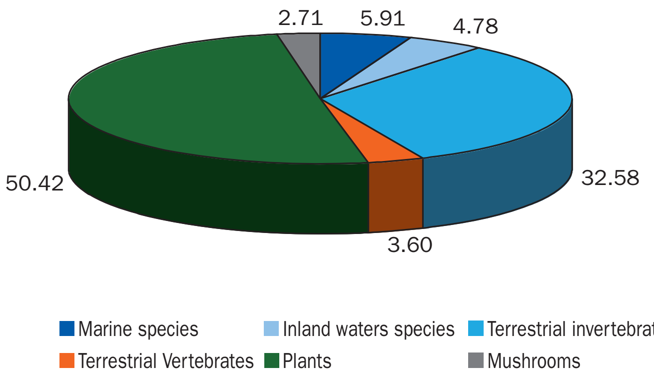


Figure 2.5: Percentage break-down among environmental/taxonomic groups of the 2,029 allochtonous species introduced into Italy since 1500 (updated to 2007 and, only for vascular plants, to 2009)[32]

Plants account for 50% of all documented alien species in Italy, followed by terrestrial Invertebrates, at 33%.

[30] *DAISIE European Invasive Alien Species Gateway (http://www.europe-aliens.org)* – updated to 2007

[31] *Non-native flora of Italy*. Celesti-Grapow *et al. (eds)*, 2009

[32] Source: ISPRA processing of data taken from *DAISIE European Invasive Alien Species Gateway (http://www.europe-aliens.org)* – updated to 2007; *Non-native Flora of Italy,* Celesti-Grapow *et al. (eds.)*, 2009

The rapid increase in alien species introduced into Italy from 1900 on is traceable to the rise in trade and the development of transportation systems, and would not appear to have had any saturation effect on ecological systems.

for 50% of the total, followed by terrestrial invertebrates, at 33%. The other groups register significantly lower percentages: marine species almost 6%, those of inland waters 4.8%, terrestrial Vertebrates 3.6% and Mushrooms 2.7%.
A trend analysis, involving calculation of the cumulated number of alien species introduced into Italy from the year 1900 on (Figure 2.6), points to an exponential increase in the number of species introduced, specially from the 1950’s onward.
This rapid increase, traceable to the growth in trade and the development of transportation systems, would not appear to lead to a saturation effect, backing the assertion that ecological systems are rarely saturated by the new species introduced.

The trend for species introduced in Italy from 1900 on points to an exponential increase in the number of alien species, especially from the 1950’s onward.

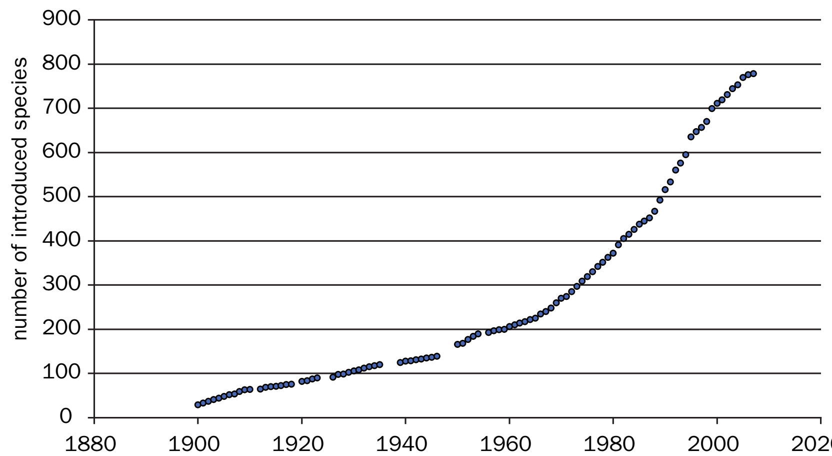


Figure 2.6: Cumulated number of alien species introduced into Italy starting from 1900, calculated in terms of 778 species whose introduction date is certain (updated to 2007)[33]

The average annual rate of new introductions, calculated from the year 1900 on, points to an exponential increase in the average number of alien species introduced per year.

Furthermore, the annual average rate of new “introductions”, calculated from 1900, on the basis of the same contingent of species, points to an exponential increase in the average number of alien species introduced each year, with the rate going from slightly more than one species a year in the early 1900’s to approximately 15 species a year by the end of that same century.

[33] Source: ISPRA processing of data taken from *DAISIE European Invasive Alien Species Gateway (http://www.europe-aliens.org)* – updated to 2007

Though "introductions" of unknown origin have risen at a higher rate than the other mechanisms of introduction, intentional modes are still the most widespread, especially for certain groups of animal species, such as Mammals, or freshwater species involved in sport fishing.

Mention should also be made of the indirect effects of actions of human origin, and especially those traceable to climate changes, already referred to and noted in numerous studies and reports. A widely read article in the review *Science*[34] stated that, before the year 2050, climate change is destined to become the second leading cause (after deforestation and forest deterioration) of loss of biodiversity on both sea and land. Various studies conducted over extended period of time have shown that the climate anomalies that have occurred to date, and especially those involving daytime temperatures and levels of rain, have altered certain physiological processes (photosynthesis, respiration, the growth of plants, efficient use of water, composition of tissues, metabolism and decomposition), as well as the distribution and phenology of plants, plus the reproduction periods of many animal species and the interactions between these species and both biotic and abiotic factors.

The indirect effects of actions of human origin, and especially those traceable to climate changes, have been noted in numerous studies and reports.

In Italy, the impacts observed up to this point include the shifting northwards, and towards higher altitudes in the geographic range, of many species. The lengthening of the vegetative season has led to increased productivity in the Alpine bio-geographic region, while the drier, hotter climatic conditions are responsible for a decrease in forest productivity and an increase in the number and severity of forest fires in the Mediterranean region.

In Italy the impacts of climate change influence the geographic ranges of many species, as well as the vegetative seasons.

One of the scenarios proposed by the Intergovernmental Panel on Climate Change (IPCC) points to a rise of 4 °C in the average temperature of our peninsula and the country's islands before the end of the century. The impact of a similar change would translate into a "latitudinal transgression" of 400 km of many species, along with a "transgression in altitude" of 400 m, as these species

[34] *Global Biodiversity Scenarios for the Year 2100.* Sala O.E. *et al.* (2000). *Science* 287:1770-1774

search for more fitting climatic conditions. Many areas, for example, could become suitable for growing grapes, or for new varieties (replacing others no longer suited to the changed climate); on the other hand, certain grape-growing regions may loose their capacity to bring the traditional varieties of grapes to ripening; regions with hot-arid climates (Pantelleria, Salento) could be pushed outside of the grape-growing zone (as well as that for growing olives and citrus fruit). Interesting studies carried out at the University of Padova point to the problems that could arise during the production of raisin wines (Recioto, Amarone, Gambellara).

The capacity of natural, semi-natural and agricultural areas to resist climate change, as well as their resilience in the face of its effects, is closely tied to biodiversity.

There is ample scientific evidence demonstrating that the capacity of natural, semi-natural and agricultural areas to resist climate change, and to adjust to its effects in resilient fashion, is highly dependent on biodiversity, in terms of specific locations, bioregions, the gene pool and the ecosystem.

On the topic of climate change, it should be remembered that natural and agricultural areas play a significant role in the global carbon cycle, and thus on the problem of the greenhouse effect. The primary sector is a net emitter of greenhouse gases, generated by the enteric fermentation of livestock, the defecations of these same animals, the physical-chemical and biological processes that occur in agricultural soil, by rice paddies and by the combustion of agricultural waste. According to the national inventory of greenhouse gas emissions[35], in 2007 agriculture was responsible for introducing into the atmosphere 37.2 million equivalent tons of CO_2 ($MtCO_2eq$), equal to 6.7% of Italy's total greenhouse gas emissions, for an increase of 1.6% over 2006 (when the figure was 36.6 $MtCO_2eq$), making agriculture the second leading sector in terms of quantity of greenhouse gas emissions, after the energy sector (83%). On the other hand, certain modes of using and managing agricultural and forest lands make possible increases in the quantities of CO_2 temporarily fixed through the conservation or expansion of stocks of carbon in forest ecosystems or agricultural soils. This possibility is tied to the ongoing development of the sector, and, therefore, to policies of agriculture and rural development, as well as energy and climate poli-

[35] *Italian Greenhouse Gas Inventory 1990-2007. National Inventory Report 2009.* ISPRA Report 98/2009, Rome - Italy

cies that influence the procedures for managing the land, as well as the sector's capacity for "spontaneously" reacting to the process of climate change.
According to the inventory cited earlier, the sector of Land Use, Land Use Change and Forestry (LULUCF[36]) accounted for the capture of 70.9 $MtCO_2eq$, equal to 12.8% of the total national emissions of greenhouse gases, marking a reduction of 36.8% compared to 2006 (when the fixing capacity was estimated at 112.2 $MtCO_2eq$). It should also be noted that local activities geared towards mitigating the greenhouse effect can generate social, economic and ecological benefits, as well as income for the owners and managers of the land involved.
There is controversy over the role of activities tied to agriculture as causes of impact on the natural heritage. On the one hand, agricultural areas are subject to the negative impacts of other activities and other spheres of production, given that they frequently are affected by urbanisation, illicit dumping of waste and industrial pollution. At the same time, agricultural activities themselves are frequently identified as one of the main causes of water pollution, loss of stability of terrains and soil pollution, as well as of increases in the greenhouse effect, loss of biodiversity and simplification of the landscape.
In Italy, the main impacts on the environment and biodiversity directly traceable to agriculture are tied to use of fertilisers and plant care products.
The distribution in agricultural soil of synthetic fertilisers, the spread of runoff from livestock enterprises and small agro-food companies, the distribution of sludge from purification operations are all key factors in the pollution of surface and underground water bodies, as well as marine coastal habitats, plus the eutrophication of waters, all with consequences on human health, not to mention the flora, the fauna and the sum total of the ecosystems to which they belong.
What is more, numerous studies indicate that a decrease in agricultural biodiversity (meaning a decrease in the varieties of the species grown, in the "buffer" strips of unfertilised grass and in

Agricultural areas are subject to the negative impact of other economic activities, while, at the same time, they can cause pollution and loss of biodiversity.

In Italy, the main impacts on the environment and biodiversity directly traceable to agriculture are tied to use of fertilisers and plant care products.

[36] LULUCF: *Land Use, Land Use Change and Forestry*

the hedgerows along waterways and ditches to meet the internal production concerns of the enterprises), together with the abandonment of crop rotation and of marginal, uncultivated zones, can have specific consequences on the migration of nutrients and other pollutants towards the surrounding watersheds.

Surface and underground waters frequently present concentrations of plant care products in excess of the legal limits.

An ISPRA survey on the contamination of surface and underground waters from plant care product residues placed in the environment, involving the analysis of 11,703 samples by the regional governments and by the ARPA's, point to surface water contamination of 57.3%, highlighting that, in 36.6% of these cases, the concentrations exceed the limits set under the law for drinking water. In underground bodies of water, on the other hand, the level of contamination is 31%, with the concentrations exceeding the legal limits in 10.2% of the cases.

The figures for Italy's primary watersheds show that, in the course of a century, the average concentration of nitrogen in the water rose threefold, with the level increasing ten times over in certain Italian rivers that run through heavily cultivated areas, such as the Po Valley Plain, where over 50% of the fertilisers sold are concentrated.

During the years 1998-2007, there was an increase of 22.1% in the quantity of fertilisers placed on the market.

On the subject of fertilisers, it should be noted that the quantity placed on the market in Italy, after a slow but continuous decrease that began in the 70's, returned to an upward trend in the period 1998-2007, registering growth of 22.1% (ISTAT, 2007). The national figure for the year 2007 moved above the 5.4 million ton mark, with more than 3 million tons consisting of mineral fertiliser, of which the most widely used type are those based on nitrogen.

The quantity of plant care products placed on the market fell by 8.2% during the period 1997-2007, but rose by 3% between 2006 and 2007.

As far as plant care products are concerned, the quantities placed on the market in the period 1997-2007 shrank by 8.2%. In 2007 more than 153,000 tons were sold, for an increase of 3% compared to the previous year, with 76.5% of the total consisting of "unclassifiable" products, and the remaining 23.5% including those products classified highly toxic, toxic and harmful, which, being the most dangerous from a toxicological, eco-toxicological and chemical-physical point of view, are subject to special restrictions in terms of their sale and preservation. Compared to 2006, the unclassifiable products were practically unchanged, while the toxic and highly toxic products decreased by approximately 242 thousand tons, though this decrease was more than offset by the noteworthy increase in harmful products (more than 4,700 tons). Taken as a whole, there-

fore, the most dangerous products increased by 14.3%.

The main initiatives for protection

As already noted, the preservation of biodiversity often conflicts with man's models for putting resources to use. Efforts to reconcile its defence as best as possible with the demands of society frequently result in agreements and legislative instruments, key elements that prove indispensable when it comes to combining the need for conservation with economic, social and cultural concerns, as well as those of local populations. Italy has endorsed numerous conventions and international agreements designed to safeguard biodiversity. Especially worthy of note, give its strategic importance on a global scale, is the Convention on Biological Diversity[37], signed in Rio de Janeiro on 5 June 1992 during the United Nations World Summit on the Environment and Development[38]. The CBD sets three specific objectives: 1) the preservation *in situ* and *ex situ* of biological diversity; 2) the sustainable use of the components of biological diversity; 3) an equitable distribution of the benefits produced by the use of genetic resources. In Italy the CBD was ratified with Law no. 124 of 14 February 1994. Later, on 16 March 1994, the CIPE (Inter-Ministerial Committee for Economic Planning) approved the document "Strategic Guidelines and Preliminary Program for the Implementation of the Convention on Biological Diversity in Italy". The CBD acknowledges the importance of the ecosystem approach as a strategy for the integrated management of the territory, of water and of living resources, in such a way as to promote their conservation and sustainable, equitable use; the application of the ecosystem approach favours a balanced approach to pursuing the three objectives of the CBD. The ecosystem strategy is based on the application of suitable scientific methodologies focussed on levels of biological organisation that include key processes, functions and interactions between the organisms and their environment. It acknowledges that human beings, with all their cultural diversity, are an integral part of ecosystems.

Italy has endorsed numerous conventions and international agreements geared towards safeguarding biodiversity, such as the Convention on Biological Diversity.

[37] Convention on Biological Diversity - CBD
[38] United Nations Conference on Environment and Development - UNCED

The "Siracusa Charter on Biodiversity".

Also worthy of note among the international agreements is the recent "Siracusa Charter on Biodiversity", signed by the Ministers of the Environment of the G8, in concert with the ministers of other countries and with the international organisations taking part in the meeting held at Siracusa on 22-24 April 2009. The Charter calls for a series of initiatives to be taken regarding interconnections between biodiversity and the climate, the economy, ecosystem services, science, research and politics. Based on these initiatives, a shared path is proposed towards the post-2010 context, taking into consideration the following elements:

- the need to intensify efforts to conserve and manage in a sustainable manner both biodiversity and natural resources;
- the need for appropriate programs and timely actions designed to reinforce the resilience of the ecosystems, seeing that a loss of biodiversity or a non-sustainable use of the same can give rise to noteworthy economic losses;
- the need to give due consideration, in establishing the context to follow the 2010 objective, to the numerous elements that can cause a loss of biodiversity or generate a medium or long-term threat to biodiversity, as these elements are identified through scientific research;
- the need for a far-reaching communications strategy that fully involves all the sectors, as well as the stakeholders, the local communities and the private sector, so as to emphasise participation and determine responsibilities;
- the need for a reform of environmental governance at all levels, of key importance to integrating biodiversity and ecosystems services in political procedures, so as to transform what are currently weaknesses of economic systems into opportunities, while supporting sustainable development and employment, with particular consideration for the conditions in which the developing countries find themselves.

The EU is deeply committed to defending nature and biodiversity. The strategic topics of the EU Environmental Action Plan for policies in defence of Nature are highly integrated in both the Strategy for Sustainable Development and the objectives of the Lisbon Treaty, as well as in the policies for the individual sectors, including agriculture, fishing, industry, energy and transport.

The cornerstones of EU policies on the conservation of nature and biodiversity are two key directives: the Bird Directive (79/409/EEC) on the protection of wild birds and the Habitat Directive (92/43/EEC) on the preservation of the natural and semi-natural habitats of wild flora and fauna. The specific objectives of the Habitat Directive include the creation of a cohesive European ecological network entitled Nature 2000 and consisting of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs), with these last being determined in accordance with the provisions of the Bird Directive. The Bird Directive was transposed into national legislation with Law 157 of 11 February 1992, while the list of Italy's SPAs was published as part of a Ministerial Decree issued on 25 March 2005. The Habitat Directive was fully transposed into Italian law under Presidential Decree no. 120 of 12 March 2003. Later the lists of the Sites of Community Importance (SCIs) were published for the Alpine Bio-geographic region (Ministerial Decree of 25 March 2004), for the Continental region (Ministerial Decree of 25 March 2005) and for the Mediterranean region (Ministerial Decree of 5 July 2007). At present, Italy's Nature Network 2000 consists of 597 SPAs, with a surface area of 4,377,721 hectares, equal to 14.5% of the national territory, and of 2,288 SCIs, with a surface area of 4,530,866 hectares, equal to 15% of the national territory (*Databank of the Nature Network 2000*, Ministry of Environment, Land and Sea, 2009). In order to correctly interpret these data, it should be remembered that some SCI's and SPA's overlap, either partially or totally.

The two cornerstones of EU policies for the conservation of nature and biodiversity are the Birds Directive and the Habitat Directive.

In Italy, the Nature 2000 Network currently consists of 597 SPAs, with a surface area of 4,377,721 hectares, equal to 14.5% of the national territory, plus 2,288 SCIs, with a surface area of 4,530,866 hectares, equal to 15% of the national territory.

Another fundamental reference for the conservation of biodiversity in Italy is Framework Law no. 394 of 6 December 1991 on protected areas, an act that "lays down the underlying principles for the establishment and management of natural protected areas, in order to guarantee and promote, in a coordinated manner, the preservation and optimal use of the country's natural heritage". Accompanying the law are a series of measures meant to protect fauna and flora, regulate hunting, protect marine species and regulate fishing, in addition to safeguarding forest resources. Taken as a whole, the legislation approved has made it possible to carry out a number of different initiatives that attempt to safeguard and improve the conditions of our natural heritage. According to the 5th EUAP – Offi-

There are 772 protected areas in Italy, occupying a terrestrial surface area of almost 3 million hectares (9.7% of the national territory).

cial List of Protected Areas (2003) – there are 772 protected areas in Italy, occupying a terrestrial surface area of almost 3 million hectares (9.7% of the national territory)[39]. More recent data, not yet made official through issue of the 6th EUAP, which is currently being approved, indicate that there are 875 protected areas in Italy, making for a terrestrial protected surface area of almost 3,095,000 hectares (10.3% of the national territory)[40].

Of particular importance among the protected areas of the sea are the Marine Protected Areas (MPA's), as well as the "Pelagos" Marine Mammals Sanctuary.

Of particular importance among the protected areas of the sea are the Marine Protected Areas (MPAs), consisting of marine environments made up of the waters, sea bottoms and the portions of coastline running along them and proving to be of significant interest, in light of their natural, geo-morphological, physical and biochemical characteristics, especially as regards marine and coastal flora and fauna, as well as their scientific, ecological, cultural, educational and economic importance. In Italy, MPAs can be established if they have been previously identified as *areas foreseen by law*. Laws 979/82, 394/91, 344/97, 426/98 and 93/01 provide a list of 50 areas as above; to date, 25 MPAs have been established, including the two underwater parks of Baia and Gaiola called for under Law 388/2000. The MPAs simultaneously meet the dual objective of safeguarding biodiversity and maintaining and developing the local economy through three levels of differentiated protection (A, B and C Zones).

Finally, mention should also be made of the "Pelagos" Sanctuary for Marine Mammals, which, being an international protected pelagic area established under an agreement between France, the Principality of Monaco and Italy, has been subject to different administrative procedures and is currently governed by measures for maintaining the good state of conservation of the populations of marine mammals and prohibiting offshore speedboat races.

Law 394/1991 introduces the "Plan for the Park", which, by subdividing the territory into areas under different levels of protection, guarantees ongoing efforts to preserve biodiversity through reconciliation with activities of human origin.

The same Law 394/1991 referred to above introduces the "Plan for the Park", which, by subdividing the territory into areas under different levels of protection, guarantees ongoing efforts to preserve biodiversity through reconciliation with activities of human origin. In the course of its complex regulatory development, this key instrument for the management of areas with a priority need

[39] 5th EUAP, Ministry of Environment and Defence of the Land, 2003

[40] *Le sfide ambientali. Documento di sintesi sullo stato dell'ambiente in Italia.* Ministry of Environment, Land and Sea, 2009

for conservation has encountered numerous problems. For example, the current framework, which regards 24 Italian national parks and is based on official regulatory provisions, shows that 7 of these parks (29%) have still not initiated any procedure for the formulation of the Plan for the Park, while 8 (33%) are in the phase of preparing and enacting the Plan, 5 (21%) are in the phase of public consultation and only 4 (17%) actually have the Plan in place. It should also be stressed that, despite the timing forecast under the law for carrying out the procedure leading to the Plan (roughly 30 months), the Park that completed the process more rapidly than the other Parks took 8 years to do so, well beyond the upper limit indicated above.
Completing the overview of nature areas subject to protection in various forms, and for various reasons, it should be remembered that, thanks to Italy's endorsement of the Ramsar (Iran) Convention of 1971 on wetlands of international importance, 51 sites of major ecological importance, covering a total surface area of approximately 58,800 hectares, are protected.
Figure 2.7 shows the regional distribution of the protected areas, as per the provisions of the legislative instruments illustrated earlier.

Thanks to Italy's endorsement of the Ramsar Convention, 51 wetland sites of major ecological importance are protected.

In compliance with the international conventions on the protection of biodiversity, as well as the European Community directives on birds and habitats, plus national laws on protected areas and the preservation of fauna, a number of different "Action Plans" have been implemented for threatened species of fauna, while "Guidelines" have been drawn up to limit species that damage native fauna and natural habitats. The Action Plans and Guidelines were drafted by the former National Institute for Wild Fauna (currently ISPRA), on assignment from the Ministry of Environment, Land and Sea. Participating in the work, depending on the specific case, were the leading experts for each species (selected by the Ministry of Environment, Land and Sea, by the main research agencies, by the Italian Zoological Union and/or by the most significant non-government associations), as well as the national authorities (national parks, the State Forestry Corps) or local authorities (protected areas, regions, provinces) territorially responsible for undertaking the actions found in the Plans.

In Italy a number of different "Action Plans" have been implemented for threatened species of fauna, while "Guidelines" have been drawn up to limit species that damage native fauna and natural habitats.

14.5% of the surface area of Italian territory holds SPAs, 15% holds SCIs and 9.7% contains protected terrestrial areas.
There are also 25 Marine Protected Areas and 51 Ramsar sites.

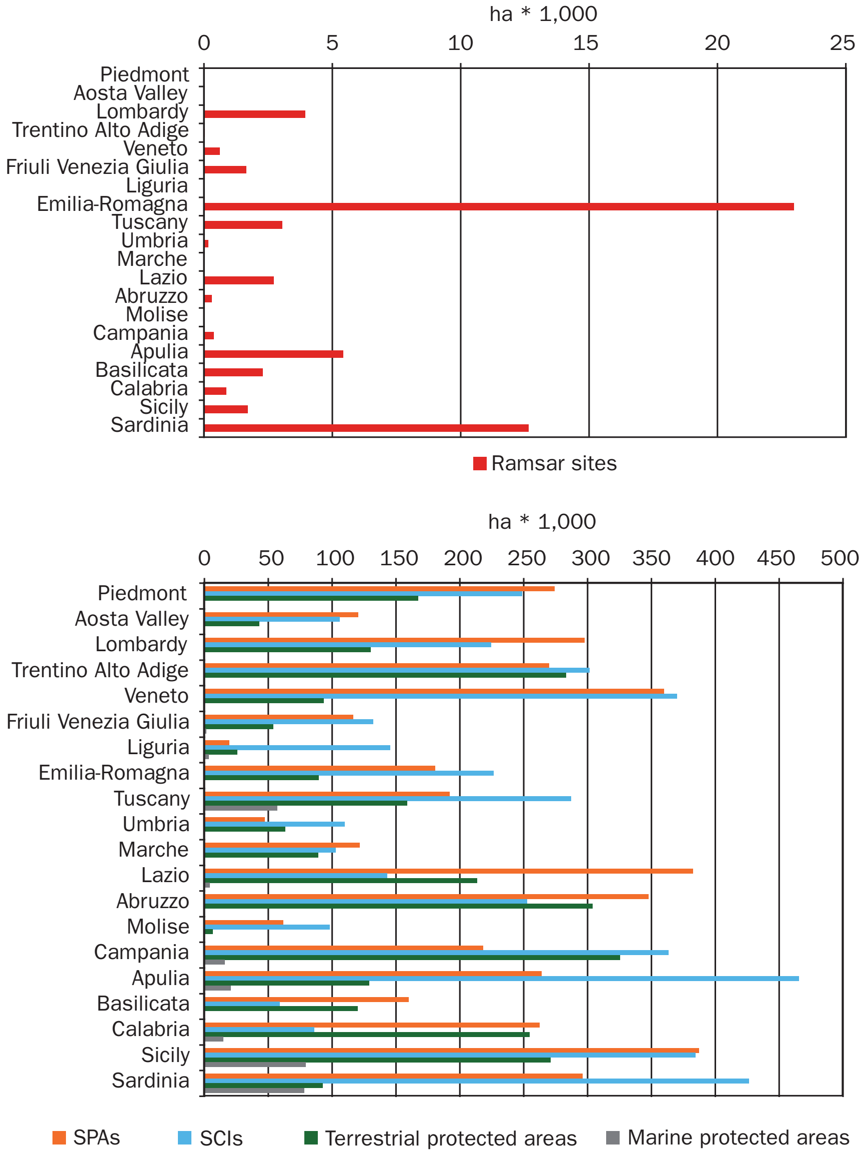


Figure 2.7: Regional distribution of protected areas [41] (Marine Mammals Sanctuary not included)[42]

[41] Source: for terrestrial protected areas: see *Official List of Protected Areas*, Ministry of Environment and Defence of the Land, 2003; for marine protected areas: ISPRA processing of data from the 5th *Official List of Protected Nature Areas*, Ministry of Environment and Defence of the Land, 2003, Managing Authority of the "Plemmirio" Marine Protected Area, Managing Authority of the "Bergeggi Island" Marine Protected Area, Managing Authority of the "Regno di Nettuno" Marine Protected Area; for the Ramsar Areas: Ministry of Environment, Land and Sea, 2008; for SCIs and SPAs: ISPRA processing of data from the Ministry of Environment, Land and Sea (respectively updated to 30 July 2009 and to 18 August 2009)

[42] The surface area of the SCI and SPA found in the Gran Paradiso National Park, a portion of which lies inside the Aosta Valley Region and a portion in Piedmont, was distributed under a criterion that attributed the majority of the areas to Aosta Valley. The SPA surface area of the Gran Sasso-Monti della Laga National Park, which falls within the territories of Abruzzo, Lazio and Marche, was assigned primarily to Abruzzo. The SPA surface area of the Abruzzo National Park, portions of which are found in Abruzzo, Lazio and Molise, was attributed in full to Abruzzo

As is true for agriculture, which we shall address further on, the fishing sector is one of the areas of responsibility shared by the European Union and its member states. The instrument used by the EU to manage all the different aspects of fishing and aquaculture (biological, environmental, economic and social) is the Common Fisheries Policy (CFP). The current CFP is based on a reform implemented in 2002, the underlying principles for which were laid out in the Council's Regulation (EC) no. 2371/2002 on the conservation and sustainable exploitation of fishing resources under the Common Fisheries Policy, which provides the legal framework for all subsequent legislation approved by the European Community. The Policy introduced a precautionary approach designed to protect and conserve resources while reducing the impact of fishing on ecosystems to a minimum and attempting to find responses to certain specific problems in areas such as the conservation of living marine resources, the preservation of the environment, the management of the fleet, the organisation of markets, systems of control etc. From a structural perspective, the European Fisheries Fund (EFF) constitutes the financial component and is based on seven-year programs (2007-2013). Once of the most significant measures introduced under the CFP is the setting of maximum limits on catches (in the Mediterranean, this involves red tuna); there are also technical measures, such as the minimum size of the mesh on the net, the use of selective fishing equipment, prohibitions against fishing in certain areas and during certain periods, the minimum sizes of fish that can be unloaded; reduction in accessory or accidental catches; limitation on fishing efforts in terms of capacity (draught, engine power and days spent at sea); reduction in illegal, undeclared and unregulated fishing.

The Common Fisheries Policy (CFP) is the instrument used by the EU, and therefore its member states, to manage all the different aspects of fishing and aquaculture: biological, environmental, economic and social.

Despite the progress made under the CFP in ensuring the environmental and socio-economic sustainability of fishing, the reality of the sector is a fragile one. The objectives set for the reduction of fishing capacity have not been reached, fishing stocks are commonly subjected to over-fishing while catches and profitability both decline. Though the environmental and economic aspects of fishing can clash in the short term, they should be considered inseparable in taking a farsighted approach to the management of fishing resources. This is why a revision of the CFP was initiated: the process is currently in the consulting phase, following publication

The CFP is currently being revised, in order to expand it beyond its current role as a principle of precaution and a mean of pursuing sustainability, as part of an "ecosystem approach".

Many other initiatives, including some undertaken on the regional and local levels, are focussed on the monitoring of the species and habitats, on environmental reclamation and restocking, on the creation of ecological networks, on the implementation of criteria of sustainability in the various production sectors, on the certification of products and on environmental education.

by the Commission, in April of 2009, of a *Green Book on the Reform of the CFP* (COM(2009)163). This revision should expand the CFP beyond its current role as a principle of precaution and a mean of pursuing sustainability, making it an "ecosystem approach" that treats fish stocks as individual elements of complex networks of connections and interdependencies, of which human activities are a full and integral part. Seen in this light, the CFP is part of the European Union's new integrated maritime policy, which posits as the lynchpin for implementation of the ecosystem approach the recent framework directive for the strategy on the marine environment (2008/56/EC), whose objective is to reach a good environmental state for Europe's marine waters by 2020, as well as the Habitat Directive referred to earlier (92/43/EEC).

Many other initiatives, some of them taken on the regional or local levels, focus on the study and monitoring of species and their habitats, as well as efforts of environmental restoration and restocking, plus the creation of ecological networks, the introduction of criteria of sustainability in the various production sectors, product certification and environmental education. Many of these efforts are directly or indirectly controlled by the series of programs carried out on the local or national levels by public or private bodies, as well as by universities and other organisations. Monitoring plays an important role in the preservation of biodiversity, and it is approached as monitoring not only of the components of biodiversity, but also of the categories of activities that can prove detrimental to biodiversity. The Chart of Nature, established under the aforementioned Framework Law no. 394/1991 on protected nature areas, the monitoring networks of the Agencies System and the reporting activities involving environmental data, such as the ISPRA Environmental Data Yearbook, are direct offshoots, or are closely tied to, the objectives found under art. 7 of the CBD.

An applied example worthy of note is the indicator referred to as "Ecological Value" and calculated under the Chart of Nature on a scale of implementation of 1:50,000. The "Ecological Value" is understood as being a natural strength and is calculated as a set of indicators traceable to three different groups. The first group regards the so-called institutional values referred to in Community directives; the second takes into account the components of biodiversity; and the third considers indicators typical of the ecology of the countryside.

The “Ecological Value” is significant (high and very high) in 62% of the territory of the Aosta Valley, in 54% of Friuli Venezia Giulia, in 34% of Veneto, in 26% of Sicily and in 16% of Molise, seeing that these are the regions in which the Chart of Nature has already been fully implemented.
Efforts of preservation *in situ* include not only the establishment of protected areas, as illustrated above, but also the identification of areas for the implementation of special measures of conservation. Falling under this objective are the measures of protection contemplated for areas adjoining the protected areas, as well as the various initiatives - noteworthy examples of which can be observed within the national territory - for the establishment of ecological networks, both terrestrial and marine.
On the subject of the ecological network, which plays an extremely important role in guaranteeing the ecological connection between the different ecosystems and the territorial zones, it is interesting to observe the extent to which it has become a part of ordinary planning. In fact, references to the ecological network can be found in 88.2% of the Territorial Plans for Provincial Coordination (PTCP) approved, enacted or in the drafting stage. Of those being drafted, almost a quarter do not present references to the ecological network, while it is much more likely to be found in the plans that have been enacted and approved. It remains to be seen whether this less frequent presence in the plans being drafted, meaning the more recent ones, should be interpreted as a sign of decreased interest towards the subject in general or as the result of difficulties encountered in achieving operational integration of the ecological network with the normal planning instruments.
The Italian Network of Germoplasm Banks for the *ex situ* preservation of wild flora (RIBES) is another major initiative for the preservation of germoplasm, as well as an incentive for studies on the subject (art. 9 of the CBD). As part of an initiative recently undertaken by ISPRA, together with BIOFORV (the workgroup on Forestry and Nursery Biodiversity) and RIBES, a document was drawn up summarising the situation of *ex situ* conservation of wild and cultivated plants in Italy. The document, which is currently under publication, presents the state of the art with regard to the *ex situ* conservation of the different categories of plants and in the individual

research sectors, though it also throws light on the critical problems and lists the main actions to be taken to resolve the more serious ones. Among those actions, note should be taken of the special nature of on-farm conservation, a form of *in situ* conservation that involves continuing to grow and raise local varieties and races, meaning those populations of crop or livestock species arrived at after centuries of natural selection by the environment, by farmers and by raisers of livestock within a given territory, confirming the key role of agricultural enterprises in conserving biodiversity.

As for the objective of the long-term use of biological components (art. 10 of the CBD), it includes initiatives designed to encourage the habitual use of biological resources, in accordance with traditional cultural practices that prove compatible, with one option for their implementation being the involvement of the local populations in the planning of actions for the restoration of biodiversity, together with improved cooperation between government authorities and the private sector. Major steps in this direction are the enactment of the 21 Agendas, plus efforts focussed on participation and access to information, as well as environmental certification and seals of quality for local products, with various examples of the application of such efforts on the local level found throughout the national territory. The Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA) and the assessments of the incidence of plans and projects, as well as surveys meant to gauge environmental damage, are all actions contemplated under art. 14 of the CBD and designed to assess, and therefore minimise, impacts that can prove harmful to biodiversity. Last but not least are the activities of research and training in the environmental sector (art. 12 of the CBD), as well as those of instruction and dissemination to the public (art. 13 of the CBD). In the case of these last programs, the Ministry of Environment, Land and Sea, together with the Ministry of Education, has carried out the program of the INFEA initiative on information, training and environmental education of 1995, a noteworthy effort of coordination meant to channel experiences and isolated initiatives on a local level in such a way that they can contribute to national programs and structures.

An initiative of note in the forestry sector is the promotion of a series of partnerships and collaborative efforts between the public and private sectors, for the primary purpose of favouring actions

Of note in the forestry sector is the promotion of a series of partnerships and

designed to spread information, heighten awareness and increase the use of voluntary instruments for the promotion of responsible forestry management, as well as, in more general terms, the development of practices centred around the social responsibility of businesses and opposition to illegal procedures. These instruments include: compensating investments by companies that intend to offset, at least in part – for example, through the restoration of deteriorated natural areas or through reforestation initiatives – the impacts of their activities; forest certification, involving not only the management of forests on a national scale, but also the chain of custody, and, therefore, the use of certified raw materials by transformation enterprises in the wood/paper sector. Nationally, two alternative systems of forest certification can be identified: the PEFC (Pan-European Forest Certification, promoted by owners of forests and the forest industry) and the FSC (Forest Stewardship Council, drawn up by environmentalist organisations and in operation for a longer period of time). With the first Italian forest certification (FSC) having been awarded to the Magnificent Community of Fiemme (Province of Trento) in 1997, as of 31th October 2009, a total of 748,065 hectares of the national forest area had obtained this recognition, meaning more than 8.5% of all Italian forest area. In addition to the Alpine regions, which hold the majority of Italy's certified forest areas, numerous zones in the central and southern Apennines have also been certified. A further development of note was the first certification of an Italian cork oak forest (FSC), in Tempio Pausania (Province of Sassari), in 2005. Under both systems, certification of private forest holdings is predominant, but certification of public property is on the rise as well.

In the agricultural sector, after decades of policies of rural development centred around the specialisation and intensification of agriculture, with the primary objective of increasing agricultural productivity, in the nineties, the Community Agricultural Policy (CAP) was geared towards integrating the objectives of environmental policy with the agricultural policies of the marketplace and rural development, in part to correct the impacts on the environment caused by the agricultural strategies followed in earlier years. In 2003, a reform of the CAP for the medium term introduced a

collaborative efforts between the public and private sectors, for the primary purpose of favouring actions designed to spread information, heighten awareness and increase the use of voluntary instruments for the promotion of responsible forestry management, as well as, in more general terms, the development of practices centred around the social responsibility of businesses and opposition to illegal procedures.

8.5% of the total hectares of national forest area is certified.

Starting with the medium-term reform of the CAP in 2003, and to an even greater extent with the Health Check of 2008, spending on rural development in Italy and other countries of the EU shifted from market measures towards forms of

income support for farmers, not only in their role as producers of food, fibre and wood and non-wood products, but, even more importantly, because of their contribution to the conservation of the countryside and the environment.

system of support for agricultural operators no longer based on the types of crops grown and the quantities produced, but rather on the exercise of agricultural activities and on the awarding of a "single payment for each enterprise", on the condition that a number of obligatory operating criteria are met in the areas of environmental defence, as defined in the environmental directives regarding natural habitats, flora and wild fauna (based on the Directives on birds and habitats), as well as water (based on the Directives on nitrates, underground waters and purification mud), food safety, the wellbeing of animals and biodiversity, as established under the Lisbon Agenda of March 2000 ad in line with the interests and expectations of society.

In November of 2008, the Ministers of Agriculture of the EU reached agreement on a *Health Check* for the CAP. The objective of the Health Check, a revision of the medium-term reform initiated in 2003, was to respond more effectively to six "new challenges", which include Climate Change, Bio-Energy, the Management of Water and Biodiversity. On that occasion, the Ministers also decided to increase the modulation and to transfer funds from the direct payments to agricultural operators to the financing of policies involving the market (Pillar I of the CAP) and Rural Development (Pillar II). The *Health Check* did not regard the set-aside measures.

In revising the Community Strategic Orientations (Decision 2009/61/EC of the Council of 19 January 2009), the objective of defending biodiversity was reinforced, with identification of a slowing in the decline of biodiversity as one of the most important Community objectives to be reached. With this in mind, rural development plays a strategic role, seeing that the concept of biodiversity is unquestionably linked to and dependent on agriculture and forestry growing as well.

During the revision of the planning for rural development in 2007-2013, many regions have opted for measures reinforcing the defence of biodiversity.

To this end, many regions, during the revision of the program of rural development for 2007-2013, decide to utilise a wide range of measures to reinforce the defence of biodiversity.

An analysis of the financial resources of the Health Check (and of the Recovery Package) allocated under the Rural Development Plans of the Regions to the six «new challenges» shows that 158.3 million euro, or 20.4% of the total were concentrated on the challenge of "biodiversity", while 140,8 million euro, or 18,2%, was allocated to "climate

change"; and "management of waters" received 173.7 million euro, accounting for 22.4% of the total. Seventeen regions decided to reinforce this priority, primarily through agro-environmental measures, in particular measure 214, "agro-environmental payments", which was reinforced by 13 regions, and measure 216, "non-production investments", used by 4 regions. The types of operations to be funded with the agro-environmental payments are all geared towards safeguarding genetic biodiversity, conserving types of vegetation with a wide range of species, protecting and maintaining grassy formations, protecting birds and other wild fauna, improving the network of biotypes, reducing the presence of harmful substances in the surrounding habitats and conserving protected flora and fauna. Furthermore, considering the high level of interdependence between biodiversity and a number of the challenges of the Health Check, in particular climate change, bioenergy and the management of water, many of the measures taken under the regional plans will also prove as measures in defence of biodiversity, though they do not address the topic directly. Examples of such measures are the initiatives meant to favour the adaptation of forest and agricultural ecosystems to climate change, the reconstruction of dry walls and tree and hedge rows to favour the control of water and erosion, as well as measures taken to diversify the rural economy and support family-run agricultural enterprises and agrotourism undertakings. In terms of maintaining or increasing the dimensions of the UAA nationwide, it should be noted that no specific objectives are set under either international or national legislation, though the last two European Action Programs in the field of the environment, as well as the 21 Agenda, set a number of general objectives, such as the sustainable use of the territory, the protection of Nature and biodiversity and the maintenance of the levels of production. These objectives are reiterated in the resulting thematic strategies, in the associated legislative proposals and in the numerous existing legislative measures. Community policies for agriculture and the environment call for incentives promoting production systems featuring low environmental impact, such as integrated and biological agriculture, as well as increased extensive production, safeguarding of habitats of elevated naturalistic value, maintenance of biodiversity and the low-intensity management of pasturelands. Equally important are the national guidelines, geared towards promoting a generational turnover, together with

In Italy the surface areas involved in or being converted to biological agriculture were equal to 1,002,414 hectares in 2008, representing roughly 8% of the national UAA.

economic and social development of agriculture, in addition to providing incentives for the reconstitution of farmlands and farming enterprises. Within this framework of measures and facilitations, particular attention is focussed on Italian biological agriculture (often referred to as "bio"), which constitutes a genuine success story for European agriculture. As shown by Figure 2.8, in 2008 the surface areas involved in or being converted to biological agriculture were equal to 1,002,414 hectares (-12,8% compared to 2007), representing roughly 8% of the national UAA. The majority of the "bio" surface area is used in growing grain, as permanent meadows and for the cultivation of trees and green forage from seed crops. At the end of 2008, the number of operators was 49,654, for a decrease of 1.2% compared to 2007. The largest number were found in Sicily, while Molise is the region that registered the largest increase in operators compared to earlier years. Sicily, followed by Calabria, has the most producers. Calabria, followed by Basilicata, leads in terms of the number of producers per UAA. Within the EU, Italy ranks in terms of biological agricultural, with regard to both the number of enterprises and the surface area utilised, and in light of the evident advantages as regards the quality of the soil, the fixing of carbon, the reduction of greenhouse gas emissions, the conservation of biodiversity and reduced introduction into the environment of residues of pesticides and fertilisers.

Following a decrease on the mid 2000's, the surface area and number of biological enterprises in Italy has stabilised, representing a major success story on both the national and European levels.

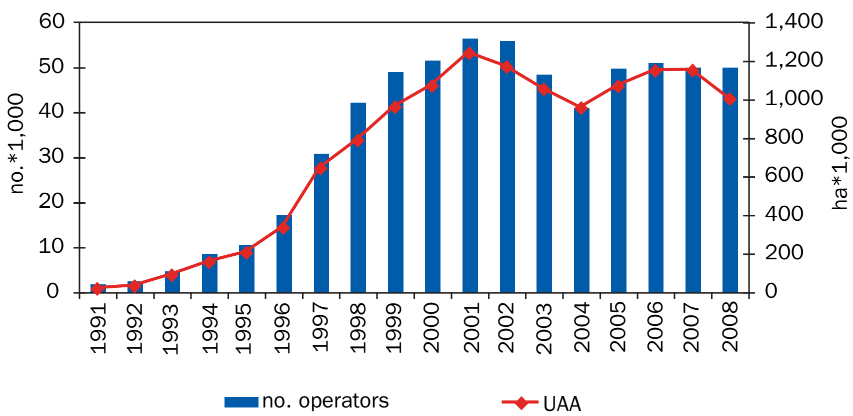


Figure 2.8: Number of operators and utilised agricultural area (UAA) according to the biological method[43]

[43] Source: SINAB

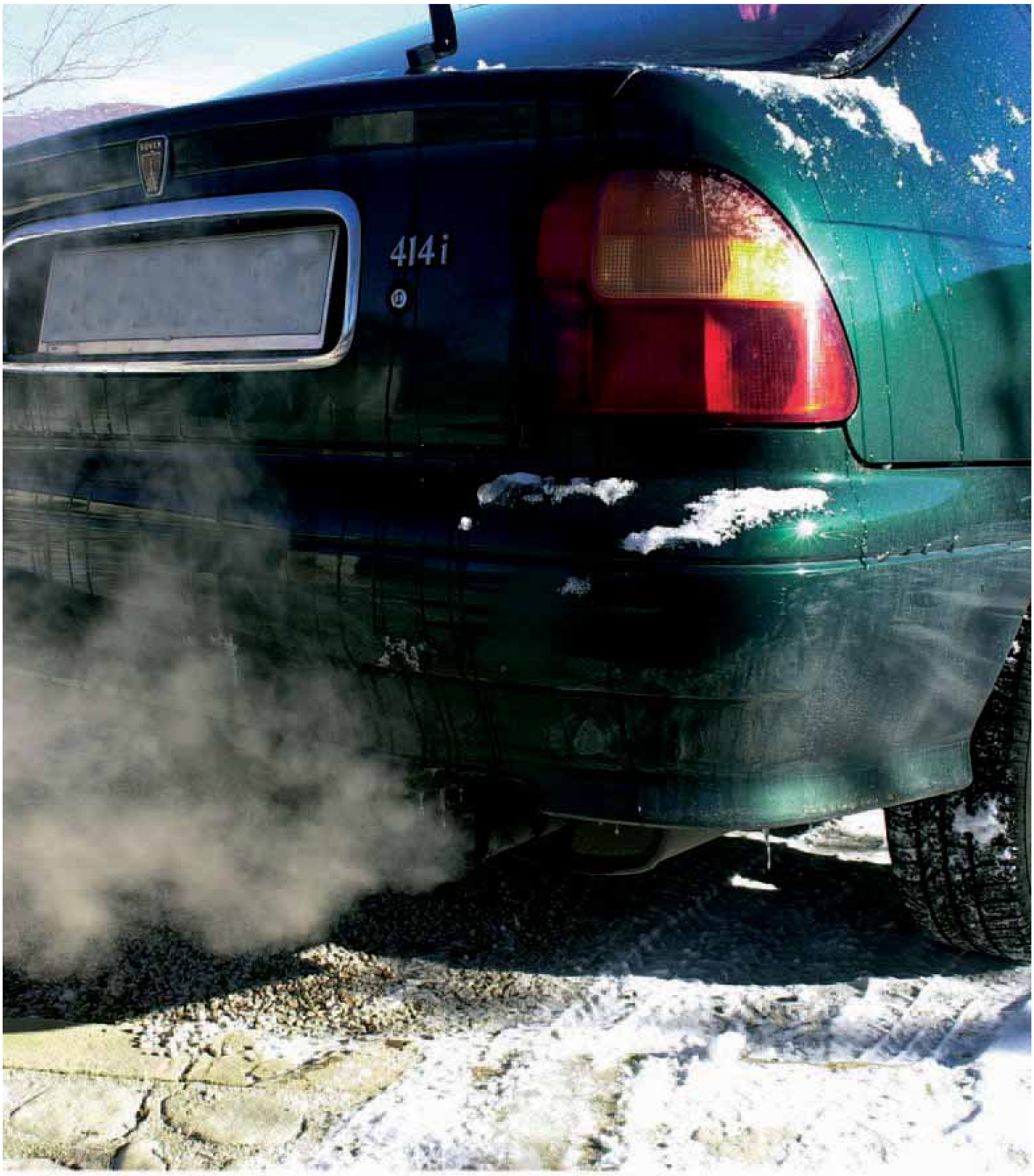
The various actions listed up to this point to safeguard nature and biodiversity can be effectively applied only if they are supported with adequate funding. An examination of the available data, supplied by ISTAT[44] shows that spending by different government bodies (grouped by COFOG)[45] on the defence of biodiversity and the countryside totalled 4.357 billion euro in 2007. In 2000, total spending on such efforts was 2.864 billion euro, making for growth of approximately 52% during the period and confirming the attention placed on the sector under public policies.
As seen, there are various responses to the unceasing loss of biodiversity, as well as various modes for safeguarding natural and agricultural areas. These efforts definitely including increasing designation of new protected areas, but also further reinforcement of existing instruments of conservation, especially in terms of increased application and spread of controls, availability of more financial resources, attention focussed on new and emerging problems, such as the spread of alien species and global climate change. A key role shall also be played by increasingly widespread practice of sustainable management and conservation on both land and sea natural environments that are not classified as protected. Italian agriculture also holds a key role at this juncture, being called on to make difficult choices between the growing demand for both “conventional” and “new” products (first and foremost bio-fuels) and the need to safeguard biodiversity and the environment through activities such as bio-remediation, carbon sequestration etc.: all valid solutions to specific, highly relevant problems.

In 2007, government bodies spent more than 4,0 billion euro on defending biodiversity and the countryside, for an increase of 52% compared to 2000.

Apart from direct conservation, a key role in responding to the problem of losing biodiversity will be played by the sustainable management and conservation of natural environments, on both land and sea, not strictly classified as protected.

[44] Spending of government bodies by function, level II, Years 2000-2007
[45] Classification Of Function Of Government: a classification draw up on the international level by the leading institutions involved in national accounting

CHAPTER 3



AIR QUALITY

According to an EEA estimate, since 1997 more than 50% of the population of major urban areas has been exposed to levels of PM_{10} higher than the limits set for the protection of human health, and roughly 61% has been exposed to ozone levels higher than the objectives set.

Introduction

Air quality represents one of the environmental emergencies that, together with the closely related issue of climate change, is of concern not only to administrators of local and central governments, but also to experts in the fields of medicine and the environment, involving citizens on a daily basis. Air quality and its defence constitute a global problem that regards, with different manifestations, Europe and the industrialised world, as well as emerging nations and other developing countries. The most critical pollutants, given the high levels they reach in the atmosphere and their impact on human health, are atmospheric particulate PM_{10} (a particle material with an aerodynamic diameter of less than 10 millionths of a metre), tropospheric ozone and nitrogen dioxide. Growing attention is being focussed on $PM_{2,5}$ (a particle material with an aerodynamic diameter of less than 2.5 millionths of a metre), whose chemical-physical characteristics make it the leading cause of the toxic effects of atmospheric particulate; the new air quality directive[1], approved in April 2008 and currently being transposed into Italian law, is the first measure to set a limit on the level of $PM_{2,5}$, to be met by 2015. In our country, as in the majority of the other European countries, the emergency primarily involves large urban areas, where the high population density, along with the resulting activities, cause elevated levels of emissions and noteworthy concentrations of pollutants in the ambient air, along with high levels of exposure. The European Environment Agency (EEA) recently estimated that, since 1997 more than 50% of the population of major European urban areas has been exposed to levels of PM_{10} higher than the limits set for the protection of human health, while approximately 61% have been exposed to levels of ozone higher than the objectives set for the same purpose[2]. An analysis of the EEA indicates that 15 of the 27 countries of the European Union shall not succeed in complying, by 2010, with one or more of the objectives set under the NEC Directive[3] in order to reduce atmospheric pollution[4].

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[1] Directive 2008/50/EC of the European Parliament and Council regarding the environmental air quality for cleaner air in Europe
[2] EEA, *Signal 2009*
[3] Directive 2001/81/EC of the European Parliament and Council on the national emission limits on a number of atmospheric pollutants
[4] EEA, Technical Report no. 9/2008

The reduction from the early 90's onward in emissions of primary particulate materials, meaning nitrogen oxides and other substances responsible for the pollution registered in Italy and in the rest of Europe, has led to an unquestioned improvement in the quality of the air (in particular, SO_2, CO, benzene and lead no longer constitute, as things currently stand, a threat to human health, except under certain local conditions and isolated circumstances), but it has not resolved the problems of particulate, nitrogen dioxide and ozone, whose levels in recent years have often exceeded regulatory levels, which, in the meantime, have become more stringent. All the above confirms that atmospheric pollution is an extremely complex problem that, in addition to being the result of chemical-physical interactions in the atmosphere, is also affected by hemispheric factors, such as cross-border transport, together with regional-local causes, including the growing anthropogenic transformation of the territory, with the resulting demands and decisions regarding energy sources, mobility and industrial development. In order to preserve air quality where it is good, and restore it where necessary, vigorous, increasingly integrated and long-term measures must be taken.

Our country is working, on both the local and national levels, to implement clean-up measures, especially in the transportation sector, where the ongoing rise in demand continues to be one of the primary causes of pollution in urban areas. On the national level, as support for the initiatives undertaken by the regional governments, which are not yet sufficient to deal with the emergency, a national plan of extra-regional measures is being drawn up.

State of air quality

O_3, PM_{10}, NO_2 are the most critical pollutants, especially in large urban areas.

The most critical pollutants, given the high concentrations found in the atmosphere, continue to be ozone (O_3) during the summer months, PM_{10} atmospheric particulate, especially in winter, and nitrogen dioxide (NO_2). This situation, common to many European countries, together with the difficulty of bringing levels of the pollutants below the regulated limits, were taken into consideration by the new directive on air quality (Directive 2008/50/EC). While maintaining the upper limits unchanged, art. 22 of the directive

makes possible requests for extensions or waivers (for nitrogen dioxide, PM_{10} and benzene) of the limit values and the deadlines for compliance. Our country, which must take advantage of this possibility, and intends to do so, is involved in this process regarding PM_{10} and nitrogen dioxide, which will depend on how complete, reliable and effective the documentation presented will be judged to be.
Though in Europe, on the whole, there have been signs of fairly marked decreases in atmospheric concentrations, and quite recently (in the case of sulphur dioxide, carbon oxide, benzene and nitrogen oxides as well), concentrations of PM_{10}, nitrogen dioxide and ozone remain a problem, especially in urban areas. The average pollution from PM_{10} and ozone in the major urban agglomerates of the 27 countries of the EU from 1999 to 2007, as shown in Figure 3.1 (where ozone is indicated as SOMO35[5]), points to a stable situation. Seeing that the graph presents the averages of situations, it provides an easily understandable illustration of periods of greater generalised intensity, such as 2003 and, though to a lesser degree, in 2006, when factors of weather and climate resulted in high level of PM_{10}, and of ozone in particular, in the atmosphere[6].
As can be seen, the average concentrations of PM_{10} sat at levels of between 27 and 31 $\mu g/m^3$[7], higher than the 20 $\mu g/m^3$[8] recommended by the World Health Organisation (WHO).

[5] SOMO35 is an index of high accumulated exposure, calculate as the total sum of the differences between the maximum daily average over eight hours and the level of 35 ppb (parts per billion)
[6] ETC/ACC, Technical Paper 2009/3 "*European Exchange of Monitoring Information and State of the Air Quality in 2007*"
[7] Obviously, this does not rule out that the annual limit of 40 $\mu g/m^3$ was also exceeded in certain agglomerates, as took place in Bulgaria, the Czech Republic, Greece, Italy, Poland, Romania and Slovenia
[8] WHO Regional Publications, European Series no. 91 "*Air Quality Guidelines for Europe*": 20 $\mu g/m^3$ is the lowest level at which total mortality (cardiopulmonary and pulmonary cancer) grows at an interval of reliability greater than 95% in the event of prolonged exposure

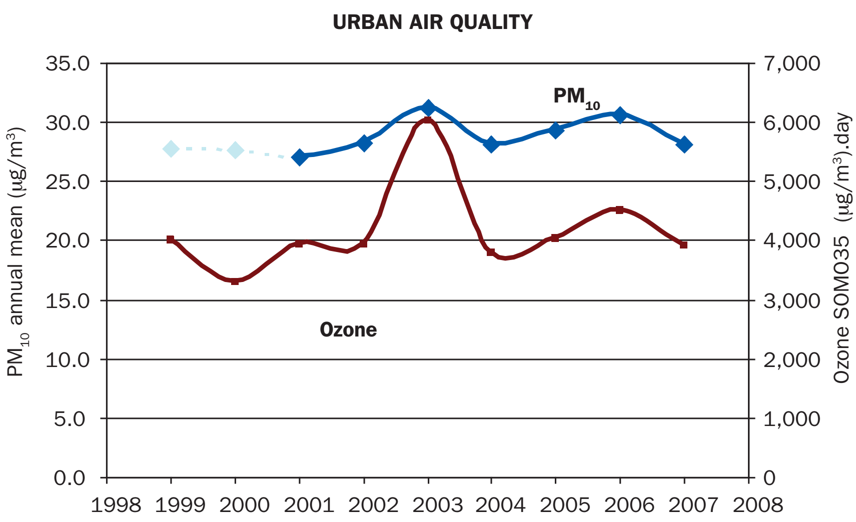


Figure 3.1: PM_{10} (annual average) and ozone (SOMO35) in the large urban agglomerates of the 27 EU countries from 1999 to 2007[9]

Between 1999 and 2007, average pollution from PM_{10} and ozone in the large urban agglomerates of the 27 countries of the EU proved stable.

The following figures on PM_{10}, $PM_{2,5}$, nitrogen dioxide and ozone illustrate the situation in Italy within the context of the rest of Europe, updated to 2007. Apart from $PM_{2.5}$, for which the information on spatial coverage was insufficient, the levels of the other pollutants in our country were found to be critical (Figures 3.2, 3.3, 3.4 and 3.5).

PM_{10}, nitrogen dioxide and ozone present critical situations in Italy.

[9] Source: ETC/ACC Technical Paper2009/3. The graph was drawn up for the European agglomerates reported on in compliance with Decision 2004/461/EC, based on the monitoring data collected in AirBase (only data from urban and suburban monitoring stations presenting at least 75% valid data were utilised)

*PM_{10}, 2007.
Over 38% of the traffic monitoring stations exceeded the daily limit for the protection of human health.*

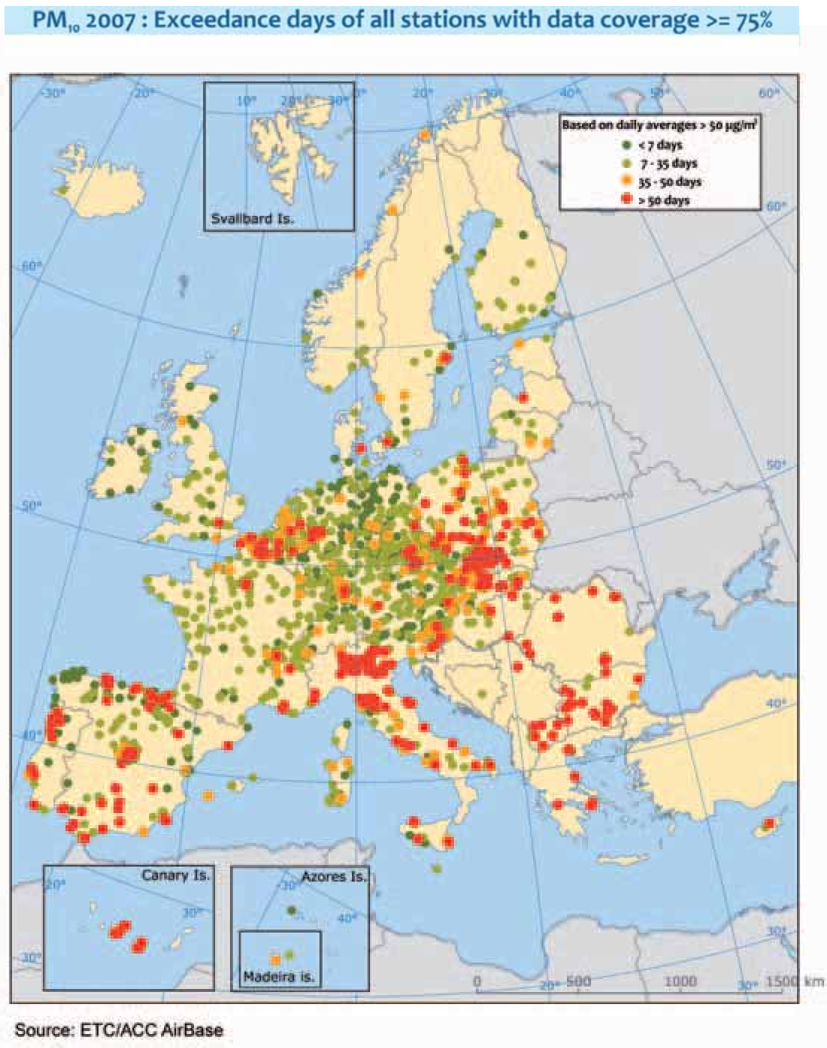
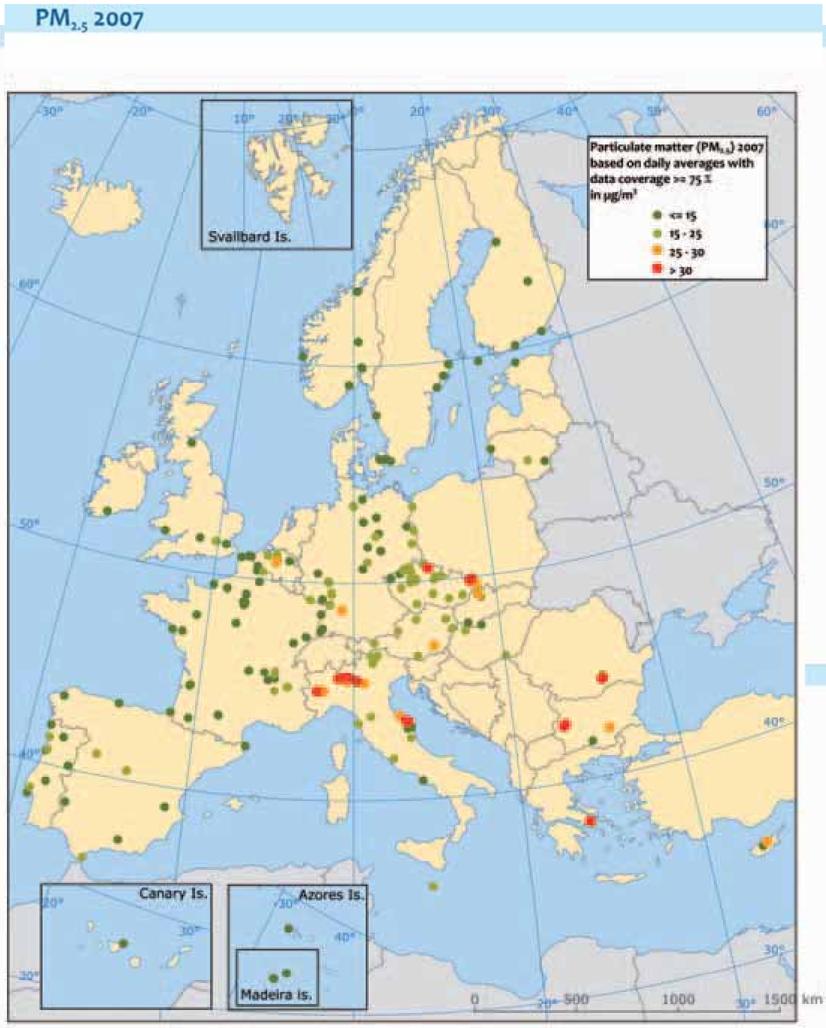


Figure 3.2: PM_{10} - Number of days in which the daily limit for the protection of human health was exceeded (50 μg/m³, not to be exceeded more than 35 times in a calendar year)[10]

[10] Source: http://air-climate.eionet.europa.eu/databases/airbase/eoi_maps/index_html

$PM_{2,5}$, 2007.
The area covered by the monitoring stations is currently insufficient.

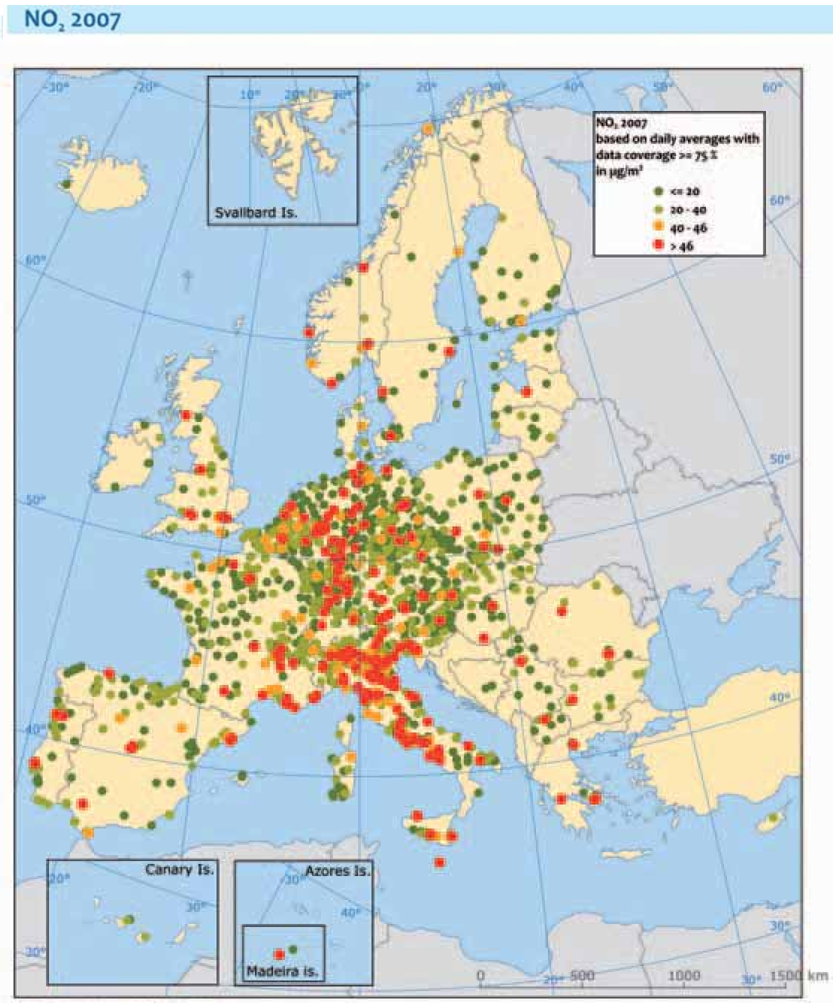


Source: ETC/ACC AirBase

Figure 3.3: $PM_{2.5}$ – Average annual concentration (limit value of 25 µg/m³ to be met in 2015)[11]

[11] Source: ibidem

Nitrogen dioxide, 2007. More than 50% of the traffic monitoring stations exceeded the annual limit.



Source: ETC/ACC AirBase

Figure 3.4: NO_2 – Average annual concentration (limit value of 40 μg/m³ to be met in 2010)[12]

[12] Source: ibidem

Ozone, 2007.
Levels higher than the long-term objective for human health were registered by 45% of the rural monitoring stations and approximately 30% of those located in urban areas.

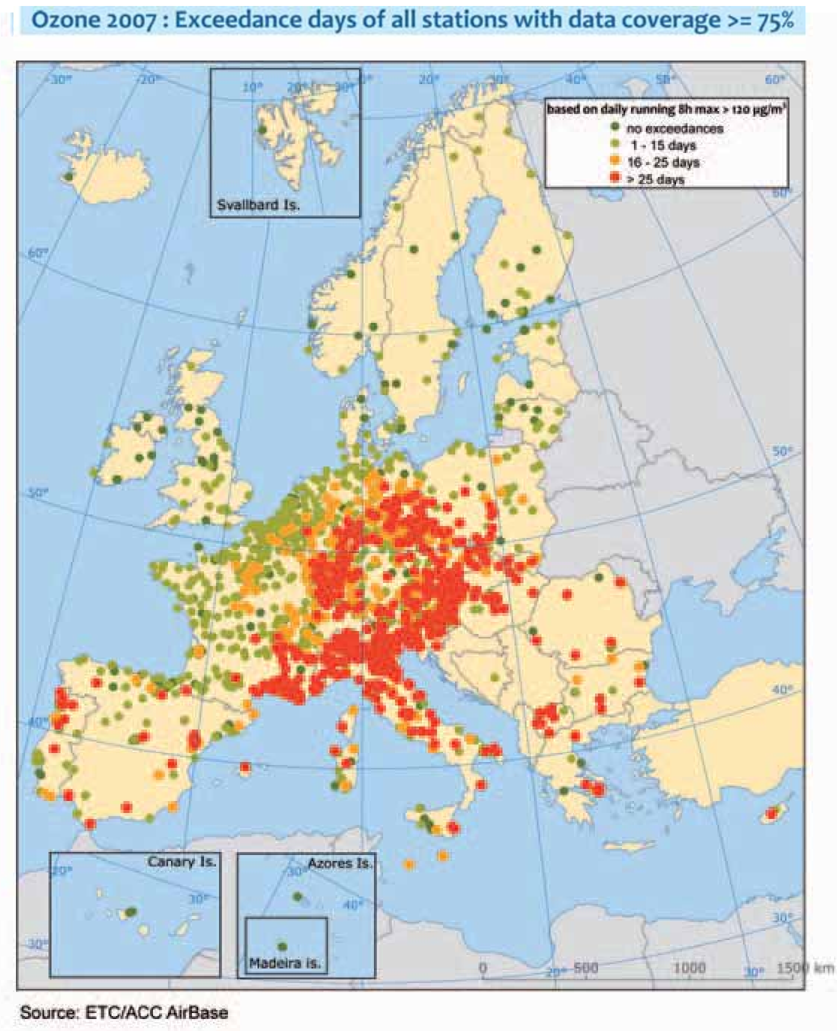


Figure 3.5: O_3 – Number of days in excess of the long-term objective for the protection of human health (120 μg/m³ as the daily maximum average over 8 hours)[13]

[13] Source: ibidem

Monitoring is the main source of information on air quality.

In Italy, the main source of information on air quality, and the most reliable, consists of the monitoring performed by approximately 700 stations distributed throughout the national territory.
The data registered at the monitoring stations are used by the individual Italian regions for the evaluation and management of air quality (Legislative Decree 351/99, Ministerial Decree DM 60/2002 and Legislative Decree 183/2004), as well as for exchanges of information among the member states of the European Community (Decision 97/101/EC on the Exchange of Information, *EoI*) and for the dissemination of information to the public, on the local level and national level, in this last case through the BRACE database (www.brace.sinanet.apat.it) and the ISPRA Yearbook of Environmental Data. The daily limit value set on PM_{10} is 50 $\mu g/m^3$, not to be exceeded on more than 35 days of the year, while the annual limit is 40 $\mu g/m^3$. These limits are often exceeded, especially the more stringent daily one, which is exceeded by 52% of the stations in 2008 (Figure 3.6). Despite the noticeable difference in monitoring density between Northern and Southern Italy (higher in the north and lower in the south), there is no mistaking the well known critical situation of large cities, especially in the Po Valley area, where the highest levels are reached most frequently.
Despite the significant decrease in emissions of PM_{10}, nitrogen oxides and non-methane volatile organic compounds registered from 1990 to 2007 (the ISPRA National Emissions Inventory), levels in the atmosphere currently present a stable situation. In the case of PM_{10}, this would appear to be confirmed by the graph in Figure 3.7, which presents a number of descriptive statistics calculated on the basis of the annual average for a selected set of monitoring stations that are few in number but uniform in terms of the time periods covered. Naturally the stability portrayed by the graph, which illustrates a situation based on averages, does not rule out the possibility of local situations that prove better or worse. This only confirms the complexity of air pollution, and especially in the case of particulate, which, in addition to having a predominant secondary component[14], such as nitrogen dioxide or ozone, presents distinctive characteristics (it is not a single chemical compound, but a

[14] The secondary component of an atmospheric pollutant does not originate from the emission source, but is formed through photochemical processes that start from other substances known as precursors (nitrogen oxides, volatile organic compounds, sulphur dioxide, ammonia)

complex and variable mix of chemical ingredients that can be of either natural or anthropogenic origin) that make understanding how it pollutes, how it should be managed and what measures of reduction should be applied even more difficult than with the other pollutants.

PM_{10}, 2008. The daily limit was exceeded by 52% of the monitoring stations. The most critical situation is in Northern Italy.

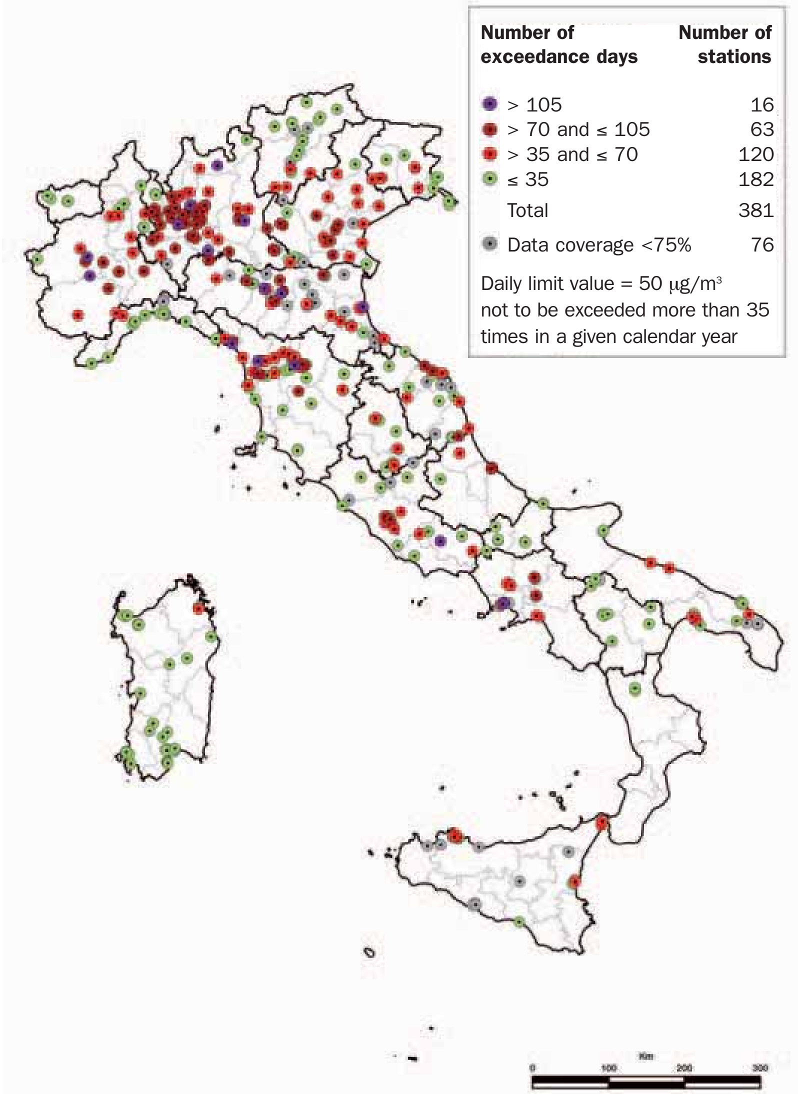


Figure 3.6: PM_{10} - Monitoring stations by categories of days over daily limit value (2008)[15]

[15] Source: ISPRA

PM_{10}: from 2003 to 2008 the situation was stable.

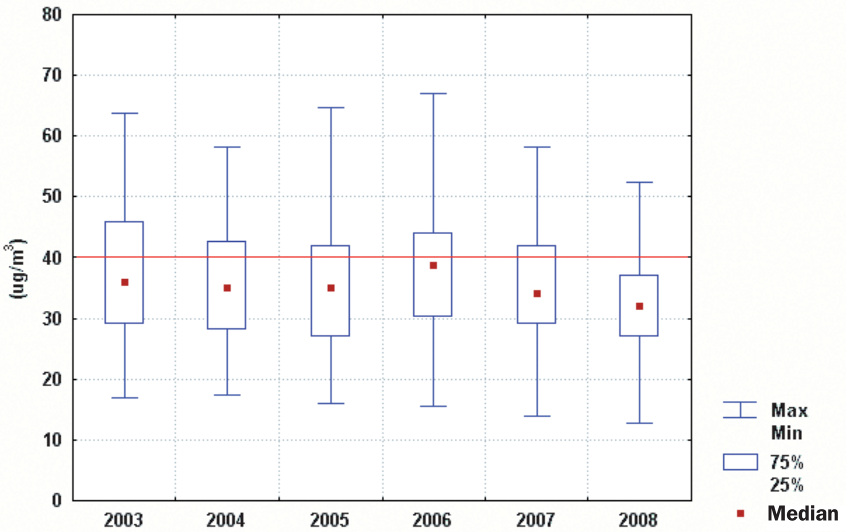


Figure 3.7: PM_{10}, annual average – Descriptive statistics calculated on the basis of a selection of 75 monitoring stations distributed throughout the national territory[16]

2006 e 2007: 40% of the resident population of Italian municipalities (>100,000 inhabitants) was exposed to levels of PM_{10} of 30-40 $\mu g/m^3$.

8,000 deaths a year can be attributed to average concentrations of PM_{10} > 20 $\mu g/m^3$.

Negative effects on health are associated primarily with $PM_{2,5}$.

A recent ISPRA analysis performed using monitoring data[17] estimates that, in 2006 and 2007, roughly 40% of the population in Italian municipalities with more than 100,000 inhabitants was exposed to levels of PM_{10} of 30-40 $\mu g/m^3$, while 30% of the population was exposed to levels higher than 40 $\mu g/m^3$. The same study estimate similar exposure values for the infant population. As regards the relation between PM_{10} found in the air that is breathed and the negative effects on health, a WHO study estimated that, in 2002-2004 more than 8,000 deaths in Italy's largest cities could be attributed to average concentrations of PM_{10} greater than 20 $\mu g/m^3$ [18] (see note 8).
It has been extensively demonstrated that the negative effects of atmospheric particulate on health are tied primarily to the smallest size fraction of the particulate, essentially on account

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[16] Source: ibidem
[17] ISPRA, Yearbook of Environmental Data, 2008 ed.
[18] M.Martuzzi, F.Mitis, I.Iavarone, M.Serinelli "Impatto sanitario di PM_{10} e Ozono in 13 città italiane", WHO, APAT, 2007

of its capacity to penetrate more deeply into the respiratory system. Based on this knowledge, Directive 2008/50/EC on air quality, soon to be transposed into Italian law, has set for $PM_{2.5}$[19], as part of an innovative approach calling for a general reduction in the concentration in the air, in order to ensure an improvement in air quality for much of the population, an annual limit value of 25 $\mu g/m^3$, to be met by 2015. In the wake of this requirement, as well as the monitoring obligations that will follow, information of the concentrations of $PM_{2.5}$ in the air, currently scarce and not indicative of the overall situation (Figure 3.8), shall tend to increase.

[19] Art. 2 of Directive 2008/50/EC states: $PM_{2.5}$ is a particulate material that through a dimensionally selective entry point, in accordance with the standard method for sampling and measuring $PM_{2,5}$, in accordance with the standard EN 14907, at a penetration efficiency of 50% for particulate material with an aerodynamic diameter of 2.5 μm

PM2,5, 2008.
Information, which is currently insufficient, shall increase following implementation of Directive 2008/50/EC.

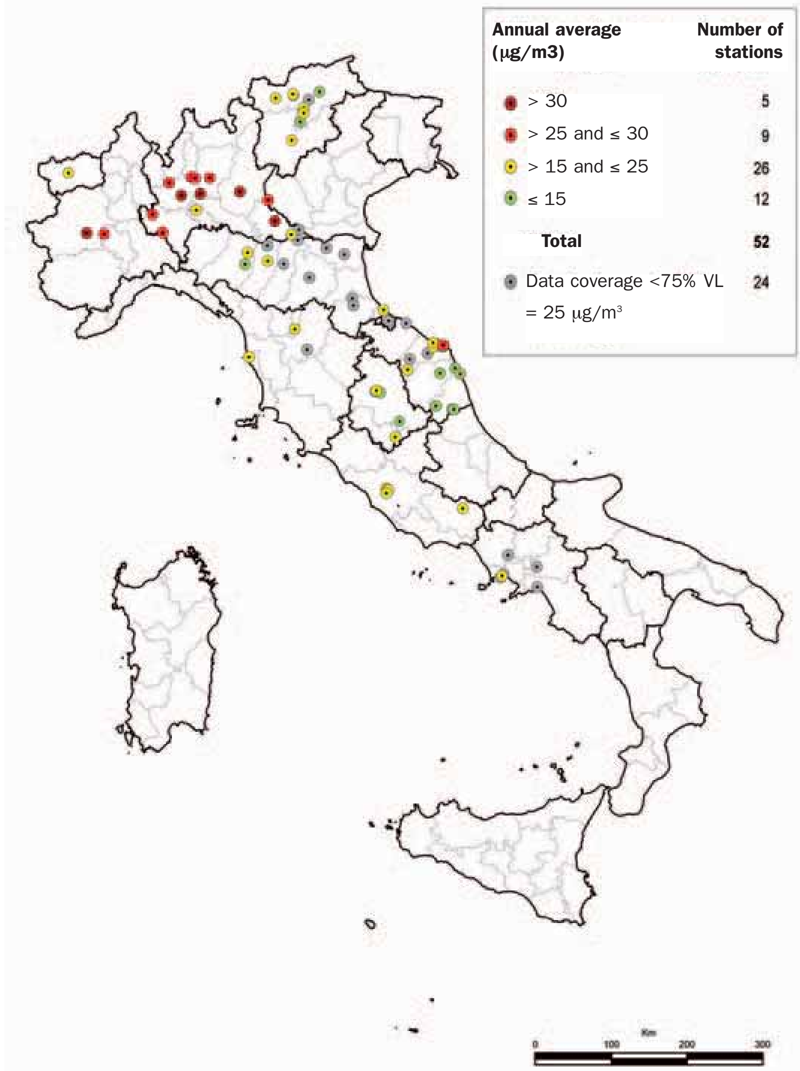

Figure 3.8: $PM_{2,5}$ - Monitoring stations by categories of average annual value (2008)[20]

[20] Source: ISPRA

Ozone, summer period 2009: 93% of the stations registered levels over the long-term objective.
The situation was most critical in Northern Italy.

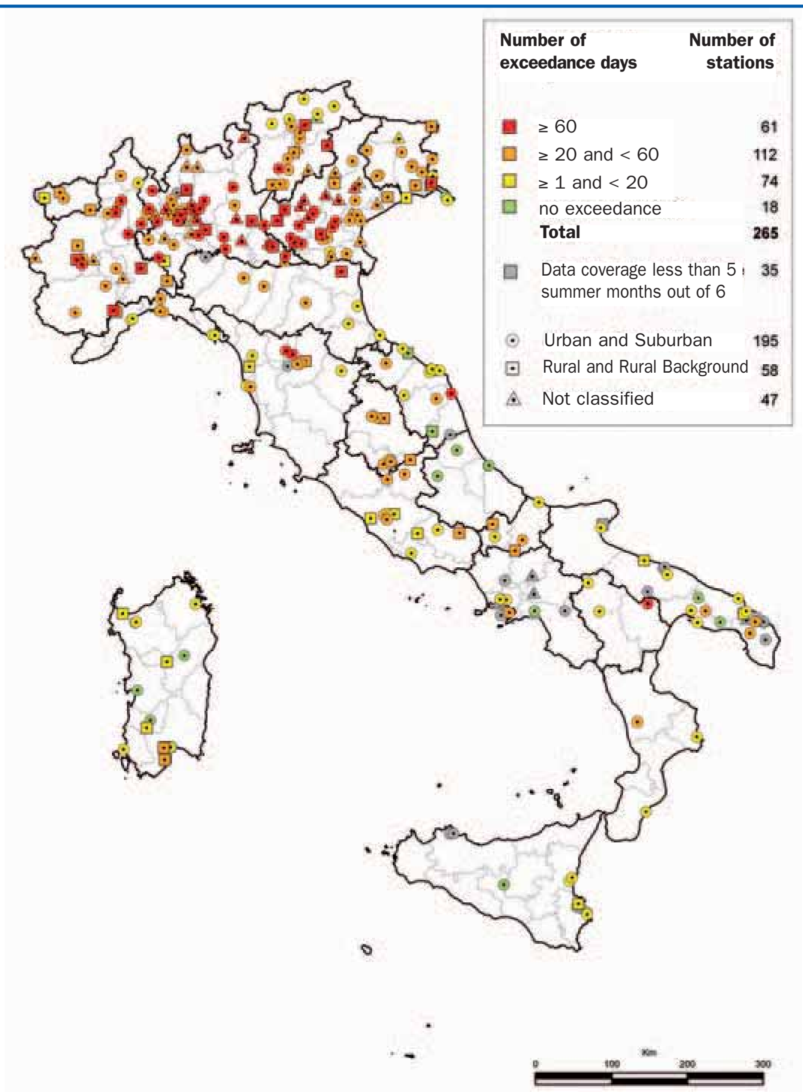

Figure 3.9: Summer O_3 – Monitoring stations by categories of days in excess of long-term objectives for the protection of human health (120 µg/m³) (2009)[21]

[21] Source: ISPRA

The highest levels of ozone are registered during the summer season and at sites where the impact of traffic is not direct.

Ozone pollution is a problem typical of summer: the highest concentrations are registered in the hottest months of the year and during the hours of maximum solar radiation, given that the ozone is formed through photochemical reactions starting from precursors that consist of volatile organic compounds and nitrogen oxides. Especially in urban areas, the ozone forms and is transformed extremely rapidly, showing highly complex behaviour that differs from that of other pollutants: unlike PM_{10}, the highest levels of ozone are registered not at sites characterised by high traffic density but at sites where the impact of traffic is not direct.
The long-term objective for the protection of human health (120 $\mu g/m^3$) - which, of all the parameters defined under the legislation is the one that best describes situations of pollution and exposure of the population weighted over time, was exceeded by the vast majority of the stations: during the summer period of 2009 (from the start of April to the end of September), only 7% of the stations (18 stations out of the 265 that supplied information for at least five summer months out of six) did not register levels in excess of the long-term objective (Figura 3.9).
Even considering the undeniable difference in monitoring density between Northern and Southern Italy, the most critical areas were found to be in Northern Italy.
As in the case of PM_{10}, the average level of ozone pollution was stationary, as demonstrated by Figure 3.10, which illustrates a number of descriptive statistics for the indicator SOMO0[22] during the summer periods from 2003 to 2008, calculated for a set of monitoring stations that is limited in number but uniform in terms of the types of station and the time periods covered.

[22] SOMO0 is an exposure index calculated by taking the total sum of the maximum daily mobile averages over eight hours, divided by the number of valid days, meaning those for which an average for eight hours is available

Summer ozone: from 2003 to 2008, the situation was stable.

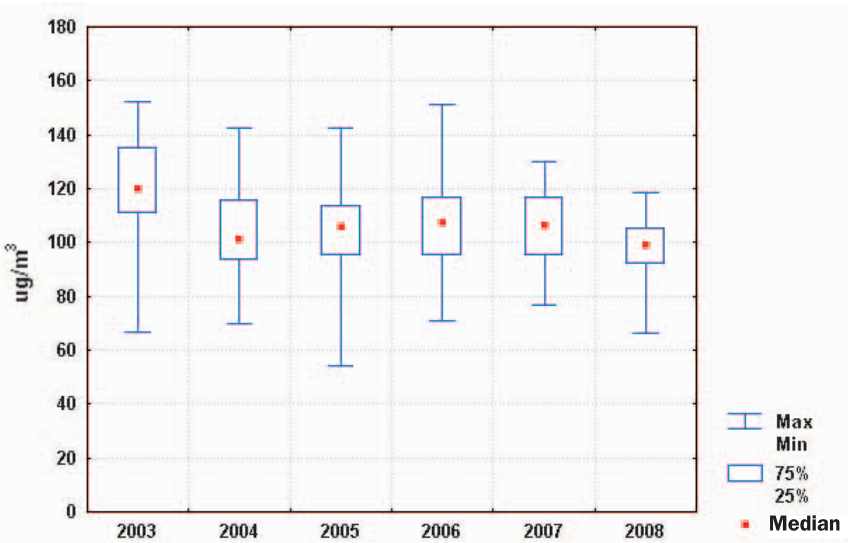

Figure 3.10: Summer O_3, SOMO0 – Descriptive statistics calculated for a selected set of 78 monitoring stations distributed throughout the national territory[23]

An ISPRA study[24] estimated that, in 2006 and 2007, the majority of the populations of Italian municipalities with more than 100,000 inhabitants was exposed to levels of ozone higher than 120 $\mu g/m^3$, and specifically to levels of between 160 and 180 $\mu g/m^3$. The same study estimated similar levels of exposure for the infant population.

2006 and 2007: the majority of the population of Italian cities (pop. >100,000) was exposed to levels of O_3 > 120 $\mu g/m^3$.

Ozone also has negative effects on human health, though to a lesser extent than PM_{10}: a WHO study estimated that, in 2002-2004, roughly 500 deaths in Italy's largest cities could be attributed to this pollutant[25].

500 deaths a year can be attributed to ozone.

Nitrogen compounds, whose chief sources are transportation an agriculture, play an important role as precursors of particulate matter and ozone, and are currently, following the drop in emissions of sulphur oxides, the primary acidifying components

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[23] Source: ISPRA
[24] ISPRA, Yearbook of Environmental Data, 2008 ed.
[25] M.Martuzzi, F.Mitis, I.Iavarone, M.Serinelli "Impatto sanitario di PM_{10} e Ozono in 13 città italiane", WHO, APAT, 2007

in the air. As for nitrogen dioxide, the annual limit value for the protection of human health (40 µg/m³), scheduled to go into effect in 2010, was respected by 71% of the stations in 2008 (Figure 3.11).

Nitrogen dioxide, 2008: at 71% of the stations, the annual limit for the protection of human health (40 µg/m³) was not exceeded.

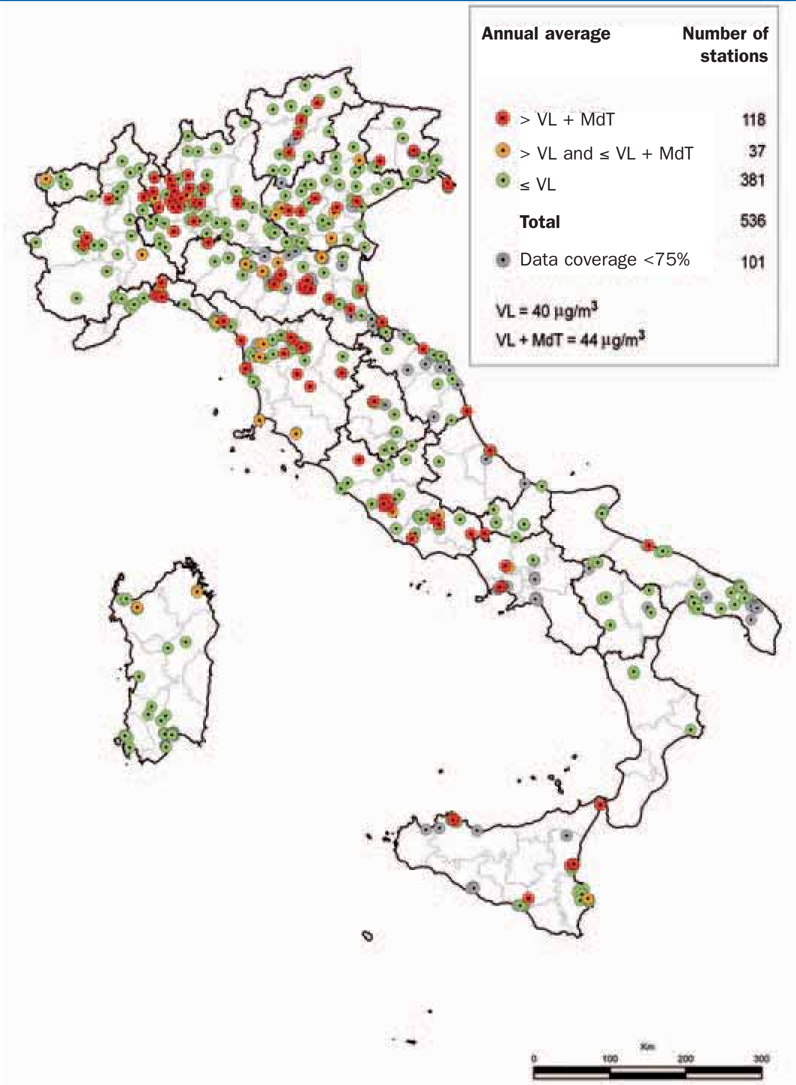

Figure 3.11: NO_2 - Monitoring stations by categories of average annual value (2008)[26]

[26] Source: ISPRA

The graph in Figure 3.12, based on a set of stations limited in number (136 stations out of the more than 500 in operation in 2008), but uniform in terms of the time period covered, shows that, in the case of nitrogen dioxide as well, average levels remained essentially between 2003 and 2008.

Nitrogen dioxide: from 2003 to 2008 the situation was stable.

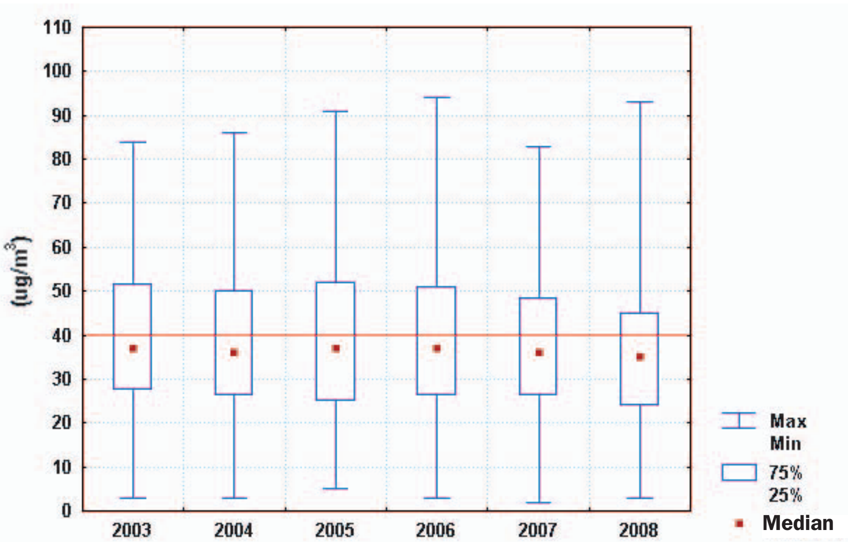

Figure 3.12: NO_2, annual average - Descriptive statistics calculated for a selected set of 136 monitoring stations distributed throughout the national territory[27]

The main causes of air quality deterioration

The growing anthropogenic transformation of the land, with its ever increasing demands in terms of sources of energy, mobility and industrial development, is the chief cause of the poor state of the air we breath.

The economic sectors contribute in different ways to emissions of the main pollutants in the air.

[27] Source: ibidem

In 2007, the transportation sector was responsible for 36% of PM_{10}, 41% of $PM_{2,5}$, 68% of NOx and 38% of NMVOC emissions in Italy.

Based on the information found in the 2007 National Emissions Inventory published by the ISPRA[28], the main source of PM_{10} as a primary component of pollution is the transportation sector, which accounts for 36% of the total, of which approximately 2/3 is traceable to roadway transport; next come industry (26%), the residential sector (17%) and agriculture (11%).
Transportation is also the main source of $PM_{2,5}$ emissions (again, in terms of $PM_{2,5}$ as a primary component alone), accounting for 41%, of which 2/3 is traceable to roadway travel; next come industry (23%), the residential sector (20%) and agriculture (12%).
As for the precursors[29] of tropospheric ozone, meaning nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC), the main source of NO_x emissions is transportation, which accounts for 68%, of which approximately 3/4 is traceable to roadway transport; industry accounts for 14%, energy production for 9% and the residential sector for 8%. In the case of NMVOC, transport accounts for 38% of all emissions, while 43% come from the use of solvents and the remainder from the industrial sector, the residential sector and other minor sectors.

Europe, 2007: 40% of NOx emissions were caused by the transport sector.

In 2007 transportation, and roadway transport in particular, were the primary source of emissions in the rest of Europe as well[30], accounting for 40% of NO_x emissions and 16% of NMVOC. The other main sources of NO_x emissions are electricity production (19%), industrial combustion and the residential sector. The main sources of NMVOC, apart from roadway transport, are domestic and industrial uses of solvents (23%), the use of solvents in paints (15%) and domestic heating (9%). The main emissions sector for PM_{10} and $PM_{2,5}$ was residential heating (19% and 27% respectively), followed by roadway transport (14% and 18% respectively).
In terms of overall emissions trends, from 1990 to 2007 marked reductions were registered in Italy in emissions of PM_{10} (-30%, with especially sharp decreases in the energy and industrial sectors), NO_x (-43%) and NMVOC (-38%)[31].

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[28] http:// www.sinanet.apat.it/it/sinanet/serie_storiche_emissioni
[29] Precursors are substances that lead to the formation of tropospheric ozone through photochemical reactions in the atmosphere
[30] EEA, Report no. 8/2009
[31] ISPRA, Italian Greenhouse Gas Inventory, 2007

Emissions trends from 1990 to 2007 were also sharply downward for Europe as a whole: in the EU27 countries, NO_x emissions decreased by 36%, NMVOC emissions by 47% and those of SO_x by approximately 72%. From 2000 to 2007, emissions of PM_{10} and $PM_{2,5}$ fell by respective figures of 11% and 12%.
In our country, emissions of tropospheric ozone precursors, PM_{10} and SO_x fell considerably in all the regions from 1990 to 2005, with the magnitude of the decrease depending on the presence of large-scale industrial plants, for which stringent limits were introduced in the 90's on smokestack emissions of SO_x, NO_x and PM_{10}[32].
The regional emissions for the substances indicated above are illustrated for the years 1990, 1995, 2000 and 2005 (Figures 3.13, 3.14, 3.15).

From 1990 to 2007, emissions of NO_x, NMVOC, SO_x, PM_{10} and $PM_{2,5}$ fell in the EU27countries.

Italy, 1990-2005: emissions of PM_{10}, SO_x and NO_x fell in all regions.

Reductions in SO_x were registered in all the regions from 1990 to 2005, in a range of 60% to 90%.

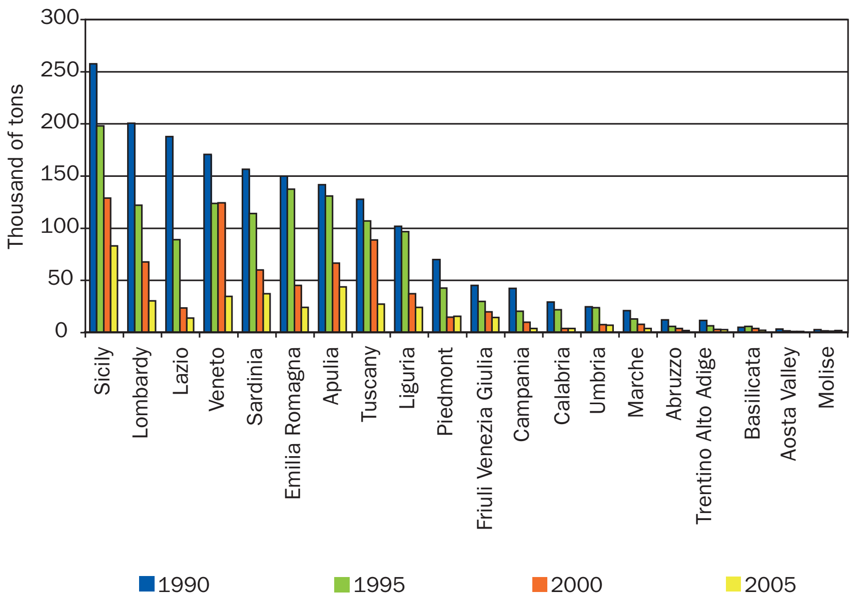

Figure 3.13: Regional emissions of SO_x[33]

[32] Ministerial Decree of 12 July 1990, "Guidelines for Limiting Polluting Emissions from Industrial Plants and Setting Minimum Emission Levels"
[33] Source: ISPRA

Reductions in NO_x were registered by all the regions from 1990 to 2005, in a range of 30% to 60%, with the exception of Molise, where emissions remained stable.

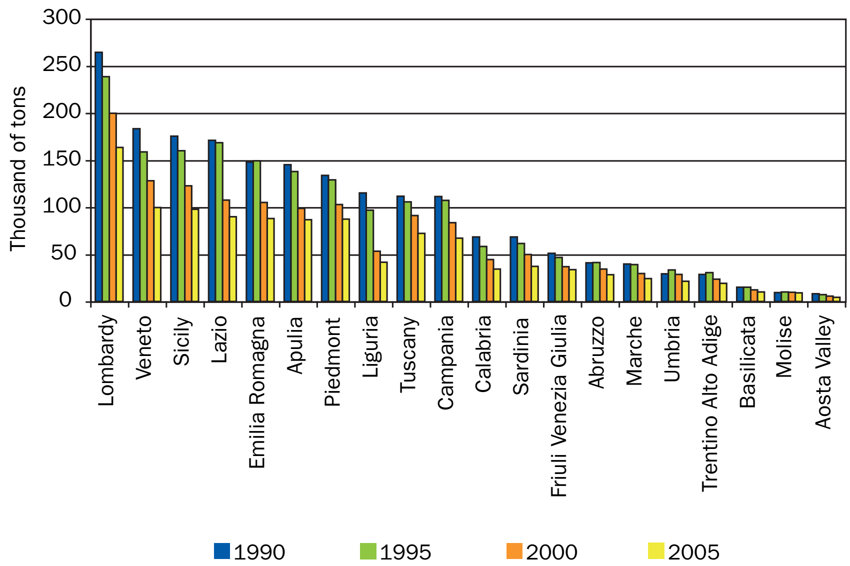

Figure 3.14: Regional emissions of NO_x [34]

Reductions in PM_{10} were registered by all the regions from 1990 to 2005, in a range of 15% to 45%, with the exception of Molise and Basilicata.

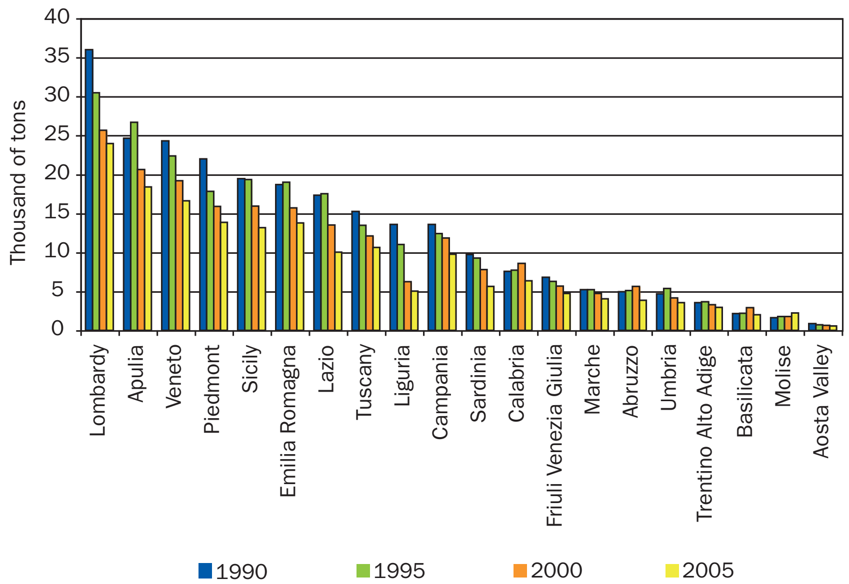

Figure 3.15: Regional emissions of PM_{10} [35]

[34] Source: ISPRA
[35] Source: ISPRA

The points briefly illustrated indicate that transport, and especially the roadway mode, is one of the main causes of the high concentrations of PM_{10}, $PM_{2,5}$ and ozone precursors registered in the air. This critical problem is especially acute in cities where the levels of population and transport density are highest. In urban settings, emissions from roadway transport account for more than 70% of overall emissions of PM_{10}, $PM_{2,5}$, NO_x and COVNM.

In urban environments roadway transport is responsible for more than 70% of PM_{10}, $PM_{2,5}$, NOx and COVNM emissions.

Levels of harmful gas emissions from roadway transport during the period 1990-2007 were the result of two contrasting trends: emissions tend to increase because of the continuous growth in the vehicle pool and the distances travelled, though, in reality, they decrease, thanks to the upgrading of the vehicle pool to meet increasingly stringent emissions standards[36] whose effect, in terms of reducing emissions, has been even greater.

The renewal of the vehicle pool has played a decisive role in the noteworthy rates of reduction registered for NO_x, COV and benzene in the years following 1995.

Since 1995, there have been significant reductions in NO_x, COV, Pb and C_6H_6, as well as PM_{10}, though to a lesser extent, on account of the renewal of the vehicle pool and the quality of the fuels.

The problem of benzene and lead in transport emissions has been solved by reducing their content in gasoline. Emissions of PM_{10} have fallen to a limited extent, because the renewal of the vehicle pool was characterised by a marked increase in diesel automobiles compared to gasoline-fuelled models, which have lower levels of PM_{10} emissions.

The growing request for mobility of both cargo and passengers is one of the chief demands that accompanies a country's growth. Over the last three decades, the demand for mobility, and especially the roadway transport portion, has grown constantly.

The demand for mobility rises together with a country's economic growth.

During the period 1990-2000 the demand for passenger transport rose by an annual average (a.a.) of 2.8%, a rate higher than the increase in the GDP (a.a. +1.6%, in Euro 2000). In the years 2000-2007 the growth in this demand slowed to a rate of a.a. 0.3%, lower than the growth in the GDP (a.a. +1%).

2000-2007: the demand for transport rose by a.a. 0,3% (GDP + 1%).

[36] These standards were introduced in Europe starting from January 1st 1993 under Directive 91/441/EC (Euro 1), up through the EC regulation of May 7th 2007, which established the standards and dates for Euro 5 and Euro 6

In 2007 private transport satisfied 81.5% of the demand for passenger transport.

Air transport shows extremely rapid growth.

Between 2000 and 2007 cargo traffic, and especially that travelling on roadways, increased by a.a. 1.4% (GDP +1%).

The demand for transport has been satisfied to an increasing extent by private transport, which accounted for 81.5% in 2007, leading to an increase in the vehicle pool. In 1990 the share was approximately 80%.
During the period 2000-2007, passenger transport by rail increased by 6.8% and bus transport by 23%, while air transport was the mode that grew most rapidly: the number of landings and take-offs rose by 135%.
Looking at cargo transport, whose growth is more directly tied to economic growth, the t-km transported over distances of more than 50 km grew by a.a. 1.2% in the period 1990-2000, a rate slightly lower than that of the GDP; during the period 2000-2007 there was growth of a.a. 1.4%, a rate significantly higher than the GDP.
Though the revisions made, during the period in question, in the methodology for collecting data may have affected their consistency, there is no question that changes in production processes ("just in time", delocalisation/fragmentation of production among the EU-27 countries) and in models of consumption have contributed to increasing cargo traffic in recent years at a rate higher than the growth of the GDP. In 2007, roadway transport absorbed 61.5% of national demand, railway transport 11.5% and short-haul shipping 21.7%. Adding to these estimated traffic figures are cargo distribution activities (transports over distances of less than 50 km), carried out exclusively on the road. The lone estimate available for assessing the impact of distribution is the distance travelled by light vehicles: equal to almost 3.5 times the total for vehicles that transport cargo over distances of more than 50 km.

Initiatives designed to improve air quality

Directive 96/62/EC[37], transposed into Italian law under Legislative Decree 351/1999[38], not only sets the quality objectives and the criteria for evaluating air quality, but also establishes the criteria for its management, meaning the maintenance of ambient air quality

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[37] Directive 1996/62/EC, issued by the Council on September 27th 1996, with regard to the assessment and management of environmental air quality – Official Gazette, issue L 296 of 21 November 1996

[38] Implementation of Directive 96/62/EC on the assessment and management of environmental air quality – Official Gazette, issue no. 241 of October 13rd 1999

where it is good and its improvement in other cases. Through a series of steps, these criteria lead to the formulation of air quality plans and short-term action plans whose content includes, among other elements, measures for safeguarding air quality.

Regions/autonomous provinces are required to implement an air quality plan when regulatory limits are exceeded.

Regions and autonomous provinces are required to implement air quality plans when the concentration of one or more of the atmospheric pollutants indicated in Ministerial Decree 60/2002[39], or under Legislative Decree 183/2004 in the case of ozone, is higher than the figure for the corresponding regulatory parameter set to protect human health.

Plans for improving air quality: investigative phase (local inventories), assessment phase (data on air quality) and proposal phase (reclamation measures, emission and air-quality scenarios).

The process of drawing up a plan for improving air quality starts with an investigative phase that examines the physical characteristics of the territory, as well as the meteorological, climatic and socio-economic conditions, with local inventories playing a key role in assessing anthropogenic pressures; a phase for assessment of the current state of air quality, plus identification of critical zones in the territory, where initiatives of maintenance or improving must be taken; a phase for the assessment of trends through the modelling of scenarios, concluding with a phase for proposals. Proposals should contain: the objectives for the reduction of emissions of atmospheric pollutants needed to achieve compliance with air quality limits, the improving measures (rulings) with which the region/autonomous province counts on reaching these objectives (the measures in question can involve economic/tax initiatives, such as reductions or incentives; technical considerations, such as the use of low-impact technology; or information efforts, including campaigns to heighten awareness), plus quantification of the air quality benefits to be obtained from application of the improving measures and the estimated time for achieving them.

Potential problems with assessing the effectiveness and quantifying the time need for the proposed improving measures.

An analysis of the information on air quality plans communicated to ISPRA by the regions/autonomous provinces, under current regulations[40],

[39] Transposition into Italian law of Directive 1999/30/EC, issued by the Council on April 22rd 1999, regarding the environmental air-quality limit values for sulphur dioxide, nitrogen dioxide, particulate and lead, plus Directive 2000/69/EC on the environmental air-quality limit values for benzene and carbon monoxide – Official Gazette, issue no. 87 of April 13rd 2002 – Ordinary Supplement no. 77

[40] Communication of information on plans and programs, in compliance with Decision 2004/224/EC, generally occurs after the stipulated deadlines; for the year 2007, only 50% of the regions/autonomous provinces had communicated their information as of 20th October 2009

From 2005 to 2007, the number of measures taken increased, especially in Emilia Romagna and the Marche. More than half the regional interventions involved mobility.

points to potential problems primarily in the proposal phase, which proves lacking in terms of assessment of the actual effectiveness of the improving measures indicated, as well as quantification of the time needed for these measures to prove effective.
The main sectors of intervention in which the additional measures identified by the regions fall are: mobility, domestic/commercial activities, industry, agriculture, other[41].
Figure 3.16 shows the number of measures implemented by the regions in the three-year period 2005 – 2007, classified by sector of intervention.

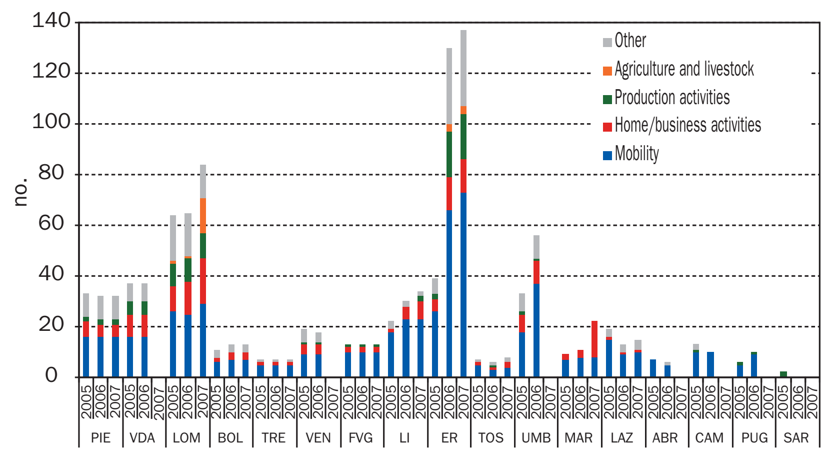

Figure 3.16: Measures taken to restore air quality, detailed by region (2005-2007)[42]

In 2007 the number of measures taken by the regions to restore air quality rose by 15% over the previous year.

As shown by Figure 3.16, the number of measures undertaken by the regions to restore air quality increased during the three-year period 2005-2007. In 2005, there were 341 measures

[41] The category “Other” includes: accessory measures in urban centres; studies and projects and initiatives for restructuring or expansion of air quality monitoring networks; the activation of air-quality control devices and initiatives involving the restructuring, upgrading to quality standards and expansion of monitoring networks
[42] Source: ISPRA processing of data communicated by the regions and the autonomous provinces by October 20th 2009. The regions that did not present the questionnaire (having failed to meet the requirement or because they were exempt) are not shown

throughout the national territory, with the number rising to 457 in 2006, while the year 2007, based on the information available as of 20th October 2009, appears to have registered a 15% increase over the previous year. Mobility continues to be the sector most frequently involved, though agriculture and the raising of livestock have received noteworthy attention by the Lombardy Region. Based on the information received to date, the regions that undertook the most measures in 2007 were Emilia Romagna, with 137, and Lombardy with 84.

In 2007 the regions that undertook the most measures were Emilia Romagna and Lombardy.

Looking specifically at the mobility sector, where the largest number of initiatives were taken, the measures were of the following types:

Measures taken.

- Promotion and dissemination of clean vehicles in public transport[43]
- Reinforcement of local public transport (LPT)
- Promotion and dissemination of clean vehicles in private transport
- Testing of exhaust emissions from motor vehicles
- Traffic restriction measures
- Regulation of urban freight distribution
- Drafting of urban plans (traffic, mobility, transport)
- Structural initiatives regarding mobility
- Initiatives for alternative mobility[44]
- Promotion and dissemination of clean vehicles in freight transport
- Technological support for sustainable mobility.

In order to provide a complete overview of the information received on the measures implemented in the mobility sector, the figures for 2006 have been examined. The number of measures enacted by each region are shown below, broken down by type.

[43] Low Environmental Impact

[44] Examples of initiatives in favour of alternative mobility: initiatives favouring two-wheeled mobility, systems of collective transport, car-sharing, car-pooling, on-call services, collective taxis

Roughly 71% of all the measures on mobility were concentrated in the regions of Piedmont, Aosta Valley, Lombardy, Liguria, Emilia Romagna and Umbria.

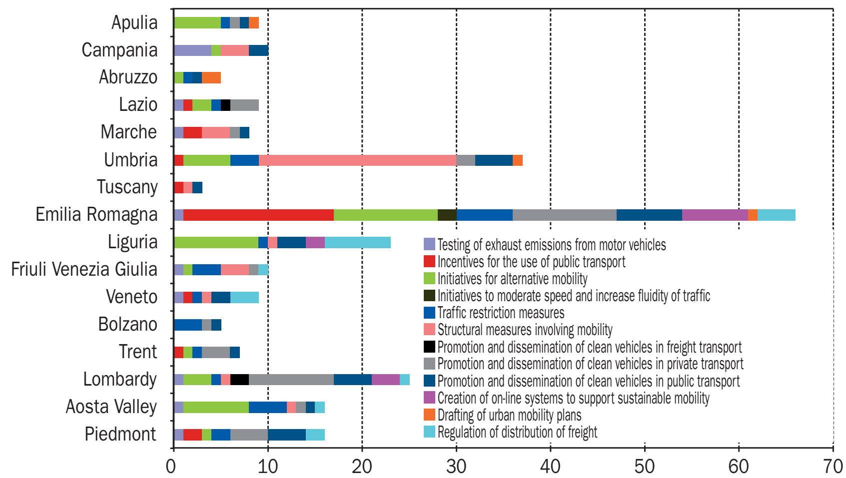

Figure 3.17: Regional restoration measures in the mobility sector (2006)[45]

Measures on mobility: the most frequently adopted regard alternative mobility (18%).

Figure 3.17 shows that the measures most frequently taken were:
- initiatives in favour of alternative mobility (18%);
- rulings regarding the public vehicle pool (14%);
- rulings regarding the private vehicle pool (14%);
- structural measures involving mobility (14%).

In support of the efforts of the regional governments, a national plan is currently being drawn up by the Ministry of the Environment, Land and Sea, in concert with the Ministry of Infrastructures and Transport, the Ministry of Economic Development and the Ministry of Agriculture, containing a package of emergency measures designed to further reduce emissions of the main pollutants in the atmosphere.
For although the measures taken on the regional and national have led to a noteworthy reduction in emissions over the years, this has not guarantee compliance with the limit values within the deadlines established under the legislation currently in force.

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[45] Source: Regions and the autonomous provinces data processed by ISPRA

With this in mind, a potential set of emergency measures is currently being jointly drafted by the competent ministries, including:

Set of emergency measures.

- reduction of emissions from the domestic heating sector (improved energy efficiency of buildings);
- potential initiatives involving speed limits on highway traffic (lowered in certain sections);
- upgrading of the off-road vehicle pool (i.e. industrial and agricultural vehicles); introduction of filters on old models an replacement with models of less impact;
- improved practices for the use of fertiliser in agriculture (placement belowground instead of spreading, introduction of new generation fertilisers).

The new directive on air quality calls for a single on-line information flow, with communication of the monitoring data in Near Real Time.

In terms of actions for the restoration of air quality, investigative initiatives, an area in which the ISPRA plays a major role, should not be neglected, nor should information efforts: environmental knowledge and transparency, in addition to constituting evident elements of democracy, serve as tools for improving the actions and forms of behaviour of both government and citizens. As things currently stand in Italy, the prevalent and most reliable source of information on the state of air quality is represented by the monitoring stations distributed throughout the national territory. It should be stressed that the regulations currently in force, and especially the Community measures about to be transposed into Italian law, set aside increasing space for the use of techniques of modelling and spatial surveying in the assessment of air quality. The communication of information from the local level to the national and European levels is, at present, a fairly complex procedure, given the large number of requirements to be met (Decision 97/101/EC, Legislative Decree 351/99, Ministerial Decree 60/2002 and Decisions 2004/461/EC and 2004/224/EC, plus Legislative Decree 183/2004), a situation that all too often gives rise to an excessive quantity of deadlines, coming one after another, as well as overabundance of modes of communication and contacts on the local level. Many of the current difficulties will be resolved with the transposition into Italian law and the enactment of the new Directive 2008/50/EC, which calls for a single flow of information travelling exclusively on-line. An advance

The regional monitoring networks are currently being update an revised, in order to make available information based on more uniform criteria and more suitable for comparison throughout the national territory and with the rest of Europe.

in the communication of information will be the availability of data in *Near Real Time* (NRT), meaning that the data registered by the monitoring stations will be available on-line only a limited amount of time following the period to which it refers. This operating mode, already used on an experimental basis in the European Union for ozone, under the Ozone Web project[46], will make available to the public data, for use as input in the development of models supporting local and national assessments and for forecasts.
In terms of the quality of the monitoring networks and their compliance with regulatory criteria, a process of updating and revision is currently underway, based on standards that call for subdivision of the territory into uniform zones, in order to improve the assessment and management of air quality. Though this revamping of the regional monitoring networks, carried out primarily by the regions and the Agency System on the local level, and by ISPRA and the Ministry of the Environment, Land and Sea on the central level, in the form of an integration of the monitoring data with other techniques (techniques of spatial surveying, modelling, satellite procedures and others), currently makes for complications when comparing data in terms of time and space, it shall ultimately result in information based on more uniform criteria and proving easier to compare for the entire national and European territories.
What continues to occur in our country, unlike the situation in the rest of Europe[47], is continued growth in the number of stations used under the EoI. As the number of stations communicating data for all the main pollutants has increased, so has the number of sets of data whose data coverage complies with the regulatory criteria, as is shown in Figure 3.18 for PM_{10}: all these developments point to an improvement in monitoring activities and, even more to the point, in the communication of information on the local and national levels.

[46] http://www.eea.europa.eu/maps/ozone/welcome
[47] AirBase shows that in 2007, as compared to 2006, the number of monitoring stations fell for all pollutants, except for the IPA and metals of Directive 2004/107/EC

Monitoring activities and, even more importantly, the communication of information from the local level to the national level, are improving.

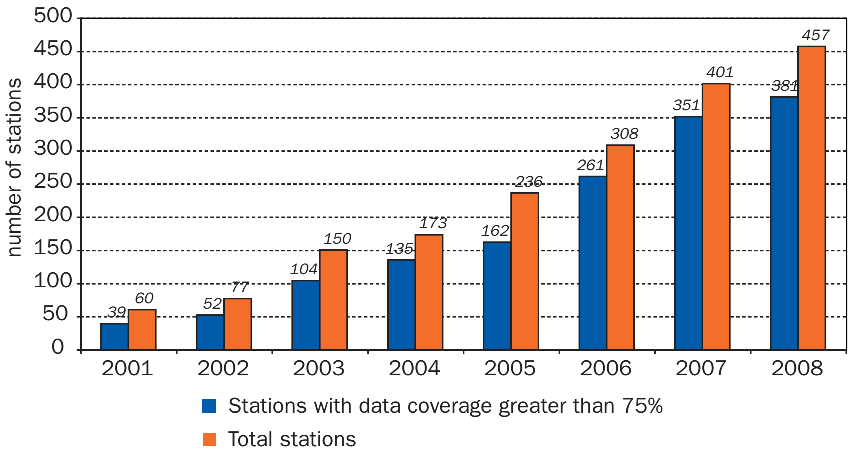
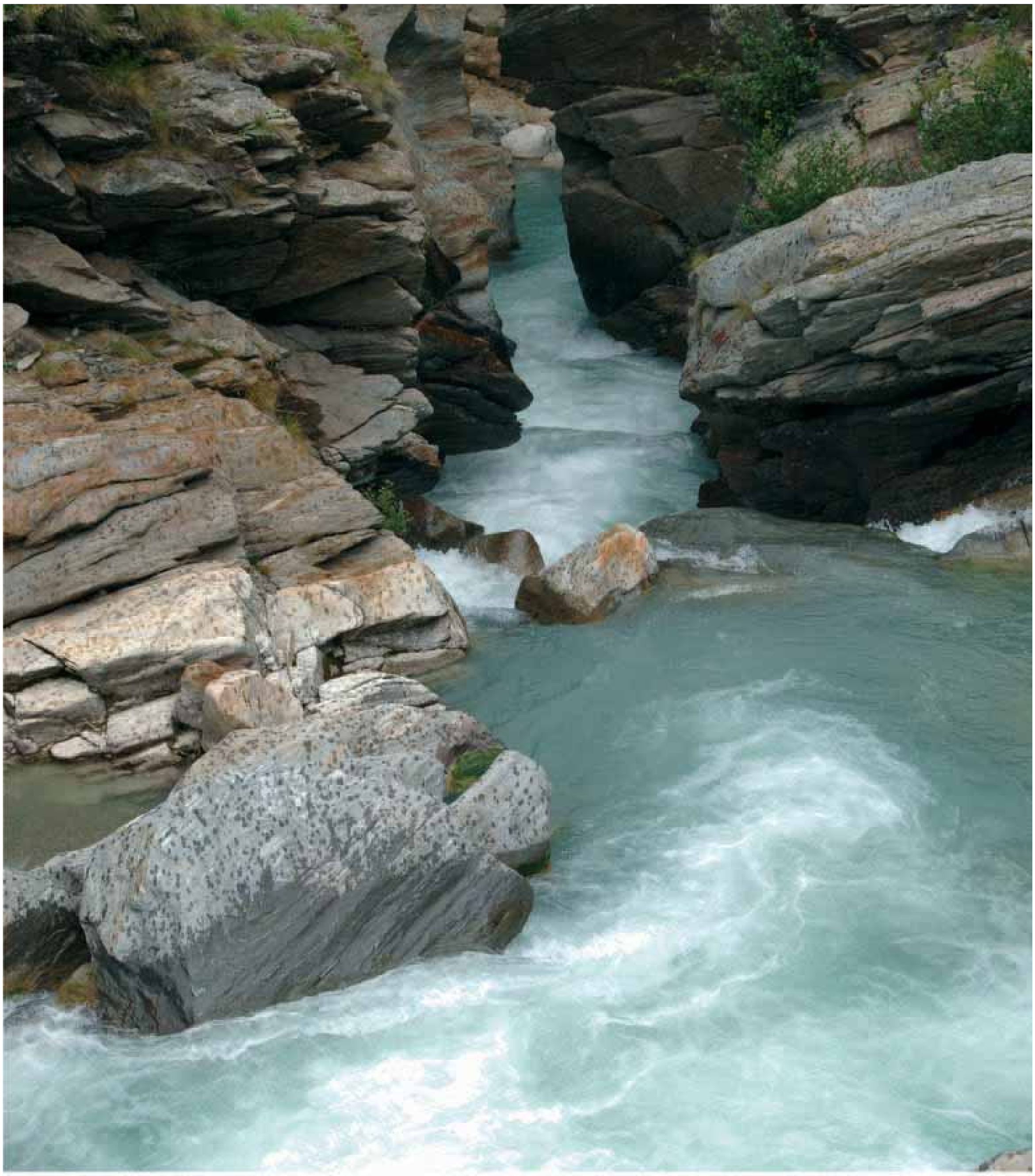


Figure 3.18: PM_{10} - Number of monitoring stations with data coverage of more than 75% and total number of stations[48]

[48] Source: ISPRA

CHAPTER 4



WATER QUALITY

Introduction

The objective of Directive 2000/60/EC, assimilated by Italian law under Legislative Decree 152/06, establishing a framework for Community water policy for the decades to come, is to modulate the wide variety of regulatory scenarios found in Member States giving them a common footing, in order to reach a consistent policy for safeguarding waters. Application of the directive entails noteworthy variations in the criteria for setting up the monitoring of the water bodies, with the classification system based on stipulated reference conditions that can vary, depending on the different types of water bodies involved, and on situations in which there are a greater number of biological and hydromorphological elements to be evaluated. The groundwork is also laid for a radical and sustainable change in the uses of water resources, under the principle that their use must be compatible with the environment and the needs of future generations.
Italy is closely involved in the common strategy, working through its Ministry of the Environment, Land and Sea while drawing on the technical support of ISPRA and the institutions responsible for water sector, in order to contribute to the intercalibration of the methodologies for designing networks to monitor and assess the ecological condition of surface water bodies, an exercise in which all the member states are required to participate.
The general commitment to developing a common strategy, as well as the new monitoring initiative, have seen increasing involvement on the part of regional governments, environmental agencies and water-basin authorities.

The state of inland water quality

The SECA defines the ecological status of waterways, combining the contributions of the IBE and LIM indexes.

Since the issue of Legislative Decree 152/06, the regional governments and the system of environmental agencies have undertaken intensive activities to bring the monitoring of water bodies in line with the new regulatory requirements, though the majority continue to follow the procedures of the obsolete Legislative Decree 152/99 in the case of both surfaced and underground waters. In large part waterways are classified under the IBE method – Extended Biotic Index – and through the use of chemical assessments that take into consideration the seven parameters that contribute to determining the LIM – Level of Pollution from Macro-Descriptors (dissolved O_2, BOD_5, COD,

NH_4, NO_3, total phosphorus, *Escherichia Coli*). The combination of the LIM and IBE indexes determines the SECA index, or Ecological Status of Waterways. In the case of lakes, the SEL index, or Ecological Status of Lakes, is determined, while underground waters are subject to the SCAS, or Chemical Status of Underground Waters, index. On the national level, the data for the Ecological Status of Waterways (SECA) show that, in 2008, 45% of the sites monitored fell under classes 1 and 2, meaning an ecological status of "high" (4%) or "good" (41%), while 33% were classified as being of "moderate" quality (Figure 4.1). A total of 999 stations were monitored throughout Italian territory, as compared to the 1,014 registered in 2007. The percentages of stations in quality classes 1 and 2 feel slightly, by respective figures of -1% e -2%, reflecting the increases in class 3 (from 32% to 33%) and in class 4 (from 15% to 17%). The figures for class 5 were the same as for last year (5%). In analysing the results, it should be kept in mind that six regions either failed to communicate their data or did so after the deadline: Basilicata, Calabria, Sicily, Sardinia, Campania and Umbria (Umbria, which began testing the new monitoring in June 2008, did not have sufficiently meaningful data).

In 2008, 78% of the sites monitored fell under SECA quality classes 1, 2 and 3, meaning an ecological status of "high" (4%), "good" (41%) and moderate (33%).

The regions whose data, for various reasons, were not included in the final analysis are: Basilicata, Calabria, Sicily, Sardinia, Campania and Umbria.

In 2008, the SECA situation was not particularly critical in Italy, seeing that 45% of the 999 points monitored fell within the quality classes of "good" and "high", while 33% were classified as "moderate". On the whole, 78% reached the quality objectives set for December 2008.

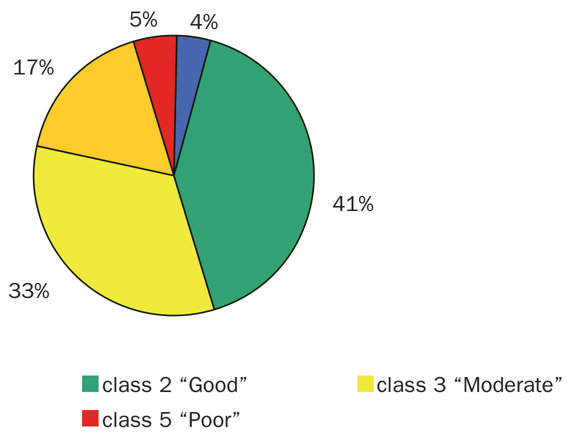


Figure 4.1: Percentage distribution of the classes of the SECA quality index (2008)[1]

An analysis of the data subdivided by macro-areas (Figure 4.2) shows that the best situation is found in Northern Italy, where the

In Northern Italy 80% of the points monitored fell in classes 1, 2 and 3.

[1] Source: ARPA/APPA data processed by ISPRA

In 2008, 80% of the 605 stations in Northern Italy fell within classes 1, 2 or 3, while 76% of the 226 stations in Central Italy were rated in the same classes, as were 73% of the 168 stations in Southern Italy and the Islands.

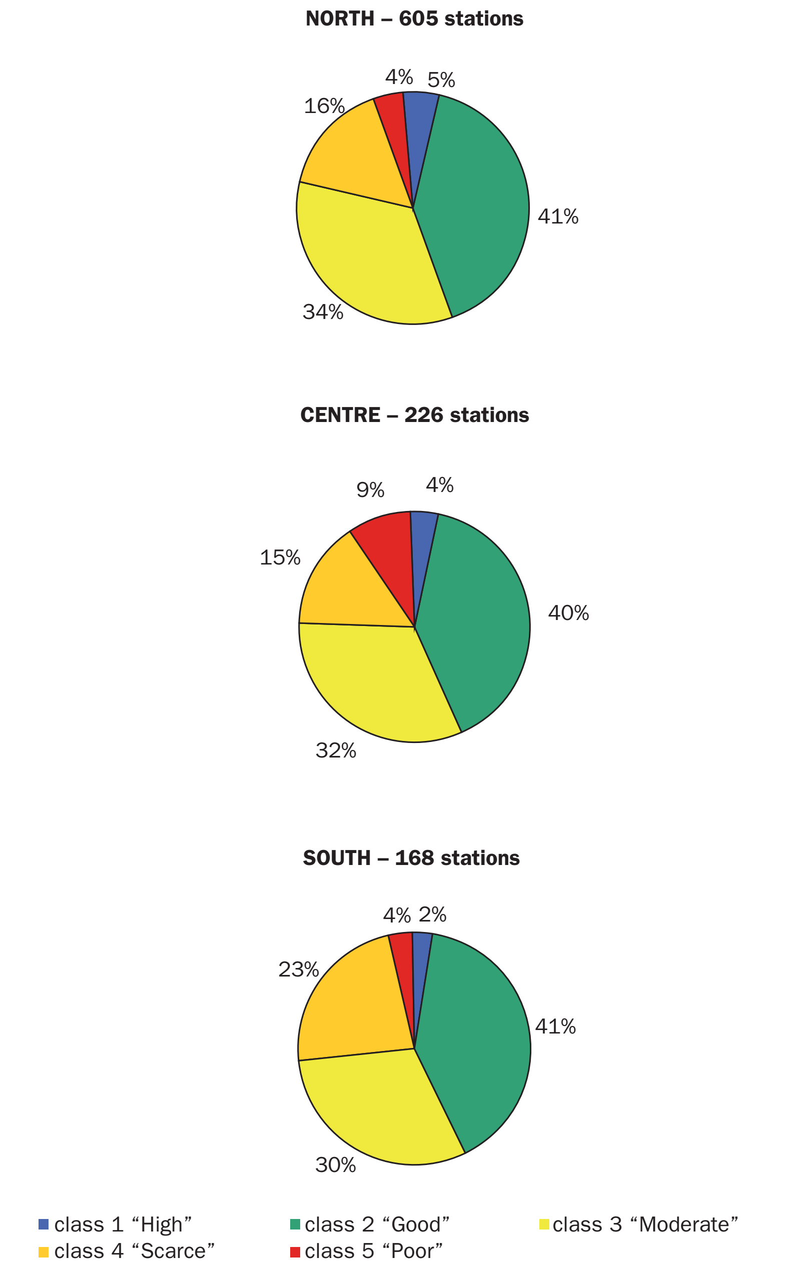


Figure 4.2: Percentage distribution of the SECA index quality classes by macro-region (2008)[2]

[2] Source: ARPA/APPA data processed by ISPRA

percentage of stations falling under classes 1, 2 and 3 is 80%, while the figure is 76% for the Central Italy and 73% for the South and the Islands. In evaluating these results, however, consideration should be given to the differences in the numbers of stations monitored in the various macro-areas: 60% of the total in the north, as compared to 23% in the central regions and 17% in the south. As is known, the SECA is established with the combined results of the chemical and biological analyses, meaning that, in terms of the incidence of the LIM and the IBE in determining the SECA (Figure 4.3), in the case of half the points sampled, the chemical and biological analyses both contribute to determining the ecological status, though, in the majority of the cases where the results show discrepancies, it is the biological analysis that determines the ecological status, given that the animal organisms analysed are sensitive not only to the water quality, but also to alterations and artificial modifications in the river and stream beds, as well as fluctuations in the flow.

In 2008, as in previous years, the macrobenthic community played a greater role in determining the SECA than did the chemical-physical macro-descriptors.

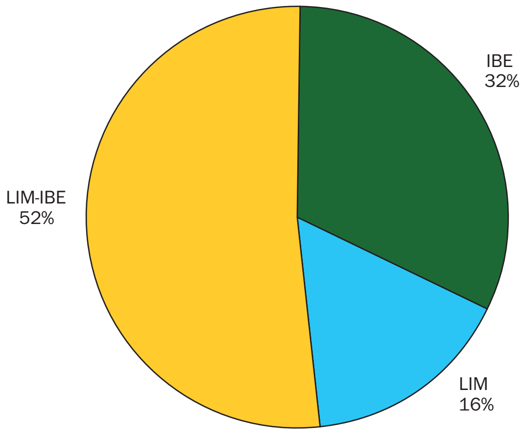


Figure 4.3: The percentage incidence of the LIM and IBE indexes on the SECA index (2008)[3]

Lake quality (Ecological Status of Lakes - SEL), taken from a total of 134 stations in 13 regions (on less region than in 2007), falls within the classes of “moderate” to “high” 65% of the time (Figure 4.4), an incidence that marks an 8% decrease compared to 2007.

The SEL is used to determine the ecological status of lakes by evaluating their different trophic states.

[3] Source: ARPA/APPA data processed by ISPRA

In 2008, 65% of the stations (134, representing 116 lakes) were ranked in the classes from "moderate" to "high".

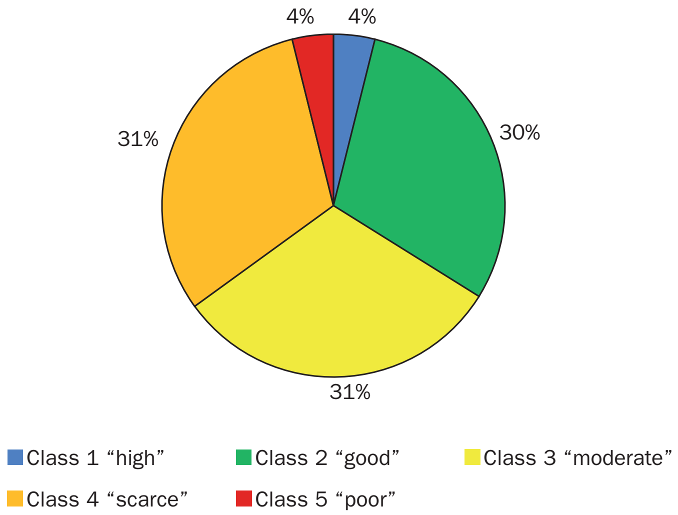


Figure 4.4: Percentage distribution of the SEL quality classes (2008)[4]

In the North, 42% of the stations fall under the SEL quality classes of "high" and "good", while 28% were classified as "sufficient".

In Northern Italy 42% of the stations fell under the quality classes of "high" and "good", while 28% were ranked as "moderate". In interpreting these results, consideration should be given to the geographic distribution of lake areas in Italy, which are more numerous in the north, as is further confirmed by the differences in the numbers of stations between the various macro-areas.
In light of the monitoring data for 2008, it can be assumed, in the case of surface water bodies (rivers and lakes), that the stations ranked in ecological quality classes 1 and 2 (SECA and SEL) belong to water bodies that should not present particular problems in arriving at the quality objective to be met by the end of 2015 under European regulations.

Monitoring of waters designated as suitable for molluscs to live in.

Another assessment of quality is that required to satisfy the objectives for the specific designated use of the waters, as per annex 2 of Legislative Decree 152/06. For 2008, data are available on 7 out of 15 coastal regions, where marine and brackish areas suitable for molluscs to live in were designated by the regions and monitored. These areas hold

[4] Source: ISPRA/Lombardy ARPA processing of data supplied by the ARPA/APPA of the autonomous provinces

bank sites and natural populations of bivalve and gastropod molluscs, but require protection and/or upgrading to safeguard the quality of the products of mollusc growing as food (Table 4.1).

Table 4.1: Waters designated as suitable for molluscs to live in (2008 monitoring)[5]

Region	Designated areas									
	TOTAL		Marine		Suitable	Not suitable	Brackish		Suitable	Not suitable
	no.	km²	no.	km²	no.		no.	km²	no.	
Veneto	8	684	1	46.5	1	0	7	637	5	2
Friuli Venezia Giulia	12	312	10	204	6	4	2	108	0	2
Liguria	2	3.92	2	3,92	2	0	0	0	0	0
Emilia Romagna	13	1,784	11	1,748	11	0	2	36.5	1	1
Tuscany	-	-	-	-	-	-	-	-	-	-
Marche	-	-	-	-	-	-	-	-	-	-
Lazio	3	-	3	-	3	0	0	0	0	0
Abruzzo	-	-	-	-	-	-	-	-	-	-
Molise	11	65.5	11	65.5	11	0	0	0	0	0
Campania	-	-	-	-	-	-	-	-	-	-
Basilicata	-	-	-	-	-	-	-	-	-	-
Apulia	-	-	-	-	-	-	-	-	-	-
Calabria	-	-	-	-	-	-	-	-	-	-
Sicily	-	-	-	-	-	-	-	-	-	-
Sardinia	17	-	7	-	2	5	10	-	5	5
TOTAL	**66**	**2,849**	**45**	**2,068**	**36**	**9**	**21**	**782**	**11**	**10**

Monitoring in 2008 of waters designated for molluscs to live in regarded 66 areas, 45 of them marine and 21 brackish. The suitable areas numbered 47, of which 36 were marine and 11 brackish.

The other designated uses regulated under Legislative Decree 152/06 regard waters suitable for fish to live in, for use as drinking water and for swimming.

The quality of underground waters, defined in accordance with Legislative Decree 152/99, is represented by the SCAS index (Chemical Status of Underground Waters), which highlights the zones containing critical environmental problems through a 5-class rating system (1-2-3-4-0). The first three classes stand for levels

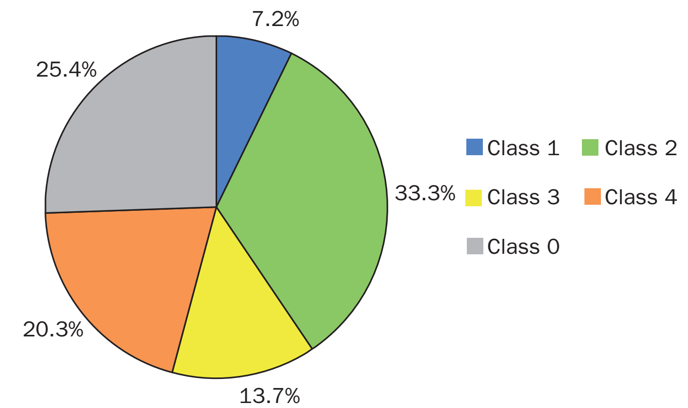
The Chemical Status of Underground Waters defines the quality of the water resource. It is obtained by analysing not only levels of pollutants generated by anthropogenic activities, but also chemical parameters of

[5] Source: Regions and autonomous provinces data processed by ISPRA

natural origin found in water tables, at times at elevated concentrations, and capable of compromising the use of the water.

of quality from good to sufficient, while the remaining two point to scarce quality, distinguishing between contaminants of anthropogenic origin (class 4) and those of organic origin (class 0).
In 2008 (Figura 4.5) 54.2% of the sampling points presented a chemical status falling within classes 1 to 3, meaning good to sufficient quality, while 20.3% were rated in class 4, poor quality due to anthropogenic causes, and the remaining 25.4% in class 0, or waters of poor quality due to natural causes tied to the specific hydrogeochemical conditions of the water tables.

In 2008, on a national level, out of 3,229 sampling points distributed in 11 regions and 2 autonomous provinces, 54.2% present a chemical status ranked between classes 1 and 3, while 20.3% are characterised by water of poor chemical quality due to causes of anthropogenic origin, and the remaining 25.4% are rated poor due to natural causes.



Note: Judgment of quality attributed to the classes:
Class 1 – *Anthropogenic impact non-existent or negligible, with excellent hydrochemical characteristics;*
Class 2 – *Anthropogenic impact limited and sustainable long-term, with good hydrochemical characteristics;*
Class 3 – *Anthropogenic impact noteworthy and hydrochemical characteristics generally good, but with certain signs of compromise;*
Class 4 – *Anthropogenic impact significant, with poor hydrochemical characteristics;*
Class 0 – *Anthropogenic impact non-existent or negligible, but with certain natural hydrochemical facies present in concentrations above the class-3 levels.*

Figure 4.5: Sampling points for SCAS quality classes (3,229 points – 11 regions and 2 autonomous provinces) (2008)[6]

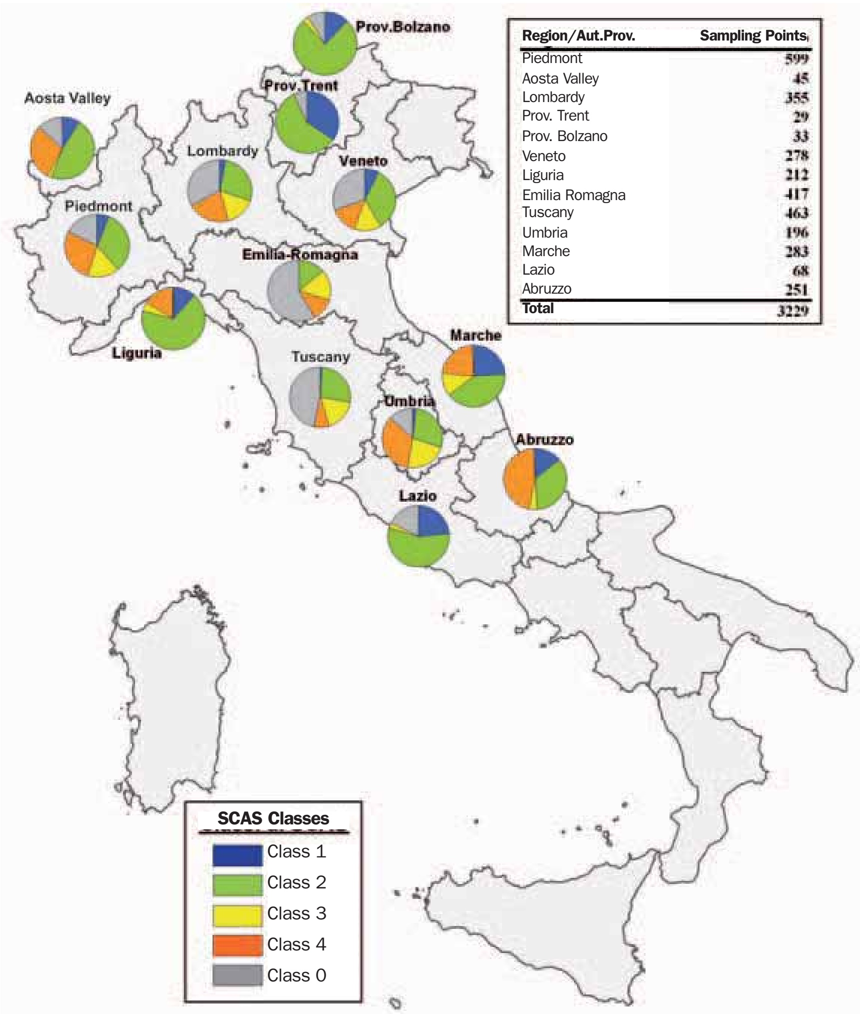
The contaminants of anthropogenic origin responsible for the demotion of many of the regions considered to class 4 include nitrates at concentrations above the limit of 50 mg/l (drinking water limit). Their presence is correlated to forms of pollution that are widespread, such as the use of nitrate-enriched fertilisers,

[6] Source: Regions and autonomous provinces data processed by ISPRA

the disposal of livestock waste, poor management of slime and dispersion from sewage systems, as well as specific sources of pollution, such as waste treatment plants etc.. Other substances responsible for deterioration in the quality of the resource include plant care products, aliphatic halogenate compounds and certain heavy metals (primarily chrome, lead, nickel and zinc), plus, though to a lesser degree, aromatic polycyclic hydrocarbons.
The presence of arsenic, iron, manganese, the ammonia ion, sulphates, chlorides and conductivity has been attributed by various regions to natural causes, in certain hydrogeological settings, producing a class 0 result.

The number of monitoring stations in the considered regions varies significantly, in absolute terms, running from a minimum of 29 to a maximum of 599. Figure 4.6 shows the percentages of the total (regional/provincial) sampling points ranked under the different quality classes. The autonomous provinces of Trent and Bolzano, and the regions of Liguria, Lazio, Marche, Aosta Valley, Veneto, Piedmont, Abruzzo and Umbria, in that order, presented percentages of sampling points falling in the classes of 1 to 3, meaning good to moderate quality, of between 93.1% to 52.6%. The highest percentages for class 4, poor on account of anthropogenic causes, were found in Abruzzo and Umbria, at respective figures of 45.8% and 34.2%. Finally, poor quality on account of natural causes, or class 0, was prevalent in Emilia Romagna and Tuscany, at respective figures of 58.3 e 46.7%.

The regions showed significantly different numbers of monitoring stations (from 29 to 599). The autonomous provinces of Trent and Bolzano, and the regions of Liguria, Lazio, Marche,Aosta Valley, Veneto, Piedmont, Abruzzo and Umbria, presented, in that order, percentages of sampling points falling under classes 1 to 3 of between 93.1% and 52.6%, while 45.8% of the points were ranked class 4 in Abruzzo and 58.3% were class 0 in Emilia Romagna.



Region/Aut.Prov.	Sampling Points
Piedmont	599
Aosta Valley	45
Lombardy	355
Prov. Trent	29
Prov. Bolzano	33
Veneto	278
Liguria	212
Emilia Romagna	417
Tuscany	463
Umbria	196
Marche	283
Lazio	68
Abruzzo	251
Total	3229

Figure 4.6: The chemical status of underground water bodies (3,229 points monitored – 11 regions and 2 autonomous provinces) (2008)[7]

Keeping in mind the differences in the numbers of both the points monitored and of the regions that have contributed to the formulation of the indicator over time, the changing quality of underground waters can be illustrated, as in Figure 4.7. During this

[7] Source: Regions and autonomous provinces data processed by ISPRA

period, the class 4 ranking, poor due to anthropogenic causes, was given to an average of 23.4% of the total stations monitored. The best situation, with the lowest percentage of 20.3%, was recorded in 2008, while the worst year, when the percentage reached a high of 28.3%, was 2006. On the average, 53% of the monitoring stations were given quality ratings of good to sufficient (classes 1, 2, 3), while class 0, poor due to natural causes, accounted for an average of 23.6% of the total.

Between 2000 and 2008 the quality classes 1, 2, 3 and 0 accounted for an average of 76.6% of all the stations monitored in all the years considered, while the remaining 23.4% of the waters were classified, on the average, as poor in quality due to anthropogenic causes.

Figure 4.7: Classes of chemical status over the years[8]

Legislative Decree 152/2006, recently modified and supplemented by Legislative Decree 30/2009, in compliance with European Directives 2000/60/EC and 2006/118/EC, sets 2015 as the deadline for achieving the objective of a “good” chemical and quantitative status. Each underground water body, therefore, shall be classified by a chemical and a quantitative status, each classified as “good” or “poor”, with the overall status of the water body corresponding to the worst of the two rankings. It follows that the new classification of chemical status, to be utilised in the upcoming monitoring cycles, will be simplified to 2 classes, as compared to the current 5. In establishing an approximate equivalency between the current classification of chemical status

Under the new measures, approximately 76.6% of the monitoring stations receive a chemical status of good, while 53% of the water stations qualify for the more valued uses of the resource.

[8] Source: ISPRA/Emilia Romagna ARPA processing of data supplied by the ARPA/APPA of the regions and autonomous provinces

and the new system, the current class 4 can be considered "poor", while the current classes 1, 2, 3 and 0 would be rated "good", considering that class 0 is the result of natural conditions found in the water table as opposed to anthropogenic impact. Under the new classification of chemical status, therefore, an average of 76.6% of the stations monitored between 2000 and 2008 would be rated "good", while 53% of the total corresponds to a quality of water compatible with the more valued uses of the resource.

The main causes of alteration

Water pollution may have natural causes, though it more often results from human activity.

Water pollution is defined as the effect of the introduction into water's bodies of substances or energies able to compromise human health, damage living resources or, in more general terms, the water-based ecological system, or to pose an obstacle to any legitimate use of water, including its potential role as an environmental attraction (the European Union). Pollution may have natural causes, though it more often results from human activity. Natural pollution occurs when rainwater comes into contact with substances of the mineral or biological worlds, whereas pollution tied to human activity is the result of massive anthropogenic development and industrialisation.

Forms of manmade pollution include the non-purified discharges of residential sewers, the dumping in the water environment of residues of industrial raw materials, plus intermediate and final products, as well as the wash-off of waste and pollutants from roads, airports and lots connected with service activities (repair shops, gas stations etc.).

Industry causes chemical and thermal pollution.

In addition, large-scale industry causes thermal pollution, which alters the chemical and biochemical balances of bodies of water, leading to a decrease in dissolved oxygen and directly reducing solubility, or indirectly increasing the metabolic rate of aquatic flora, with all the attendant consequences.

The gases polluting the air lead to "acid rains", with direct and indirect consequences on aquatic organisms, as well as damage to human health.

The acid rains, the result of fallout from the atmosphere of particles, gases and acid precipitation, are a further problem. Acid rains are essentially caused by sulphur oxides and, to a lesser extent, by nitrogen oxides found in the air due to natural causes (volcanoes) or on account of human activities. The consequences on aquatic organisms can be direct, due to the toxicity of the water, or indirect, tied to the disappearance of vegetable matter or prey more sensitive to acidification and part of

the food chain. Acidity in rivers and lakes can modify populations of diatoms and brown algae, in addition to altering the distribution and variety of fish life. Furthermore, foodstuffs originating from acid waters can be harmful to human health, such as fish whose bodies have accumulated large quantities of toxic metals (aluminium, manganese, zinc, mercury, cadmium). The drawing of excessive supplies of water can also alter the quality of the resource. Areas highly settled by man constitute a critical component in the elevated water demand for civic, industrial, agricultural and recreational uses, as well as the equally voluminous flows of waste needing to be purified. In certain cases, the systems of collection and purification prove to be inadequate and not suitable (in terms of potential, levels of processing, absence of appropriate measures to control stormwater runoff) to reduce the pollution content of sewage's volumes and industrial waste water produced by vast areas of development. A further difficulty is monitoring industrial discharges precisely, as well as the lack of awareness of such problems on the part of some operators in the various production sectors. Finally, the drawing of excessive supplies from water tables in coastal zones can lead to the intrusion of sea water in the water table, with the onset of salinity that renders the water no longer fit for its designated uses.

Areas highly settled by man constitute a critical component in the elevated water demand and in the production of equally voluminous flows of waste needing to be purified.

Intensive livestock raising activities generate noteworthy pressures, on account of the liquid waste produced and the runoff of defecations, as well as the residue from slaughterhouse and milk and cheese producing activities. The intensive use in agriculture of fertilisers (mineral, organic, organo-mineral fertilisers and soil enhancers), as well as plant care products (herbicides, fungicides, insecticides, miticides and various others), used to defend crops against parasites and pathogens, to control the development of infesting plants and to ensure greater quantities and higher quality standards of agricultural products, can have an impact of water life, in addition to modifying the quality of both surface and underground drinking water. Apart from the runoff of fertilisers, an overabundance of nutritional substances, as well as nitrogen and phosphate compounds from residential and industrial outlets, can lead to the eutrophication of water, meaning excessive growth and unruly multiplication of aquatic vegetable matter, and especially algae.

Residues from livestock raising and the massive use of plant care products and fertilisers in agriculture can have an impact on aquatic life and modify the quality of drinking water.

The survey initiated in 2003 on the presence of plant-care product residues in bodies of water, as part of the "Plan for Controlling the Envi-

Plan for controlling the environment la effects of plant-care products.

ronmental Effects of Plant Care Products" (Legislative Decree 194/95), called for a rationalisation of the regional monitoring programs, focussing the research on the substances effectively used within the territory while identifying the priorities for potential environmental risks.

In 2006, overall monitoring involved 3,403 sampling points, 11,703 samples and 331 substances.

The monitoring, which was performed in 2006, involved a total of 3,403 sampling points (1,123 for surface waters, 2,280 for underground waters), 11,703 samples and 331 substances researched. The most widespread contamination was found in surface waters, with residues of plant-care products observe at 644 monitoring points (57.3% of the total) and, in 36.6% of these cases, at concentrations greater than the limits set for drinking water under the law. Of the monitoring points for underground waters, 707 were contaminated (31.0% of the total), and in 10.2% of these cases the concentration was above the limit. A total of 131 substances were detected, with a greater number found in the surfaced waters (125), while the underground waters contained 52. In terms of the types of substances found in the waters, the most widespread were herbicides and the related metabolites (especially the triazinetriones). This is due both to the mode of use, which can take place directly in the soil, and to the period of the treatments, which generally coincides with the heaviest meteoric precipitations, so that streams an infiltration transport the substances into the surface and underground bodies of water more rapidly. A critical problem would appear to be contamination from Terbuthylazine, the lone triazine substance still on the market, used primarily for the growing of corn and sorghum. This contamination is widespread throughout the Po Valley and Veneto areas, and it can also be found in certain central-southern regions: it was reported for 51% of the surface-water sampling points and 15.8% of those for underground waters. Also worthy of note is the widespread presence, throughout the Po Valley and Venetia areas, of Atrazine, a substance that had not been sold for roughly two decades, making its residue a contamination from past. There are also noteworthy levels of Metolachor, Oxadiazon, Cloridazon, Procimidone and certain herbicides used in rice fields, such as Bentazone, Quinclorac, 2.6-Diclorobenzammide and Esazinone. Mention should also be made of the presence of Glyphodate, which, though one of the most widely used substances in Italy, is currently monitored only in Lombardy, where it was found in 31.8% of the surface water points surveyed. The national overview of the presence of plant-care products in waters is still incom-

Many priority substances and other pollutants are present in the waters, but the most widely found were herbicides and their metabolites.

The presence of Terbuthylazine and Atrazine was an especially critical problem in the Po Valley and Venetia areas and in certain central – southern regions.

plete (Figures 4.8 and 4.9). There remain significant differences between the regions, not only in terms of the extension of the monitoring networks and the frequency of the sampling, but also the number of substances surveyed. Overall the monitoring is more effective in the northern regions than in the central–southern zones, where it often fails to accurately reflect the actual situation, seeing that it regards a limited number of substances no longer used in agriculture.

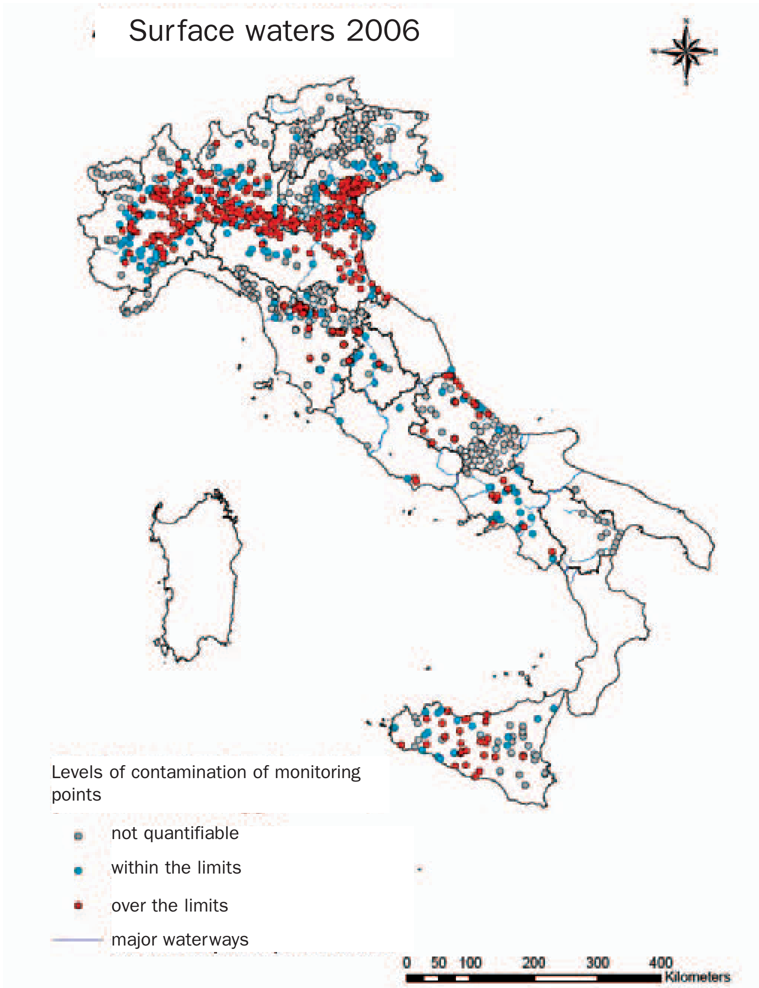


Figure 4.8: National outlook for the presence of pesticides in surface waters (2006)[9]

Levels of contamination of Italian surface waters, especially noticeable in the Po Valley and Venetia areas, where the surveys performed were more effective.

[9] Source: Regions and autonomous provinces data processed by ISPRA

Levels of contamination of Italian underground waters, especially noticeable in Piedmont, Lombardy, Veneto and Friuli Venezia Giulia, where the surveys performed were more effective.

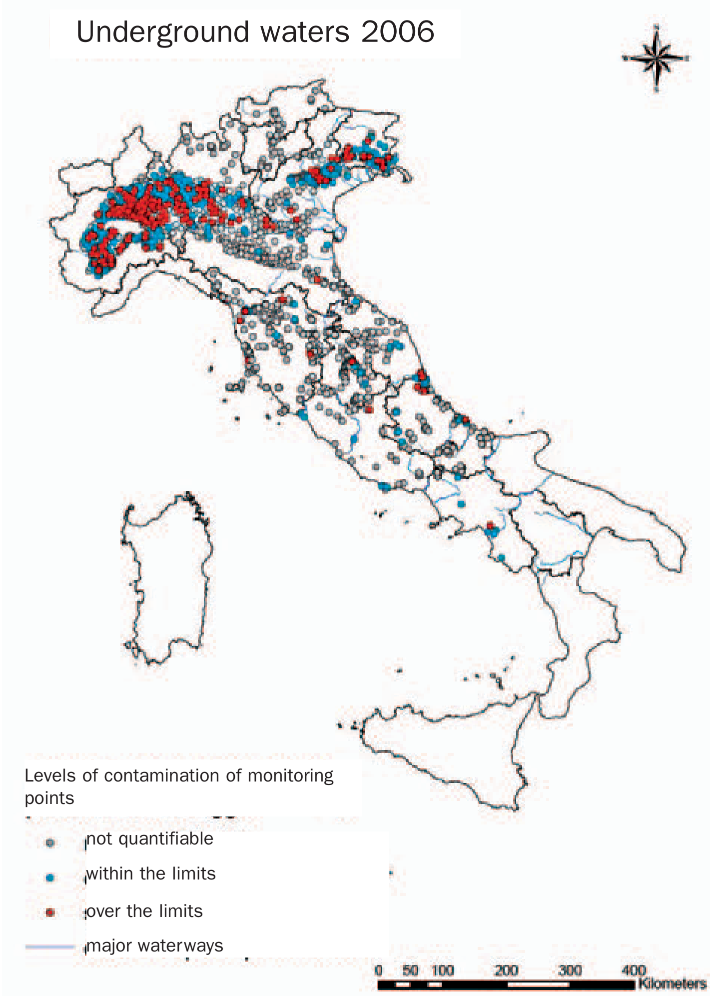


Figure 4.9: National outlook for the presence of plant care products in underground waters (2006)[10]

A survey carried out by the ISTAT statistics institute, together with the Environmental Observatory on Italian Cities, showed that per capita consumption of water for domestic use in Italy's 111 provincial seats was lower in 2008 than in 2007 (-2.2 %), falling to a level of 61.7 m^3 per inhabitant/year (Figure 4.10). When the figure for 2008 is compared to that for 2000, a decrease of 11% is observed, with this reduction

[10] Source: Regions and autonomous provinces data processed by ISPRA

due primarily to a more attentive use of the resource, as well as to the planning initiatives undertaken by municipal governments.

In 2008, per capita consumption of water for domestic use in Italy's 111 provincial seats was lower than in 2007 (-2.2 %), reaching a level of 61.7 m^3 per inhabitant.

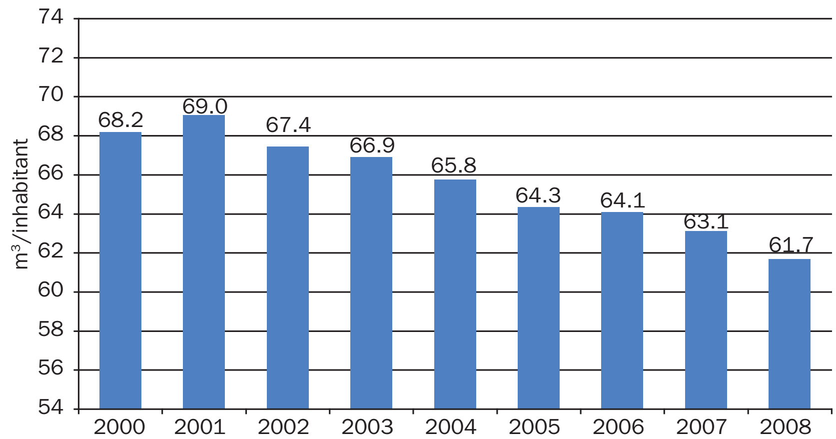


Figure 4.10: Per capita consumption of water for domestic use in 111 provincial seats[11]

The distribution of drinking water in municipal systems is analysed using two quantitative variables recorded during the census[12]: water placed in the distribution networks and total water supplied for all the different uses. The regional differences between the water placed in the networks and the water supplied is due to a variety of factors, including: leaks in the conduits; overflows in holding tanks when available water exceeds capacity in given periods of the year or at certain points in the day; theft and the illicit drawing of supplies from the networks.

The difference between the water supplied and that placed in the networks is equal to 32.1% for the entire national territory.

The difference between the water supplied and the water placed in the municipal distribution networks thus provides an indicator of the network dispersion. Within the national territory, this difference can reach 32.1%. The territorial distribution of network dispersion shows that the lowest level is found in northwest Italy (24.7%), while the highest was registered in the south (40.3%) (Figure 4.11).

[11] Source: ISTAT data processed by ISPRA
[12] ISTAT, results of census on water services for 2008, carried out in 2009

The level of network dispersion in northern Italy (24.7%) is much lower than the maximum in the south (40,3%).

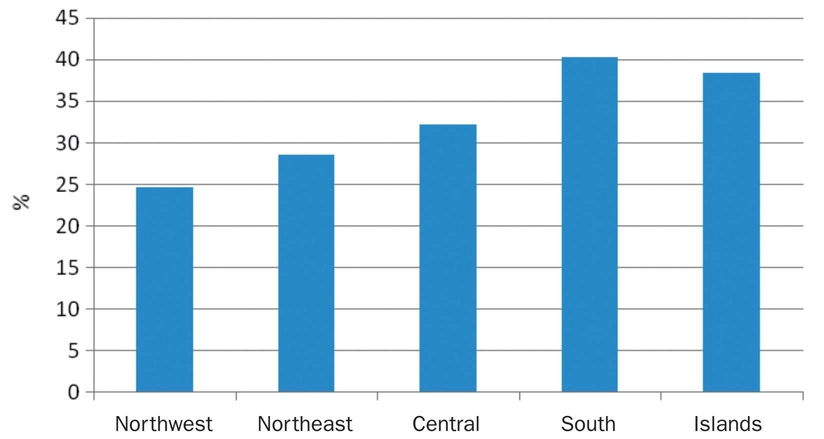


Figure 4.11: Geographic distribution of the difference between water placed in the networks and water suplied (2008)[13]

Actions designed to protect water quality

The regulatory instruments of planning, management and control make it possible, at different levels and in increasingly integrated fashion, to safeguard the status of water resources. The planning instrument called for under Directive 2000/60/EC is the District Basin Management Plan.

Watershed basins.

The districts can consist of one or more watershed basins.
The term “watershed basin” refers to the territory in which all the surface waters flow through a series of streams, rivers and lakes, emptying into the sea at a single mouth, estuary or delta.

Art. 64 of Legislative Decree 152/2006, which implemented the Directive, identified the watershed districts into which all of Italian territory were to be divided, while art. 117 governed the Management Plans, stipulating that a management plan was to be implemented for each district.

The Watershed District Management Plans must be implemented by 22 December 2009.

In order to meet the Community deadline for enactment of the Management Plans, meaning 22 December 2009, Legislative Decree no. 208 of 30 December 2008, converted following modification into Law no. 13 of 27 February 2009, further stated that

[13] Source: ISTAT

"the Management Plans are to be implemented ......in accordance with the available acts and opinions, no later than 22nd December 2009, by the Institutional Committees of the Basin Authorities of national importance, with the addition of members designated by the regions whose territories fall within the watershed district referred to in the Management Plan and which are not already represented on the Institutional Committees".

In accordance with these instructions, and though the District Basin Authorities are not yet operative, the Basin Authorities established under Law 183/89, and falling within the watershed districts, have initiated, in collaboration with the regional governments, the procedures for drafting Management Plans for the eight watershed districts (Eastern Alps, Po Valley, Northern Apennines, Serchio River, Central Apennines, Southern Apennines, Sardinia, Sicily) into which the national territory is divided (Figure 4.12).

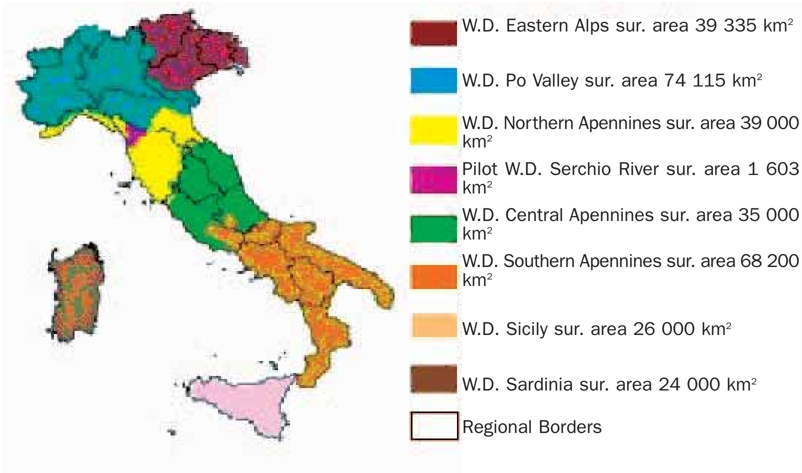


Figure 4.12: Italian watershed districts[14]

The Management Plans (art. 6 of Legislative Decree 152/2006, plus subsequent modifications and additions) fall under the category of plans for which Strategic Environmental Assessments must be drawn up (SEA). At present, in parallel with the phases of public

[14] Source: www.appenninomeridionale.it

consultation on the plans called for under Directive 2000/60/EC, the public consultations provided for under the SEA procedures are underway, regarding the environmental reports of the plans themselves. The plans must contain elements involving the planning and scheduling of initiatives and standards of use geared towards preserving, defending and upgrading the soil while making proper use of waters, all based on the physical and environmental characteristics of the territory of the basins involved.

The PTA provides up-to-date knowledge on the status of waters while setting environmental objectives and determining the measures to be applied on the regional level.

The fundamental groundwork for the drafting of the Management Plans is provided by the Water Defence Plans of the regions with territorial jurisdiction, whose contents must be supplemented with regard to the district basin.

The Water Defence Plan (PTA) is drawn up by the regions; in accordance with art. 121 of Legislative Decree 152/06, it is specific to the sector and must contain, in addition to initiatives geared towards achieving or maintaining quality objectives, the measures needed to defend the levels of quality and quantity of the water system.

This plan, already contemplated under art. 44 of Legislative Decree 152/99, together with the initial characterisation of the meaningful watershed basins and the classification of the status of surface and underground water bodies, has made it possible to obtain, to date, excellent knowledge of the status of the water resources.

To date, 7 PTAs have been implemented and 11 have been approved.

The current national situation, in terms of protection plans, consists of seven plans that have been implemented (Veneto, Liguria, Umbria, Marche, Basilicata and Campania) and eleven plans that have been approved (Piedmont, Aosta Valley, Lombardy, the Autonomous Provinces of Trent and Bolzano, Emilia Romagna, Tuscany, Lazio, Apulia, Sicily and Sardinia).

Initiatives for the protection of water include the construction and upgrading of collecting systems and urban waste water treatment plants.

Initiatives for the protection of water include the construction and upgrading of sewage networks and urban waste water treatment plants. Community Directive 91/271/EEC on the treatment of urban waste water set 31th December 2005 as the deadline for the technological upgrading of urban waste water purification plants and sewage networks servicing agglomerates with more than 2,000 equivalent inhabitants (e.i.). Starting from that date, the purification and sewage infrastructures must meet the standards called for under the legislation.

Assessment of compliance has also been extended to purification and sewage systems servicing agglomerates of smaller

size.Though it was not possible to complete the national reference outlook for 2006, the information obtained regarded 17 regions, together with the autonomous provinces of Trent and Bolzano (Figures 4.13 – 4.14).

In 2006, the level of compliance for sewage systems nationally was 93%.
The figures on Calabria, Sicily and Basilicata were not available.

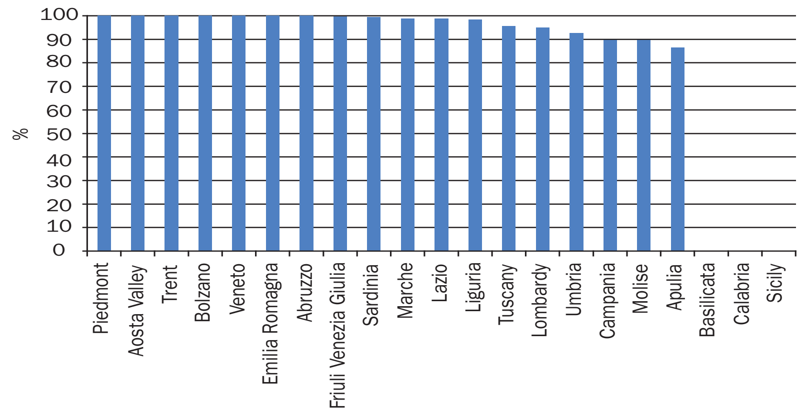


Figure 4.13: Level of compliance of the regions' sewage systems (2006)[15]

In 2006, the level of compliance for purification systems nationally was 77%.
The figures on Calabria and Sicily were not available.

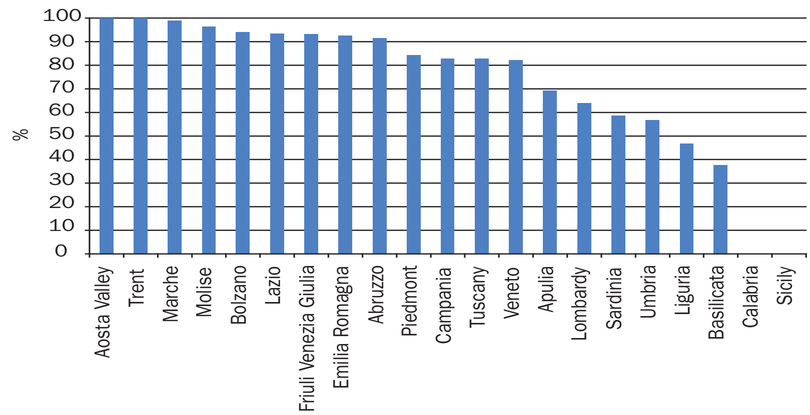


Figure 4.14: Level of compliance of the regions' purification systems (2006)[16]

In 2006, though all the information necessary for a complete overview has not been transmitted, the national level of compliance of purification systems was 77%, while the level for sewage systems was 93%.

The national level of compliance for sewage networks was 93%, while the level for purification systems was 77%.

[15] Source: Regions and autonomous provinces data processed by ISPRA
[16] Source: Regions and autonomous provinces data processed by ISPRA

There is scarce reuse of treated waste water.

Another critical problem affecting the overall system for rationalising the use of the resource on the national level is represented by the scarce reuse of treated waste water. In Italy initiatives involving the reuse of waste water are much more limited than in other countries, though there is a positive trend that has resulted in an increase in such efforts in recent years.

The Ministerial Decree of 185/2003 stipulates that treated waste water may be used for irrigation purposes, civic purposes and industrial purposes.

The reuse of treated waste water is governed by Ministerial Decree no. 185 of 2003. The decree regulates the designated uses and the related quality requirements, in order to protect the quality and quantity of water resources, and with the objective of limiting the procurement of supplies of surface and underground waters, reducing the impact of discharges on the receiving water bodies and favouring water savings through the multiple use of waste water.

Reuse constitutes one of the instruments for implementing a rational and sustainable management of water resources.

The measure referred to above stipulates that treated waste water may be used for *irrigation purposes*, *civic purposes* and *industrial purposes*, with such reuse being viewed as one of the instruments for implementing a rational and sustainable management of water resources.

The national legislation provides incentives for expanded reuse, providing for it to be included in Water Defence Plans.

For that matter, the national legislation provides incentives for expanded reuse, calling for it to be included in Water Defence Plans.

This means that the regions must implement regulations and measures that favour the recycling of water and the reuse of treated waste water.

In light of the above, the planning of the initiatives necessary for the modernisation of the existing purification plants and their upgrading to meet legal requirements must increasingly take into account the importance of the reuse of treated waste water and the recycling of slime.

The Nitrates Directive, transposed into Italian law first as Legislative Decree 152/99, and then under Legislative Decree 152/06, requires that the member

In terms of pollution caused by nitrates from agriculture, in '91 the Council of the European Communities implemented Directive 91/676/EEC (the Nitrates Directive), assimilated by Italian Law first under Legislative Decree 152/99 and then under Legislative Decree 152/06, for the purpose of reducing or preventing the pollution of waters caused either directly or indirectly by nitrates

from an agricultural source. Following implementation of this decree, the member states are required to carry out controls on the nitrate concentration of fresh waters, to designate “vulnerable zones” and to draw up action programmes for the same, in addition to formulating Codes of Good Practice and drawing up programs for training and informing farmers.

states carry out controls on nitrate concentrations, designate vulnerable zones, formulate codes of good practice etc.

Among the crucial factors to enforce the Directive 2000/60/EC, mention should be made about the knowledge of availability and uses of the resources, the summary of pressures and significant impacts, the completion of monitoring network for all types of water bodies and a summary of the economic analysis on water utilise. In carrying out all these initiatives, every effort should be made to employ the economic, human and scientific resources available to our country in the best way possible.

FOCUS

FIRST APPLICATION OF DIRECTIVE 2000/60/EC TO SURFACE WATERS

Introduction

The Community reference legislation regulating the ecological and chemical quality of waters is the Water Framework Directive (2000/60/EC) which came into force on 22 December 2000 and was implemented in Italy by means of Legislative Decree 152/2006. The said Directive creates a framework for greater cooperation between the European Union Member States with regard to the protection of aquatic environments and introduces the concept of environmental quality standards, establishing that they must achieve the best "ecological status" and "chemical status" possible or, nevertheless, achieve a "good surface water status" at the latest 15 years from the entry into force of the Directive, that is by 2015.

In Italy, the implementation of the Water Directive is coordinated at national level by the Ministry of the Environment, with the collaboration of the Institute for Environmental Protection and Research (ISPRA), and with the participation of the Basin Authority, the regions, ARPA/APPA and other research institutes.

Following approval by the Council of Environmental Agencies, ISPRA set up several inter-agency work groups, including: the coordination group, the rivers and lakes group, the groundwater group, the group relative to the European Information system. In order to meet the reporting obligations laid down by the Water Directive this system, WISE (*Water Information System for Europe*), develops instruments for the processing and transmission of data and information to the European Commission.

Under the mandate of the competent MATTM management, ISPRA is the coordinator of the *Geographical Intercalibration Group* for the Mediterranean Ecoregion (Med GIG) for marine coastal and transitional waters.

The application of the Directive involves four main stages which deal with the following:

1. Typology
   The Member States must identify distinct significant features for water bodies, on the basis of their hydromorphological and physic-chemical characteristics.
2. Reference conditions
   For each type, Member States must establish a group of reference conditions representing, as far as possible, undisturbed natural conditions or conditions where anthropogenic impact is absent or negligible with reference to Biological (BQE), hydromorphological, chemical and physic-chemical Quality Elements.
3. Monitoring networks
   Each Member State must establish monitoring networks designed to: classify water bodies into one of the 5 ecological status classes; identify eventual changes in the ecological status of water basins held to be "at risk". The monitoring programmes must show the response of BQEs to impacts it may be exposed to distinguishing the spatial/temporal variability relative to the natural background values from variability linked to anthropogenic pressures to which the system is subject.
4. Classification system
   The conditions given for each BQE must be compared to the reference conditions. Depending upon the degree of deviation from the reference conditions (*Environmental Quality Ratio*, EQR) the water body will be allocated to one of 5 classes of ecological status: "high", "good", "moderate", "poor", "bad".

The stages described are implemented at national level by the Ministerial Decrees linked to Legislative Decree 152/2006:

- Characterisation decree (DM 131/2008 – *Regulation containing the technical criteria for the characterisation of water bodies (characterisation and identification of water bodies, analysis of pressures*);
- Monitoring decree (DM "Ambiente" 14 April 2009, no. 56 – *Regulation containing "Technical criteria for the monitoring of water bodies and identification of the reference conditions for the amendment of the technical regulations of the legislative decree*

of 3 April 2006, n. 152, containing environmental regulations laid down under article 75, paragraph 3, of the legislative decree");
- the Classification decree (currently awaiting approval).

In order to facilitate a uniform and shared implementation of the Directive, the European Commission and the Union Member States launched *Common Implementation Strategies* that led to the creation of ad hoc work groups and drawing up of non-prescriptive guidelines publicly accessible via the website[1].

Italy has also taken over the European coordination of the second stage of measures for the intercalibration of classification criteria to the scale of the Mediterranean ecoregion (MED GIG: *Mediterranean Geographic Intercalibration Group* – Stage II). Coordination was entrusted to ISPRA which has the task of completing the Intercalibration activities by June 2011 and providing the European Commission with the different ecological classification methods that have been shared, tested and are therefore adoptable by all Member States in the Mediterranean Ecoregion.
An initial intercalibration exercise (MED GIG Stage I) was launched in 2004 and concluded in 2007 under the coordination of the former APAT. The results produced, although partial, were published in the Commission Decision 2008/915/EC.
The second phase of activities will address various problems and examine a number of issues in greater depth. These mainly relate to: a) the capacity of the classification systems proposed to adequately represent anthropogenic pressures and their effect upon ecosystems; b) a more precise assessment of the "Reference conditions", also in order to ensure the correct assessment of so-called "natural" variability; c) the right weight to attribute to the abiotic elements (hydromorphological, physico-chemical and chemical) that concur in determining the ecological status of water bodies.

[1] http://forum.europa.eu.int/Public/irc/env/wfd/library

NATIONAL CHARACTERISATION SYSTEM (ITALIAN MINISTERIAL DECREE 131/2008)

Rivers and lakes

The definition of river's type is based on the natural diversity of watercourses, taking into account the result of the integration of regional differences and upstream-downstream gradient.
The activity takes place on three levels:

a) definition of the hydro-ecoregion (HER), or geographic areas defined on the basis of factors such as orography, geology and climate, within which freshwater ecosystems should have a limited variability in terms of chemical, physical and biological characteristics (Figure 1);
b) definition of broad river types within HERs on the basis of a limited number of variables, not included among those used to define HERs – origin of the watercourse, distance from the source, etc;
c) definition of detailed types (optional).

The HERs defined by Cemagref [2] for Europe were adopted for Italy; the following obligatory descriptors were considered:

- perennial nature and persistence (temporary or perennial rivers);
- origin of watercourse (surface flow, from glaciers, etc.);
- distance from source (indicator of watercourse size);
- riverbed morphology (for temporary rivers);
- influence of upstream basin.

[2] Centre National du Machinisme Agricole, du Génie Rural, des Eaux et de Forêts (F) (The main research centre in the French water sector)

Hydro-ecoregion

1 Alpi Occidentali
2 Prealpi_Dolomiti
3 Alpi Centro-Orientali
4 Alpi Meridionali
5 Monferrato
6 Pianura Padana
7 Carso
8 Appennino Piemontese
9 Alpi Mediterranee
10 Appennino Settentrionale
11 Toscana
12 Costa Adriatica
13 Appennino Centrale
14 Roma_Viterbese
15 Basso Lazio
14 Vesuvio
16 Basilicata_Tavoliere
17 Puglia_Carsica
18 Appennino Meridionale
19 Calabria Nebrodi
20 Sicilia
21 Sardegna

Figure 1: Italian hydro-ecoregions[3]

Natural lakes and heavily modified natural and artificial lakes present in Italy are characterised on the basis of morphometric descriptors (quota, depth, surface area), the prevalent composition of the geological substrate (limestone, siliceous or volcanic) and physic-chemical descriptors (conductivity and thermal stratification), distinguishing between the Alpine and Mediterranean eco-regions.
DM 131/08 defines the methods to be used for the characterisation of different types of surface waters, the analysis of pressures and identification of water bodies, following characterisation, in 5 stages.
The first stage involves identifying the limits of surface water categories. A water body may only belong to a single category of water (rivers, lakes/reservoirs, transitional waters and coastal waters) and to one single type.
The second stage involves identifying size criteria only, at least during the preliminary stage, neglecting a great number of minor elements to avoid encountering important logistical difficulties.
The third involves identifying the limits by means of physical features that are significant with reference to the aims to be pursued for rivers (confluences, variations in gradient, morphology, hydrology, interac-

[3] Source: Italian Ministerial Decree 131/08

tions with the aquifer), for lakes (morphological components), for transitional waters (variations in salinity, morphological structures, barrier islands) and for marine waters (presence of a major source of freshwater and river mouths).
The fourth involves the assessment of the status of waters, the relative pressures and the boundaries of protected areas.
The fifth stage concerns the identification of minor elements[4] of surface waters as separate water bodies, grouping them into a larger adjoining water bodies as well as identification of heavily modified or artificial water bodies.
In order to analyse pressures and impacts, the regions will require accurate detailed knowledge of the anthropogenic activities (wastewater discharges, morphological changes, water withdrawals, use of plant protection products, surplus fertilisers) and of the environmental effects brought about by these pressures for each body of water.
In the Po basin, the Basin Authority, the regions and the System of Environmental Agencies belonging to them (Aosta Valley, Piedmont, Lombardy, Emilia Romagna, Veneto, Liguria and the Autonomous Province of Trent) acted in a coordinated manner to obtain a preliminary list of the types of water bodies (rivers, lakes, transitional and coastal waters) present in the basin, in compliance with the regulations drawn up by the Ministry of the Environment.

Table 1: Water bodies in the Po district[5]

Rivers	Lakes	Transitional	Marine	Groundwater
1,890	107	18	1	145

Characterisation was also carried out in the regions of Tuscany, Umbria, Marche and Abruzzo and in the Autonomous Province of Bolzano. Characterisation is currently underway in Friuli Venezia Giulia, Lazio, in Calabria (partly) and in Campania (to a very limited extent). Characterisation is currently not taking place in Basilicata, Molise, Sicily or Sardinia.

[4] Elements not included among those to be identified in the second phase because of their dimensions but that may be identified as individual water bodies provided they meet at least one of the criteria established in section B.3.5.1 of the decree; for example, surface water important for human consumption, for the life of fish, for swimming, elements that are important for biodiversity, identified as reference sites/environments, etc.
[5] Source: Region Lombardy

Marine coastal and transitional waters

The main geomorphological and hydrological factors distinguishing marine coastal environments were taken into consideration in order to carry out a full, accurate characterisation of Italian marine coastal waters: the morphology of the coastal area, whether exposed (including the adjacent land) or submerged; the nature of the substrate; the depth of the submerged intertidal zones; the vertical stability of the water column.

At national level, a coastal geomorphological study[6] had already lead to a distinction of the Italian coasts in 6 main types: mountain coast (A), terrace coast (B), littoral plain (C), torrent plain (D), river plain (E), dune plain (F) (Figure 2).

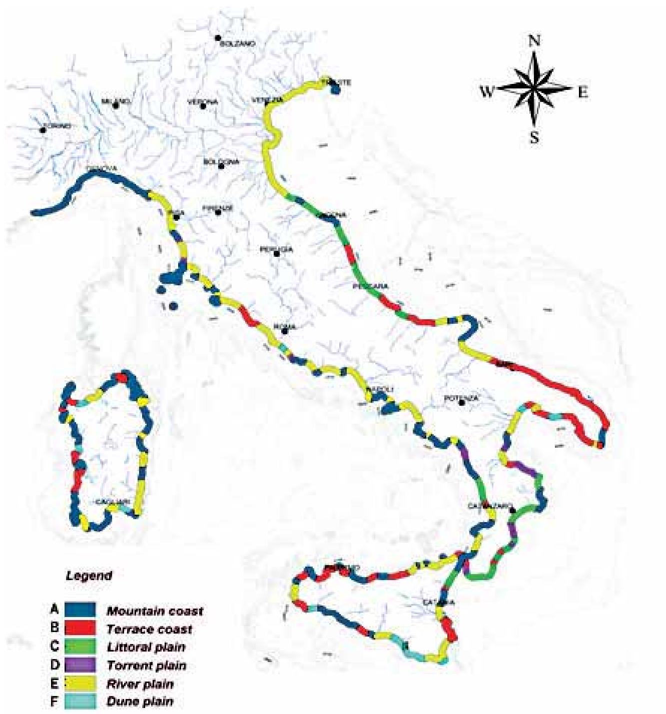


Figure 2: Characterisation of the Italian marine coastal zones on the basis of coastal geomorphology[7]

[6] Brondi *et al.*, 2003
[7] Source: Bondi et al., 2003

On the other hand, it is unlikely that all possible types of coast could be represented on the basis of a characterisation that only takes into account the geomorphological characteristics of intertidal zones.
For this reason it was decided to include factors further qualifying coastal zones relative to continental freshwater inputs which are lighter and therefore tend to stratify on the lower layers. The presence of fluvial inputs may bring about high density stratification like that taking place in the Adriatic coastal strip subjected to Po Valley inputs.

The hydrological parameter best suited to describing this type of approach is represented by the stability of the water column which provides a direct measurement of density stratification. This extends the concept of type to numerous factors, or anthropogenic pressure indicators, influencing the quality of the coastal zone (nutrients, pollutants, etc, potentially contained in freshwater leading to stratification).

The examination of data from the national monitoring programme (*ex lege* 979/82 “Defence of the Sea”) carried out by 15 coastal regions with the Ministry of the Environment led to the identification of three different types of hydrological system based on the mean annual values relative to the vertical stability of the water column: high (1), moderate (2), low (3).

The characterisation of Italian transitional waters took into account various hydromorphological and physic-chemical descriptors set out for System B, Annex II in section 1.2.3. of Directive 2000/60/EC: geo-morphology, tidal regime, surface area and salinity.
This led to the identification of 21 possible transitional water types, one of which relative to delta-river mouths and twenty relative to lagoons.
The division of water bodies into types is necessary for the definition of type-specific reference conditions. Given that it is not currently possible to determine 21 different reference conditions and that 70% of Italian transitional environments are euha-

line or polyhaline, 3 macrotypes were established by grouping together the types defined by DM 131/2008 on the basis of tidal excursion and salinity (distinguishing between water bodies with salinity greater or less than 30 PSU).
At regional level lagoons, represented as lagoon complexes on account of the considerable structural differences revealed when examining their geomorphological and hydrodynamic characteristics, can be further “sub-characterised” by applying physic-chemical, geomorphological and hydrodynamic descriptors in compliance with the provisions of Directive 2000/60/EC.

MONITORING AND CLASSIFICATION (ITALIAN MINISTERIAL DECREE 56/2009)

The aim of national monitoring programmes is to establish a coherent and exhaustive overview of the ecological and chemical status of the waters in each hydrographic basin, including marine coastal waters allocated to the hydrographic district in which the relative hydrographic basin lies, and to enable the classification of all surface waters “identified” for the purposes provided for by the Directive.
The competent authorities will define monitoring programmes for each period in which a district management plan is applied, ensuring that the following activities are carried out for each hydrographic basin:

- choice of water bodies to undergo surveillance and/or operational monitoring relative to the different aims of the two types of control;
- the identification of sufficient monitoring sites in appropriate locations for assessment of chemical and ecological status, taking into account the aims of the ecological status of the minimum indications set out in the sampling protocols.

Our knowledge of anthropogenic activities, their pressure and past monitoring data allows us to assess the vulnerability of water body status and forecast their capacity to meet the quality objectives established within the times laid down by the Directive. As far as

probable attainment of the above objectives is concerned, water bodies are classified as “not at risk”, “probably at risk” and “at risk”.
The directive provides for 3 types of monitoring: surveillance, operational and investigative.
Surveillance monitoring is undertaken for “water bodies likely to be at risk” (that is, where available data does not allow us to assign the risk category and further information is required) and for “water bodies not at risk”.
Surveillance monitoring may also be undertaken at points in water bodies at risk that are important for the assessment of long-term variations resulting from widespread anthropogenic activities, or that are particularly significant at basin level, or where held necessary by the regions on the basis of the characteristics of the area involved.
The priority target for surveillance monitoring is “water bodies likely to be at risk” so that the effective risk condition can be established.
Operational monitoring is to be undertaken for the category of “water bodies at risk” in order to establish the status of the water body identified as being at risk of not meeting environmental objectives as well as assessing any changes in the status of such water bodies due to programmes of measures for the purpose of classifying such water bodies.
Investigative monitoring will be carried for specific cases: where the reasons for any exceedance is unknown or where surveillance monitoring indicates that there is the risk to fail the objective. It may also be undertaken to assess the magnitude and impacts of accidental pollution.
The directive also establishes the frequency of sampling during the monitoring period, according to the different biological quality elements, chosen on the basis of the type of monitoring to be used.
The surveillance monitoring cycle must be six yearly while operational monitoring shall be undertaken on a three-yearly basis.

Classification involves determining the ecological and chemical status of each water body. The former is based on a comparison with the specific reference conditions for each type of water body (EQR)[8], while the latter is based on compliance with environmental quality standards laid down by the above decree for the substances in the priority list.

Until the official classification methods are established the various ARPA/APPA have partly complied with the new monitoring system, adopting it alongside the old system (under D.Lgs. 152/99) as well as replacing it.

The new regulatory situation requires in-depth studies to be carried out on the various biological compartments of the river, lake and marine systems for classification of ecological status.
Biological quality elements (BQE) play a key role in the classification of water bodies while hydro-morphological and physico-chemical quality elements provide "support" for the ascertainment of ecological quality status.

Listed below are various BQEs to be used for rivers, lakes, marine coastal and transitional waters for the classification awaiting definition, in the order given in Annex I of DM 56/09 (Table A.1.1), and the classification systems in use.

River systems are examined by taking into account **phytobenthos** formed by various types of algal *taxa* but the most tested and most suitable *taxon* for monitoring of flowing waters is the **diatom**. Diatomae are very well known from both a systematic and ecological point of view; moreover their cosmopolitan distribution in all flowing waters and high sensitivity to eutrophication and pollution make them excellent bioindicators.
Aquatic **macrophytes** include plants macroscopically visible in aquatic and brackish habitats and river beds. The group comprises herbaceous angiosperms, pteridophytes, bryophytes and filamentous algae. In addition to their important ecological

[8] *Environmental Quality Ratio* (EQR) = (Actual value of EQ/ Reference value of EQ)

role, the use of macrophytes as quality indicators for flowing waters is based on the fact that some species and groups of species are sensitive to changes in water bodies and are affected in different ways by anthropogenic impact.

The **benthic communities** of soft bottom have the capacity to respond significantly to environmental changes, whether natural or anthropogenic in origin. Their persistence allows us to develop a highly integrated interpretation of the spatial and temporal changes taking place in the physical world. In fact, they could be said to represent the "biological memory" of the ecosystem. The structure of the macrobenthic communities is strongly correlated to abiotic factors such as hydrodynamism, texture of substrate, concentration of organic matter and, last but not least, the presence of pollutants. As a result it is liable to considerable spatial and temporal variations. The analysis of these communities makes it possible to reveal eventual environmental changes taking place in relation to possible variations in the aforementioned factors for all types of surface waters.
The relative ease of collecting samples and identifying these organisms together with their widespread diffusion in water courses make benthic macroinvertebrates particularly suited to the use of bio-monitoring and assessment of the quality of fordable rivers[9].
The method being tested is based on a multi-habitat approach involving a collection of macroinvertebrates proportional to the relative extension of the various habitats estimated prior to start of sampling. In lake environments they live in sediment (endobenthos) or on it (epibenthos). Sediments play an important role in the chemical and biological processes of lake ecosystems because the substances dissolved in the water above accumulate in them by means of adsorption.

Classification methods used for coastal marine and transitional environments, at Mediterranean Ecoregion level, are merely indices concerning benthic communities on soft bottom. The various indices formulated generally respond extremely well to the

[9] Buffagni *et al.*, 2008

organic enrichment of the sediment, reflected in the composition of the species and the structure of the macro-zoo-benthic communities. M-AMBI (Multivariate AZTI *Marine Biotic Index*), an index consolidated by an extensive bibliography, will soon be used in Italy. It is based on the analysis of the structure of the community present which involves the division of the species present into 5 ecological groups, in relation to the degree of specialisation/ opportunism and their sensitivity to environmental stress gradients[10].
In addition to M-AMBI, the classification systems proposed for transitional waters included BITS (*Benthic Index based on Taxonomic Sufficiency*). BITS only requires taxonomic recognition of benthic macrofauna at family level. The analysis of the structure of the community then divides the families into 3 ecological groups: sensitive, tolerant and opportunistic[11].

Fish populations (rivers, lakes, transitional waters) play an important role in environmental assessments because they respond to various types of environmental stress, integrating the effects of environmental factors change on other components of the aquatic ecosystem, because of their dependence on them for survival, growth or reproduction. Moreover, given that many species have a relatively long life, analyses at population level (e.g. structures based on size or age classes) and population (e.g. list of species, relations between them) can provide long-term documentation of environmental stress as well as representing a way of assessing the efficiency of the environmental upgrading measures designed to bring about the quality objectives[12].

Phytoplankton monitoring (composition, abundance and biomass) is requested for lake**,** transitional and marine coastal waters with blooms of potentially toxic or harmful species being identified, where present, for the latter.
Due to its position at the base of the trophic level phytoplankton

[10] Muxika *et al.*, 2007 - Borja *et al.*, 2008
[11] Mistri and Munari, 2008
[12] Tancioni *et al.*, 2005; Scardi *et al.*, 2005

plays an important ecological role. Phytoplankton primary production is an important link in the food chain in fresh and marine waters, guaranteeing the necessary flow of matter and energy for the maintenance of heterotrophic organisms. Phytoplankton is equally important as an indicator because it comprises a high number of species with different ecological role, many of which sensitive to both organic and inorganic pollution, as well as to variations in the salinity, temperature and trophic level of the waters. It consists of small photosynthetic organisms (unicellular microalgae) that live in suspension in the waters of lakes, rivers and seas.

These organisms have a short life cycle and rapid growth and reproduction rates, making them ideal as short-time impact indicators. However, their excess proliferation leads to a rapid reduction in the quality of the waters (eutrophication).

Microalgal studies make it possible to evaluate the influence of eutrophic factors (nitrogen and phosphorus loads) and pollutants upon biological communities. In the marine context chlorophyll *a* is a useful trophic indicator because it is directly correlated to the quantity of phytoplankton biomass present in the water column.

The current classification system for the phytoplankton BQE in coastal waters is based on the values of the chlorophyll *a* parameter measured on the surface, chosen as a biomass indicator.

The infralittoral communities on rocky substrate dominated by **macroalgae** respond to changes in environmental conditions in relatively brief times, which is why they are particularly suited to monitoring of the ecological status of coastal waters.

The prevalent methods used to classify coastal waters according to this Biological Quality Element at Mediterranean Ecoregion level, are based on the principle that a high ecological status of the water body corresponds to the presence of macroalgal communities dominated by well structured brown algae (*Cystoseira* sp.), while a poor status was characterised by the dominance of opportunistic species with low morphological complexity like *Ulvales* (green algae), *Bangiophycidae* (red algae) and Cyanobacteria.

In Italy, positive results seem to have been obtained using the

CARLIT (Littoral Cartography)[13] method which implies "visual census" followed by the mapping of algal associations present along the infralittoral belt, highlighting the different types of anthropogenic pressures present and revealing good correlation with other water quality parameters[14].

Transitional waters are notoriously eutrophic environments by their own nature. Methods based on the observation of communities comprising macroalgal and phanerogam species seem to be particularly suitable for the assessment of the ecological status of these water bodies. The different species present can be divided into three ecological groups: opportunist, indifferent and sensitive to environmental stress gradients. The reliability of these methods is linked to the number of species present in the monitoring stations. The adopted approach for the formulation of classification indexes include presence/absence of opportunist, indifferent and sensitive species, the percentage of dominance in the area under examination, the R/C (*Rodophyceae/Chlorophyceae*) ratio and marine spermatophyta coverage, if present[15].

Posidonia oceanica prairies play an important role in the characterisation process of marine coastal environments. . Thanks to its wide distribution and sensitivity to anthropogenic disturbances *Posidonia oceanica* is one of the angiosperms listed by Italian Ministerial Decree DM 56/2009 "Monitoraggio" as a Biological Quality Element used in classifying ecological status.

Various classification indexes were proposed by the Member States belonging to the Mediterranean Ecoregion. One index that has already been tested in Italy (POSWARE - ISPRA, 2009) is formulated on the base of the following set of descriptors: density of prairies (no. of bundles per sq m), primary production (assessed in terms of annual weight increase of rhizome), annual rhizome elongation and leaf production (no. of leaves produced per year). Another factor that must be considered is the natural variability of these descriptors along the depth gradient, from the shore

[13] Ballesteros *et al.*, 2007
[14] Mangialajo *et al.*, 2007
[15] Sfriso *et al.*, 2007, 2009

outwards, which has made it necessary to “discrete” the survey areas in bathymetric intervals and to take these effects into account when calculating the index.

As far as chemical quality is concerned, Directive 2000/60/EC establishes that water pollution prevention and control must be pursued through a combined approach involving both control of pollution at source (emission limits) as well as the application of Environmental Quality Standards (EQSs). Environmental Quality Standards are defined as “the concentration of a particular pollutant or group of pollutants in water, sediments or biota which should not be exceeded in order to protect human health and the environment”.
The Directive classifies pollutants as: priority substances (including priority hazardous substances); hazardous substances; major pollutants.
As far as the classification of chemical status is concerned, water should be classified as achieving good chemical status or failing to achieve good chemical status, on the basis of emission limits and Environmental Quality Standards laid down by the previous European Directives on hazardous substances (76/464/EEC and following legislation), as well as in relation to the Environmental Quality Standards established for pollutant compounds not included in these Directives.
Italian Ministerial Decree 56/2009 lays down the technical guidelines for the monitoring programmes for surface water status assessment, in compliance with Directive 2000/60/EC and Annex II to the same Directive. In particular, the substances defining chemical status are contained in a priority list with 33 “priority” substances and 8 substances from the secondary legislation resulting from 76/464/EEC.

The definition of chemical status and safeguarding of water bodies requires compliance with the EQSs listed in Directive /105/EC of 16th December 2008.
As mentioned in the Directive, in addition to accepting the EQSs, Member States may also independently define quality standards (also for sediments and biota) provided that these standards guar-

antee the same "safety" in guaranteeing water bodies as those laid down for waters. Referring to biota, the Directive identifies three quality standards relative to mercury (and its compounds), hexachlorobenzene and hexachlorobutadiene.

In both surveillance monitoring as well as operational monitoring the chemical substances to be monitored are identified by analysing pressures and impacts on the area under examination. The substances in the priority list are monitored whenever there are discharges, emissions or losses in the water bodies under examination. The other chemicals, listed in Annex 8 of Italian Legislative Decree 152/06 are monitored whenever the level of discharges, emissions or losses are such that they are considered a risk for the attainment or maintenance of the quality objectives (art. 77 and following of Italian Legislative Decree 152/06).

Two case studies are described below: "Experimental monitoring of surface waters in the region of Umbria (2008/2009); "Characterisation of the Venice lagoon and identification of water bodies".

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CASE STUDY

Experimental monitoring of surface waters in the region of Umbria (2008/2009)

2008 was a year that brought major changes in the monitoring of the environmental quality of surface waters in the region of Umbria. During the year, in compliance with the new legislation regulating this sector, the region of Umbria has defined the preliminary phases of monitoring programme and launched the monitoring activity in compliance with Italian Legislative Decree 152/06, and subsequent amendments and additions, both for the category of watercourses and the category of lakes.

The first phase involved the characterisation of the surface hydrographic network (watercourses and lakes) and the identification of water bodies, in compliance with Italian Ministerial Decree 131/2008 and in agreement with the technical indications laid down by both community and national guidelines. 133 rivers belonging to 18 types were identified for the watercourse category within the 3 Hydro-ecoregions[1] making up the region as shown in Table 1.

10 water bodies belonging to 3 different types were identified for the lakes category (Table 2).

During the second phase, the water bodies were subjected to the analysis of significant pressures affecting the relative sub-basins. The main pressure factors considered were as follows:

- diffuse sources (urban areas, agriculture, fertilised-irrigated areas);
- point sources (pollutant loads from municipal waste water treatment plants, point loads from sewage overflows, industrial pollution, potential presence of priority substances).

[1] Uniform macro-areas with aquatic ecosystems distinguished by highly comparable general features due to the limited variability of the chemical, physical and biological characteristics of the surface waters

Table 1: Types identified in the Region of Umbria in compliance with DM 131/08 and distribution of water bodies by type (watercourses)[2]

	TYPE	Water bodies belonging to the type
		no.
1	13SR1T	1
2	13SR2T	12
3	13SR3T	2
4	13SR4T	1
5	13SR5T	3
6	13SS2T	1
7	11SR2T	5
8	11SR2D	2
9	11SR3D	2
10	11SR4T	1
11	11SR5F	2
12	11SS2T	24
13	11SS3T	16
14	11SS4T	2
15	11SS5T	6
16	14SR2T	2
17	13IN7T	12
18	11IN7T	39
TOTAL		133

Table 2: Types identified in the Region of Umbria in compliance with DM 131/08 and distribution of water bodies by type (lakes)[3]

	Type	Description of type	Water bodies belonging to the type
			no.
1	ME-1	polymictic Mediterranean lakes	5
2	ME-2	Shallow limestone Mediterranean lakes	3
3	ME-4	Deep limestone Mediterranean lakes	2
TOTAL			**10**

The analysis of pressures were carried out by means of cluster analysis which grouped water bodies in nine pressure levels.
This analysis was accompanied by a preliminary assessment of the potential risk of failure to attain the environmental quality

[2] Source: ARPA Umbria
[3] Source: Ibidem

objectives laid down by Directive 2000/60/EC, based on existing monitoring data for the entire regional network. On the basis of this analysis 27 water bodies in the watercourses category were identified as being at risk (R), 13 not at risk (NR) and 93 potentially at risk (PR); 6 water bodies in the lakes category were identified as being at risk (R) while 4 were considered potentially at risk (PR).

On the bases of pressures' results and risk analyses, it was decided to test the possibility of grouping water bodies as suggested by Italian Ministerial Decree DM 56/2009, limited to water bodies belonging to the watercourses category because it was held necessary to monitor directly all water bodies identified in the lakes category.
This led to the identification of 55 "basic monitoring units", compounded by one or more water bodies belonging to the river type, to the same pressure cluster and with the same risk status, and in sites not too distant from each other. Representative water bodies were identified for each unit so that they could undergo monitoring, giving preference to those which already had active monitoring stations in compliance with existing laws and for which time-series data was already available.
The initial identification of water bodies undergoing monitoring and their distinctive features was followed by complex checks and fine-tuning of the network by means of on-site inspections designed to observe environmental parameters confirming the representative nature and adequacy of features proposed. Specific programmes of measures were proposed for each surveillance and operational monitoring station. As far as monitoring of biological quality elements is concerned, the monitoring programme was defined on the bases of criteria dictated by the applicable laws and on the bases of the spatial and temporal variability of the bio-indicators monitored.

As far as physic-chemical parameters are concerned, it was decided to divide both the main parameters and substances in the priority list into analytical sets. In the purposes of monitoring, rivers were divided into four groups: the first comprises water

bodies at the outlet points of the main basins; the second comprises water bodies defined as significant by the Italian Legislative Decree 152/99; the third comprises other water bodies belonging to the main network and the last group composed by the water bodies belonging to a minor or temporary network.
A general monitoring programme (parameter sets and frequencies) was developed for each of these groups together with specific monitoring programmes for the single stations within each group on the basis of the pressure analysis results.
In general, it was decided to subject stations at the outlet point of the main sub-basins to "complete" surveillance monitoring including all analytical sets.
As far as lakes were concerned, the detailed monitoring programmes were defined on the basis of pressures acting upon the single water bodies.

Table 3: Set of analytical parameters monitored[4]

Analytical set	Analytical sub-set	Type of parameter
B		Main physico-chemical parameters
E		*Escherichia coli* + chemical parameters
A	A1	Metals (Table 1/A + Table 1/B)
	A2	Phenols (Table 1/A + Table 1/B)
	A3	VOC+BTEX (Table 1/A + Table 1/C)
	A4	Pesticides+IPA (Table 1/A + Table 1/B)
C		Phenoxyacids

Table 4: General monitoring programme of rivers – division of micropollutant sets within groups of stations identified for monitoring[5]

River groups	Analytical sets			
	B	E	A	C
Water bodies at the outlet points of the main basins	three-monthly	monthly	monthly	three-monthly
Water bodies defined as significant under Italian Legislative Decree 152/99	three-monthly		monthly	three-monthly
Other water bodies in the main network	three-monthly		monthly	three-monthly
Minor and temporary rivers	three-monthly		three-monthly	

[4] Source: Ibidem
[5] Source: Ibidem

The results of these activities enabled the definitive identification of the regional monitoring network for the purposes of the assessment of the environmental quality of surface waters in the region of Umbria under Italian Legislative Decree 152/06 and amendments and additions.

For the water courses category, the monitoring network proposed comprises 44 surveillance monitoring stations relative to water bodies defined as "probably at risk" and 24 operational monitoring stations for water bodies "at risk". The network comprises 24 stations active for the environmental quality monitoring of water bodies defined as significant under Italian legislative decree 152/99 and amendments and additions; the remaining newly activated stations are distributed both among other main water bodies not monitored so far as well as among minor and temporary water bodies.

The proposed network for lakes comprises 7 surveillance monitoring stations and 8 operational monitoring stations. Each station represents the environmental quality of a water body with the exception of Lake Trasimeno whose size and morphological characteristics are such that two monitoring stations will be activated, also with the aim of checking the homogeneity of the water body. Only 3 stations in the network are newly activated; the others are all stations activated for monitoring in compliance with Italian Legislative Decree 152/06 and amendments and additions.

Trials involving the new monitoring network began in 2008 and are due to conclude in 2009. In 2008 a sampling activity was begun in the monitoring stations concerning water bodies belonging to the main watercourses (for a total of 28 stations) for the watercourse category while trials were extended to the minor water bodies in 2009.

As far as lakes are concerned, trials concerned 8 stations representing 7 lakes; the trials are due to conclude in 2009.

During the current phase, ARPA Umbria is involved in the process

of identification of river reference sites. The first step of the activity, carried out in accordance with technical guidelines contained in Italian Ministerial Decree DM 56/2009, involved the selection of potential reference sites, carried out using the spatial method, that is, on the basis of the assessment and quantification of the existing anthropogenic pressures and collection of information on a wide scale (cartographic information and experimental data). In the coming months, the selected sites will undergo checks, in the form of on-site biological validation designed to confirm their suitability as reference sites. The results of the application of the spatial method have already proved inadequate given that it was only possible to identify potential reference sites for some of the river types present in the region.

As a result, in order to complete this phase of the process it will be necessary to adopt other methods put forward by Ministerial Decree 56/2009 (theoretical method, temporal method, combined approach, etc.). The absence of time-series data or paleo-reconstructions for Umbrian rivers excludes the possibility of using temporal methods; therefore the only possibilities are use of statistical or forecast methods or, alternatively, a search for reference sites representative of Umbrian water bodies in other Italian regions. This last possibility may only be examined once the process of adjustment to Italian Legislative Decree 152/2006 has been carried out throughout Italy.
The identification of reference sites for lakes within the region is even more complex. In fact, the initial analysis of pressure distribution and past monitoring data showed that none of the water bodies identified possessed the characteristics necessary to be defined a reference site.

After identifying the reference conditions for each type of water body, the next step involves identifying and designating Heavily Modified Water Bodies (HMWBs) and Artificial Water Bodies (AWBs). Only then will all the elements necessary for the complete definition of the monitoring network, including the reference site network, be available.

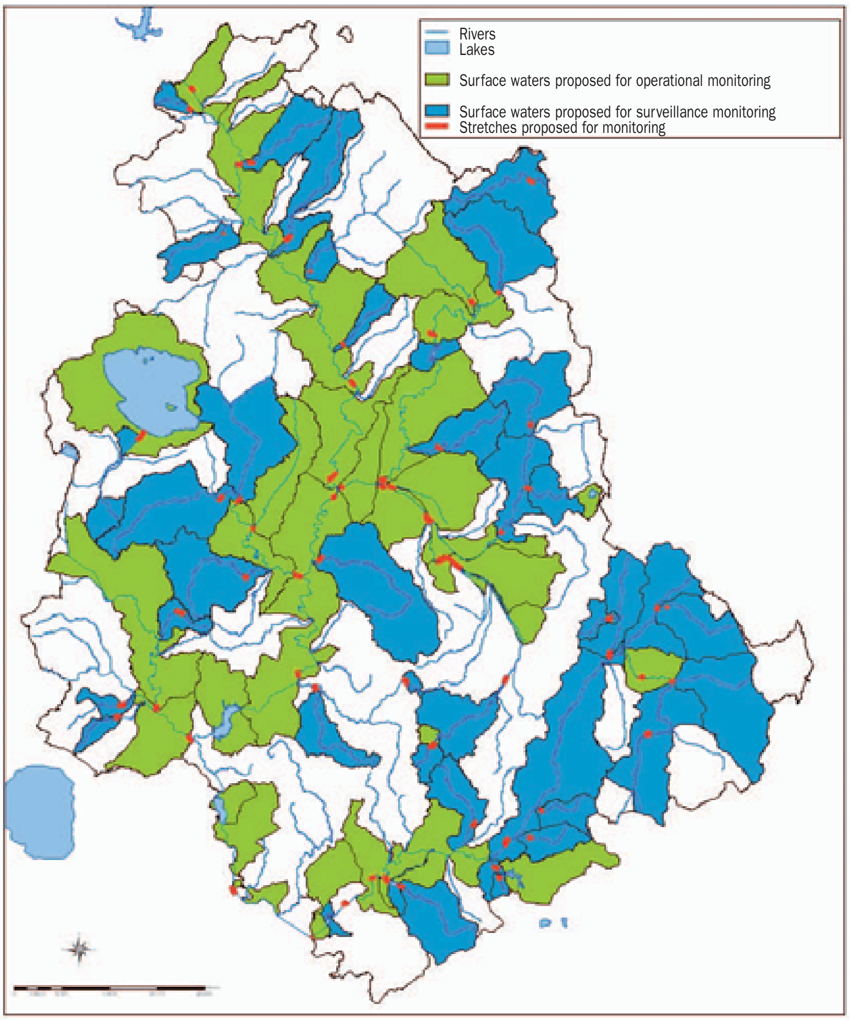

Figure 1: Surface waters to undergo monitoring and stretches proposed for operational and surveillance monitoring[6]

All the activities described are merely the first part of the process outlined by Italian Legislative Decree 152/2006. The assessment of the environmental quality of surface waters in compliance with the new laws will only be concluded once all the technical-legisla-

[6] Source: Ibidem

tive instruments are available at national level and once a wider scale comparison has been carried out with all actors involved by competent area:

- Integration of the monitoring network at district scale (Central Apennine District);
- Definition and fine-tuning, at national level, of the biological indicator assessment metrics, together with the intercalibration system launched at community level by intercalibration groups for ecoregions (GIG – Geographical Intercalibration Group).

In conclusion, although the absence of definitive methods for the assessment of biological elements and the continued uncertainties with regard to the definition of reference sites have made it impossible to assess the quality of regional water bodies, steps have been taken to launch various procedures and define criteria adapting monitoring plans for the classification of water bodies in compliance with the provisions of the laws implementing the directive in Italy.

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CASE STUDY

Characterisation of the Venice lagoon and identification of water bodies

This section presents a case study adopting the criteria for the characterisation and identification of water bodies, applying the procedures laid down by the Italian Ministerial Decree DM 131/2008 to the Venice lagoon. An initial example of zonation of the Venice lagoon under Directive 2000/60/CE was proposed in the document *"Guida alla tipizzazione dei corpi idrici di Transizione e alla definizione delle condizioni di riferimento ai Sensi della direttiva 2000/60/CE - El-Pr-TW-Tipizzazione_Condizioni di Riferimento-01.01" – Guide to to the characterisation of transitional waters and to the definition of reference conditions in compliance with directive 2000/60/EC – El-Pr-TW-Characterisation_Reference Conditions-01-01* (ICRAM, 2007). The proposal was subsequently implemented, with various amendments agreed upon with ICRAM, by ARPA Veneto and published in *"Proposta di prima tipizzazione delle acque marine coastal e di transizione della Regione del Veneto, ai sensi del Decreto del Ministero dell'Ambiente e della Tutela del Territorio e del Mare n. 131 del 16 giugno 2008 recante modifiche al Decreto Legislativo 3 aprile 2006, n. 152 (allegati 1 e 3 della parte terza), di attuazione della Direttiva 2000/60/CE" (Proposal for a preliminary characterisation of the marine coastal and transitional waters of the Veneto Region under the Decree of the Ministry of the Environment no. 131 of 16 June 2008 amending the Italian Legislative Decree of 3 April 2006, no. 152 (Annexes 1 and 3 of the third part), implementing Directive 2000/60/EC)* . Finally, to date, the official document containing the characterisation and identification of the water bodies of the Venice lagoon is the "Piano di Gestione dei bacini delle Alpi Orientali - sub-unità idrografica bacino scolante, laguna di Venezia e mare antistante" ("Management Plan for the basins of the Eastern Alps – hydrographic sub-unit drainage basin, Venice lagoon and adjoining sea") published in July 2008.

Limits of the hydrographic basin and of the transitional waters

The area comprising the Venice lagoon, its drainage basin and adjoining sea is identified as the "Hydrographic sub-unit of the Venice lagoon, its drainage basin and adjoining sea" belonging to the Eastern Alpine District.

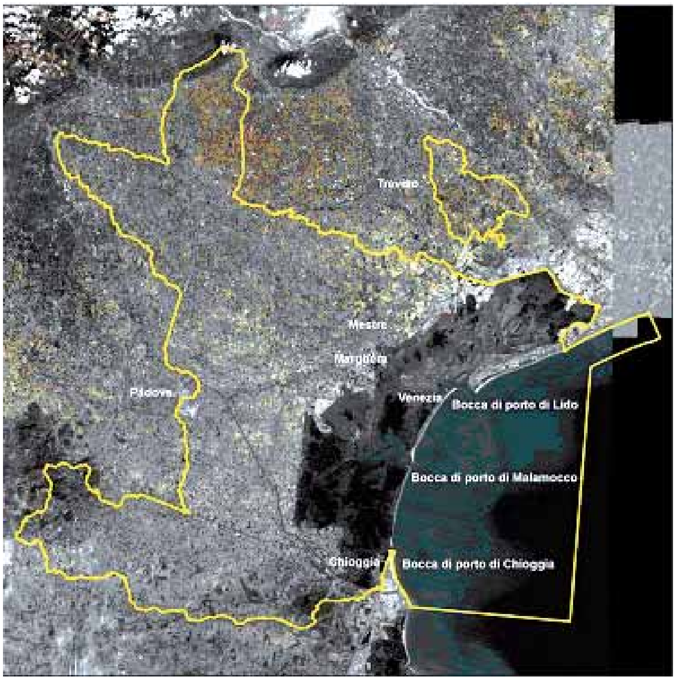

Figure 1: Hydrographic sub-unit of the Venice lagoon, its drainage basin and adjoining sea[1]

The first step in the zonation of water bodies involves identifying the limits of the category to which the environment concerned belongs. For transitional waters these limits are the river category, upstream, and the coastal water category, downstream.
Under the definition of “transitional waters” contained in the Italian Ministerial Decree 131/2008, the limits of the Venice lagoon can be identified:
upstream, as the permanently exposed lagoon boundaries;
downstream, as the barrier islands (Cavallino, Lido, Pellestrina and Sottomarina) and by the outer edge of the breakwaters at the three inlets (Lido, Malamocco and Chioggia).

[1]Source: PG_laguna_venezia_rev01, www.alpiorientali.it

Once the limits of the transitional waters have been defined, we need to identify heavily modified water bodies, which form a separate category and are therefore initially excluded from the characterisation procedure (they will be subsequently included in the category that most closely resembles their characteristics). The water bodies in the Venice lagoon provisionally allocated to this category are the industrial canals of Porto Marghera, the canals in the historic centre of Venice and the fish farms.

Characterisation of the lagoon

The Venice lagoon is a large microtidal coastal lagoon (surface area of approximately 550 km^2 and tidal excursion of over 50 cm throughout). Given the vast area covered and the heterogenous nature of the environment it is impossible to consider the whole lagoon in terms of a single type given that its ecological status cannot be referred to a single reference condition.
On the basis of the three-yearly mean annual salinity data contained in past studies (Progetto MELa3 – Magistrato alle Acque di Venezia – Consorzio Venezia Nuova) two different types were identified: polyhaline, with reference to the lagoon boundary areas which are permeated by freshwater; and euhaline, in the areas subjected to exchanges with the sea.
Adopting this procedure, in compliance with the national system, the Venice lagoon can be divided into 2 types:

- coastal lagoon, microtidal, large, polyhaline;
- coastal lagoon, microtidal, large, euhaline;

However, adopting this division, the internal homogeneity within each type does not permit the identification of type-specific conditions representing the biological quality of the various environments. The two types contain zones characterised by extremely different depths, residence times and intertidal structures. The hydromorphological analysis of the lagoon reveals a clear distinction between areas that are more or less sheltered by saltmarshes in both the northern and central-southern lagoon areas. It should also be pointed out that the southern lagoon is crossed by the Romea state road which creates a physical barrier reducing the speed of the exchange of water between the Val di Brenta and the rest of the lagoon.

Considering the degree of exposure/shelter as a sub-characterisation criteria, the Venice lagoon can be divided into 4 types of surface water body (Figure 2):

- coastal lagoon, microtidal, large, polyhaline – sheltered (mt.g.pol.c);
- coastal lagoon, microtidal, large, euhaline –sheltered (mt.g.eu.c);
- coastal lagoon, microtidal, large, polyhaline – exposed (mt.g.pol.nc);
- coastal lagoon, microtidal, large, euhaline – exposed (mt.g.eu.nc);

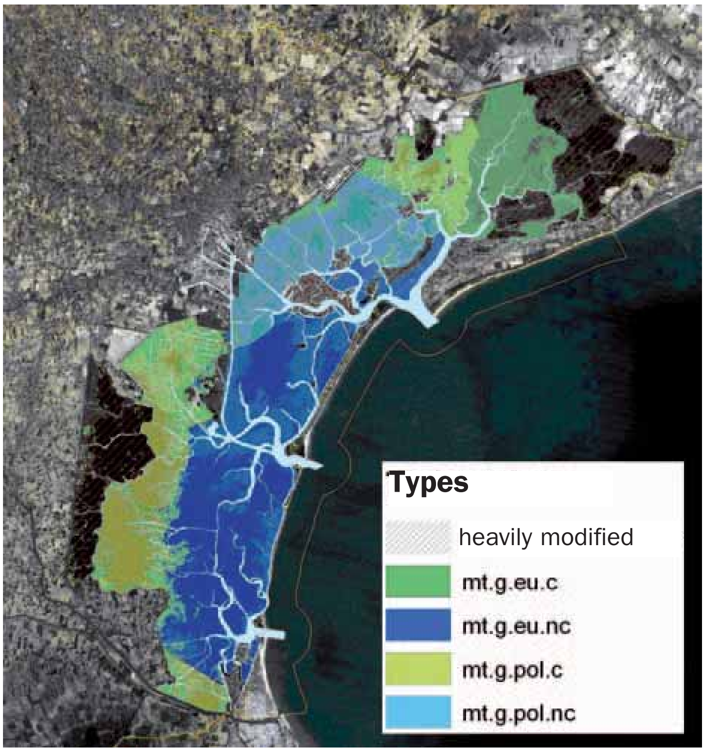

Figure 2: Characterisation of the Venice lagoon[2]

[2] Source: Ibidem

Identification of the water bodies

The final phase of zonation of the Venice lagoon involves identifying the water bodies, the physical reference unit for the classification of the environmental status and for the planning of monitoring activities.
Subdividing the area into water bodies makes it possible to obtain geographical units that are as uniform as possible in terms of pressure and status for the purpose of attaining a representative classification without excessive fragmentation.

The Venice lagoon is currently divided into 12 water bodies (Figure 3), 8 of which natural and 4 heavily modified, as shown in the "Management Plan for the basins of the Eastern Alps – hydrographic sub-unit drainage basin, Venice lagoon and adjoining sea".

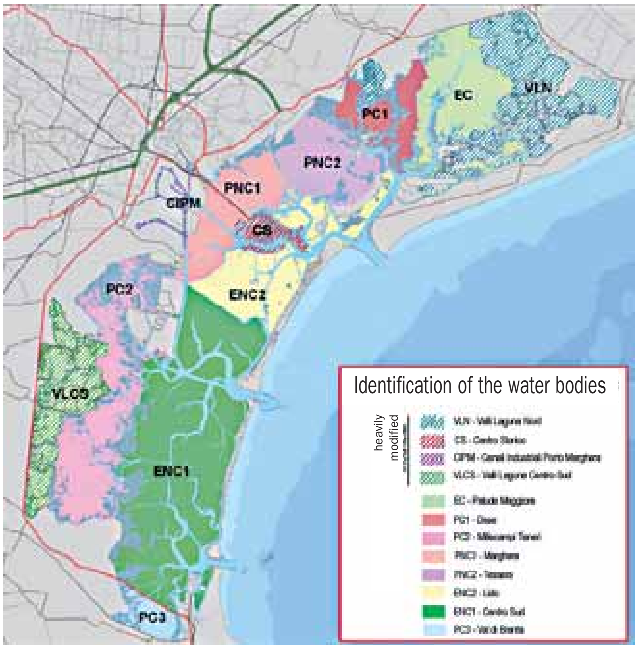

Figure 3: Identification of the water bodies of the Venice lagoon[3]

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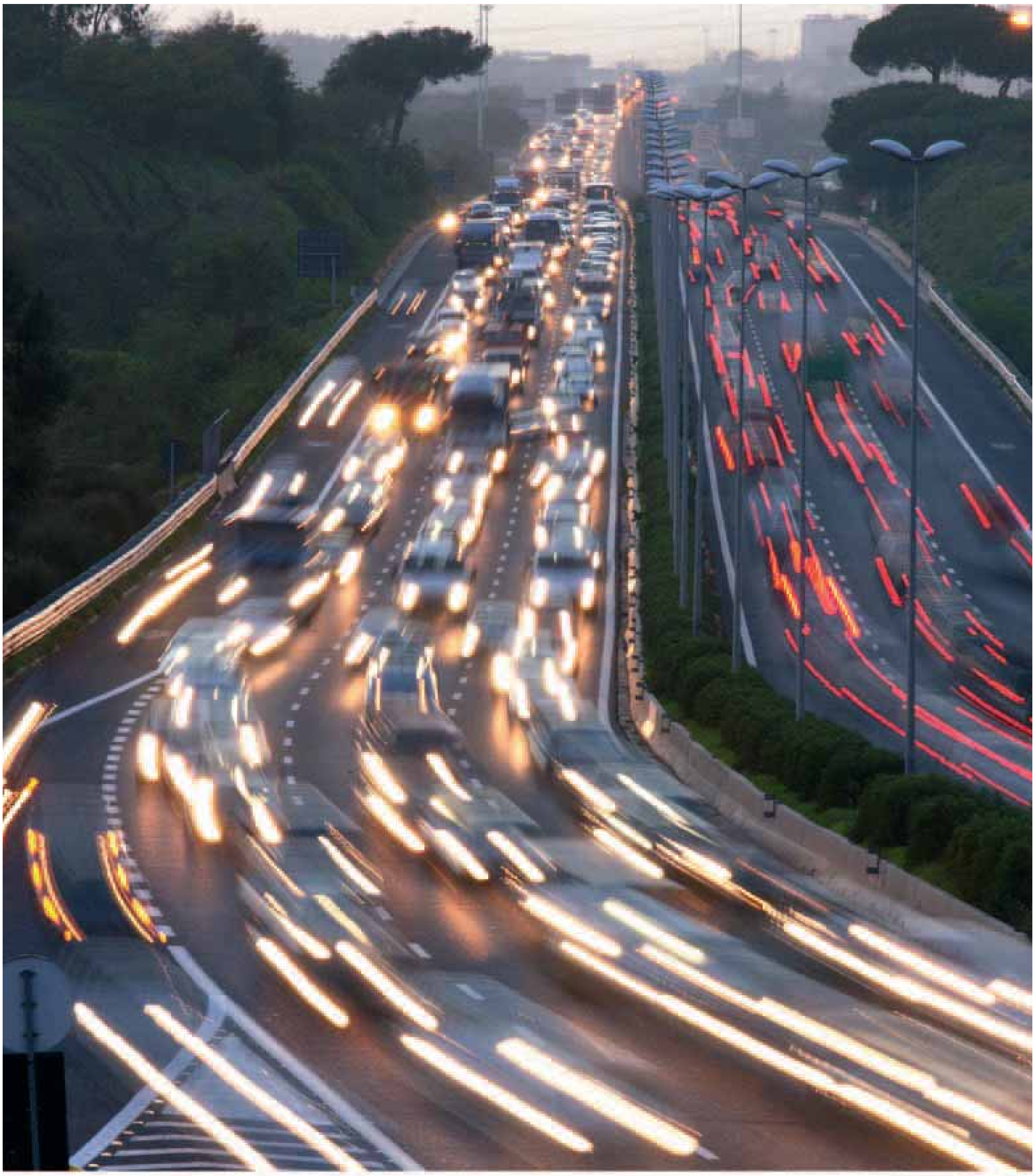
[3] Source: Ibidem



EXPOSURE TO PHYSICAL AGENTS

NOISE
NON-IONISING RADIATION
ULTRAVIOLET RADIATION
IONISING RADIATION

Introduction

The term "Physical Agents" describes those environmental pollutants which, governed by the laws of physics, bring about a change of the environmental conditions of the context in which they are present.

The term "Physical Agents" describes those environmental pollutants which, governed by the laws of physics, bring about a change of the environmental conditions of the context in which they are present. Their presence, in living and working environments determine how much energy, potentially detrimental to human health, is emitted. Physical Agents that effect the environment are electromagnetic fields, the levels of noise in a residential setting and in daily life, ionising radiation, vibrations, light pollution and ultraviolet (UV) radiation.

Noise pollution is characterized by how widespread it is and the high impact it has on the environment, on eco-systems and on the population and is significant enough to induce the EU to pursue as an objective, the reduction of the number of people exposed to noise.

Noise pollution is considered one of the most significant causes in the deterioration of the quality of everyday life and it constitutes one of the most serious environmental problems. It is characterized by how widespread it is and the high impact it has on the environment, eco-systems and the population. The bothersome or disturbing effects it causes have been well documented and are such that the European Community has been persuaded that reducing the number of people living in its member states exposed to noise must be a primary objective, achievable by adopting the same methods aimed at minimising the phenomenon. The detailed legislation on this subject and the existence of preventative and clean-up measures has to date, failed to resolve this environmental issue and it remains a priority.

There continues to be greater social concern about the dangerous effects that electromagnetic pollution has on human health.

There continues to be considerable social concern about electromagnetic pollution because of the dangerous effects it has on human health, even if at national level, the risk connected with prolonged exposure is considered low, in part because cause and effect between exposure to electric, magnetic and electromagnetic fields and any subsequent consequences to health has not been established. Legislation regarding this aspect has also resulted in specific regulations clearly aimed at safeguarding the individual.

Ionising radiation consists of particles and/or energy of natural or artificial origin pable to modify the structure of the matter with which it interacts.

Ionising radiation consists of particles and/or energy of natural or artificial origin able to modify the structure of the matter with which it interacts. Interaction with biological tissue can cause cell damage with possible morphological and functional changes to affected organs that can cause health problems in those individuals who have been exposed to it. Although, there are no active nuclear plants in Italy, the pressure on the environment

caused by ionising radiation continues to be both relevant and manifold. This includes: the production and necessary treatment of radioactive waste created by diagnostic and/or radiotherapy procedures carried out in hospitals; the growing worldwide production and circulation of radioactive materials; the radiation coming from natural origin materials (NORM and radon) that are, to date, the main source of exposure. Therefore, radiation protection must continue to be the key issue of any environmental safeguards along with the protection of the population and workers. The risks that would derive from any decrease in care and ability to control and to monitor the levels of radioactivity in the environment and in foodstuffs, could inevitably lead to uncontrollable social and economic situations that would arise from insufficient knowledge of the problems caused by exposure to ionising radiation.

Interaction with biological tissue can result in possible cell damage, in the form of morphological or functional alterations to the organs concerned.

Less attention is paid to other agents by members of the public and legislators alike, and this would seem to be because the impact they have on man and the environment is perceived differently or as being less significant. Vibrations, for example, disturb an extremely limited percentage of individuals and only in very specific situations (the proximity to certain types of transport infrastructures) and light pollution does not create any easily apparent discomfort to individuals. Ultraviolet (UV) radiation warrants separate consideration, as the health implications are particularly noticeable in terms of the damage excessive exposure to this type of radiation causes to the skin and eyes. With the exception of occupational exposure to UV rays emitted by artificial sources, exposure to the Sun, the most significant natural source of such rays, has not yet been formally regulated. Both national and international institutes confine themselves to simply issuing recommendations by means of opportune notices published in the press, what protective measures should be taken and to providing bulletins about UV levels.

The medical consequences of being exposed to UV radiation are particularly evident when it comes to the damage this causes to skin and eyes.
To date, no actual laws have been passed to regulate exposure to the sun, which is the main natural source of this type of radiation.

In any event, it must be borne in mind that corrective measures on this point would be difficult to impose in that these would impinge on an individual’s habits and limit personal behaviour that is, conversely, a source of satisfaction (for example tanning in the summer or artificial tanning).

NOISE

The problem

European policy regarding noise pollution, considered one of the most serious environmental problems, has determined that the progressive reduction of the number of people exposed to levels of noise deemed detrimental to the quality of life or, potentially, to the health of local residents, is a matter of priority. The main measures adopted by the European Commission are the creation of a network of experts from all the different of this subject area; to specify what information is to be made available and that it should be accurately produced and supplied in a comparable and uniform manner that supports the political initiatives taken. Equally important are the proclamation of European Directive 2002/49/EU[1] regarding the assessment and management of environmental noise and Directive 2002/49/EC, transposed into Italian legislation with Legislative Decree no. 194/2005[2]. This sets out how to assess environmental noise and asks the pertinent authorities in member States to draw up acoustic strategic maps showing urban agglomeration sand the main vehicular, railway and airport infrastructures using L_{den} and $L_{night,}$ the new indicators introduced to estimate the annoyance levels or the degree of sleep-related problems resulting from noise. Other actions introduced by the directive deal with the adoption, by member states, of Action Plans aimed at reducing environmental noise, especially in those areas where it has proved detrimental to health; safeguarding those areas where the acoustic quality is good, and ensuring that the public is provided with information about environmental noise and its effects, and even, in some circumstances, the involvement of members of the public in the process of drawing up the plan itself.

With regard to noise pollution, considered one of the main environmental problems today, the main objective, at European level, is the progressive reduction of the number of people exposed to noise levels deemed detrimental to people's quality of life or health.

With regard to informing the public and building a shared data bank that will make it possible to make consistent and compa-

[1] Directive 2002/49/EU, issued by the European Parliament and Council on 25 June 2002, concerns the measurement and management of environmental noise.
[2] Legislative Decree no. 194 of 19 August 2005: «The Implementation of Directive 2002/49/EU regarding the measurement and management of environmental noise» (Legislative Decree published in the Official Gazette – general series – no. 222 of 23 September 2005)

rable readings of the situations that exist in member states. Since October 2009, it has been possible to consult the NOISE[3] (*Noise Observation and Information Service for Europe)*, database that holds information obtained through the implementation of actions envisaged in the directive. Since 1996, the year in which the *Green Paper on Future Noise Policy*[4], the first document to define European policy regarding noise pollution was published, standard, shared information that addresses the issue of noise pollution has been available within Europe. An initial analysis of the data that constitutes an organic and complex information system shows that there is a significant percentage of the population exposed to noise levels high enough to be bothersome or disturbing although levels vary between the different member States and in relation to the diverse sources of noise. According to the data collected in February 2009, around 41 million people living in Europe's urban agglomeration are exposed to L_{den} values exceeding 55 dB(A) caused by the noise from roadway infrastructures.

It has been shown that around 41 million people in the European Community in urban agglomeration are exposed to environmental noise at Lden levels that exceed 55dB (A) caused by roadway infrastructures.

Analysing the total number of people living outside the urban agglomerations of the European Community, in buildings exposed to a noise source, namely road traffic, that produces L_{den} values above 65 dB(A), it can be seen (Figure 5.1) that in comparison to other member countries, a large percentage of the population of Italy is exposed. The situation is worse still if one considers that the total number of people, living in the same circumstances as those described above, exposed to L_{den} levels above 75 dB (A) (a decidedly high level) is greater than 80,000. This represents a group of people living with the highest levels of noise registered anywhere in countries that are part of the European Community. (Figure 5.2). In addition to the critical aspects already presented, a complete and even more in-depth study of the data just published may show, in due course, the actual connotations and dynamic principals that the subject acquires at both national and community levels.

[3] http://noise.eionet.europa.eu/index.html
[4] Future Noise Policy. European Commission Green Paper. Brussels, 04/11/1996

Analysing the total number of people living outside the urban agglomeration of the European Community, in buildings exposed to a noise source, namely road traffic, that produces L_{den} values above 65 dB(A), it can be seen that in comparison to other member countries, a large percentage of the population of Italy is exposed.

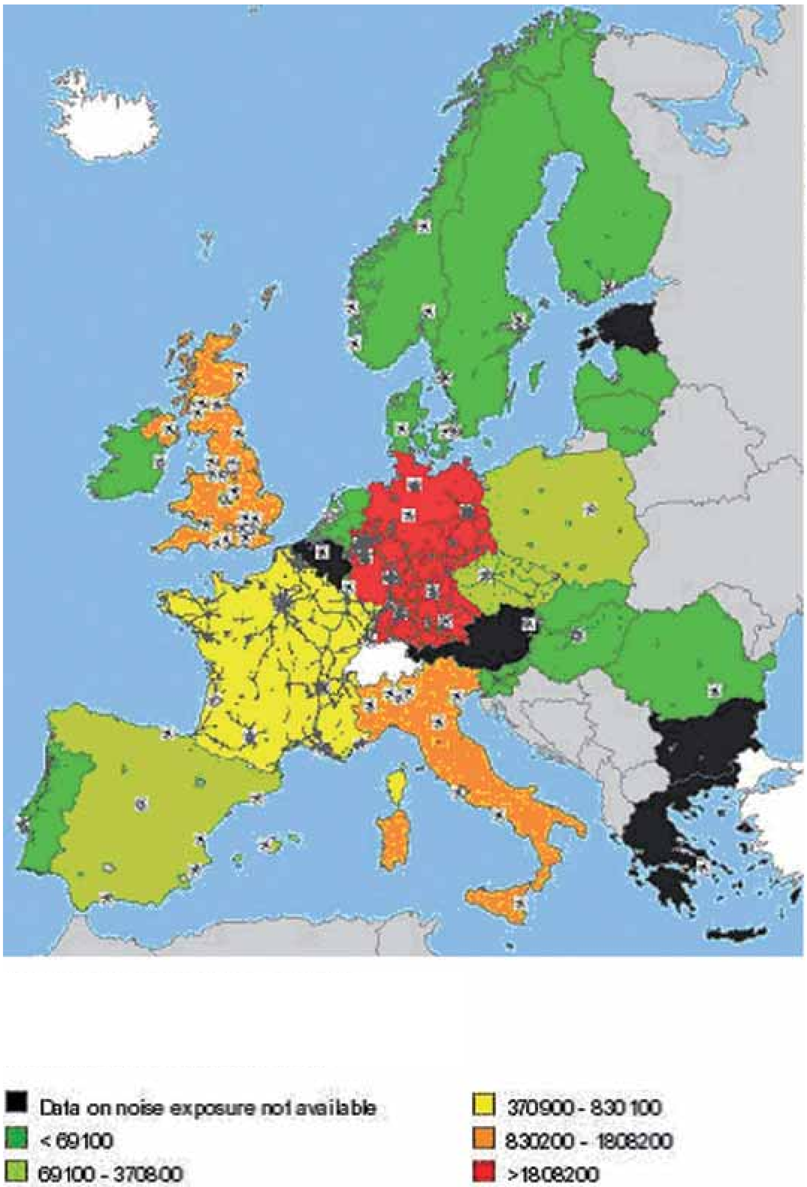


Figure 5.1: The total number of people living outside the urban agglomeration of the European Community in buildings exposed to a noise source, namely traffic on major roads, that produces L_{den} values above 65 dB(A) (2009)[5]

[5] Source: NOISE, Noise Observation and Information Service for Europe

Analysing the total number of people living outside the urban agglomeration of the European Community, in buildings exposed to a noise source, namely major road traffic, that results in L_{den} values above 75 dB(A), the situation in Italy is actually even worse. The number of people exposed to these higher levels, greater than those recorded in other countries is more than 80,000.

Figure 5.2: The total number of people in the European Community who live outside the urban agglomeration in buildings exposed to a noise source, namely major road traffic, that results in L_{den} levels > 75 dB(A) (2009)[6]

[6] Source: NOISE, Noise Observation and Information Service for Europe

In many cases, the targets set out in Legislative Decree 194/2005 issued in compliance with END Directive 2002/49 EC have not been met by the deadlines established.

The conditions set out in Legislative Decree 194/2005 in answer to Directive END 2002/49/EC concern: urban agglomeration with more than 250 thousand residents; roadway infrastructures that carry more than 6 million vehicles per year; rail infrastructures with more than 60 thousand convoys per year and major airports handling more than 50 thousand flights per year. To date however, the targets have not, in many cases been met by the deadlines established. In particular, of the ten urban agglomeration concerned, only three have presented a strategic acoustic map and none has drawn up an Action Plan. As far as the airports are concerned, of the nine major airports involved, six have presented a strategic chart and four, an Action Plan. There has been greater compliance by the vehicular infrastructures, with twelve out of the thirteen of the pertinent roadway networks – those carrying more than six million vehicles per year – presenting an acoustic map whilst of the four railway infrastructures carrying more than 60 thousand convoys per year, only one has presented an acoustic map. (Table 5.1)

Of the ten urban agglomeration concerned, three have presented a strategic acoustic map but none has drawn up an Action Plan. The situation regarding the roadway infrastructures however is better, as 12 of the 13 concerned have presented an acoustic map.

Table 5.1: The State of Affair regarding compliance with the actions envisaged in the first phase of Legislative Decree 194/2005[7]

Competent authorities	Compliance with Legisltive Decree 194/2005		
	Notifications effected	Acoustic Maps/ Strategic Acoustic Maps	Action Plans
	no.		
Agglomeration	10	3	0
Roadways	13	12	16
Railways	4	1	2
Airports	9	6	4

Despite of, and taking into account the differing methods used and disparate periods of time concerned, studies carried out on the residents in some of Italy's urban areas have made it possible to extrapolate the percentage of the population exposed to L_{den} values greater than 65 dB (A) and L_{night} values greater than 55 dB (A) as a result of noise produced, in almost all cases, by vehicular traffic. These percent-

[7] Source: Data available from the Ministry of the Environment, Land and Sea responsible for safeguarding the territory and the surrounding seas

ages amount to 24% of the population as far as L_{den} values greater than 65 dB(A) are concerned and 27% for L_{night} values greater than 55 dB(A). Analysis of the work of the network of environmental Regional Agencies throughout 2008 shows that 3,645 controls were carried out and that there are distinct differences in the percentages incurred in the various sectors. The highest percentages, namely 43.2%, represent service and / or commercial activities, followed by productive activities with 28% and roadway infrastructures with 22.9% (Figure 5.3). The percentages regarding service and / or commercial activities and of productive activities, respectively showed a 48.2% and 35.4% decrease in comparison with the previous year, and by 35.4%, whilst roadway infrastructures were subjected to a greater number of controls than the 9.7% recorded the year before.

The public takes great interest in this subject and both personal and environmental safeguards are the key areas of concern. They are responsible for 74 out of 100 complaints made, of which 51% of controls reveals that the limits imposed are being exceeded.

74% of all controls undertaken were in response to complaints made by members of the public. Of these, the vast majority revealed dissatisfaction with regard to service and productive activities, building sites and short-term demonstrations (94%) whilst a much lower number concerned transport infrastructures (15%). The greater number of complaints made, and the number of cases that recorded excess levels (51%), reveal that the public has a consistent interest in noise pollution, and that faced with what are effectively critical conditions, they would like greater safeguards to be in place.

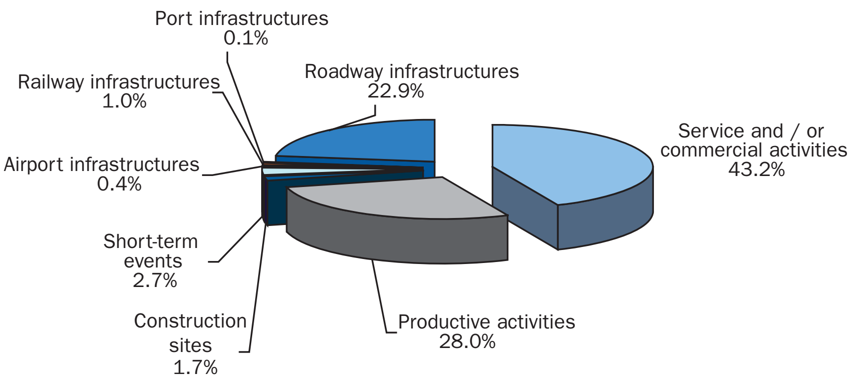


Figure 5.3: Distribution of the sources controlled (3,645) amongst the different types of activities/infrastructures (2008)[8]

The noise sources subject to controls and that the public considers to be extremely bothersome, are commercial and service activities (43.2%), productive activities (28,0%) and roadway infrastructures (22.9%).

[8] Source: ARPA / APPA data processed by ISPRA
Note: No data is available on the autonomous province of Bolzano or the regions of the Veneto, Lazio, Molise and Campania

The main sources of noise

The main sources of noise that have registered an increase in volume have been identified as road, rail and air traffic.

The main sources of noise, identified as road, rail and air traffic, have all registered a general increase in volume, with distinctive characteristics of the rise linked to individual sources.
Despite showing a percentage decrease of -4.3% last year, an overall increase of 11.8% between 2004 and 2008 is, none-the-less evident, whilst data pertaining to airport traffic in particular showed an overall increase of approximately 60% between 1990 and 2008.
As far as passenger rail traffic is concerned, 315 million trains-km travelled on the State Railway system in 2007 (up 5.6% on 2004), whilst rail freight accounted for 63 million trains-km (down 1.2% on 2004).
The requirement for those bodies responsible for running transport infrastructures to draft plans about the actions to take to contain and abate noise as set out in the Ministerial Decree of 29th November 2000 does not yet appear to have been carried out by all the companies concerned. That said, many of them have published the studies that they carried out during the course of the previous year.

Shortcomings in the legislation and the lack of dialogue between the principal players create an obstacle to an organic definition of the action to take.

The increase in the above-mentioned pressure factors, combined with the shortcomings in the legislation and the lack of synergy and forms of dialogue between the principal players, is an obstacle to the determination of an organic and shared definition of the action to take.
Vehicle traffic represents the main source of urban noise pollution, although other sources that should not be ignored include industrial and small-scale production activities, commercial activities with all their related plants and systems (air conditioning, refrigerators etc.) and discotheques, which have a notable impact on their immediate surroundings.

Actions to limit noise pollution

The manner and methods used to bring uniformity to Community and national legislation need to be identified and shared across all the different sectors in this field.

The progressive implementation of the END Directive, albeit with noticeable differences between member countries, shows that at both Community and national levels there is a greater knowledge about the state of the environment in terms of noise pollution, and a greater sharing of the problems encountered and actions undertaken. The need to implement the directive by means of the regulations set out in Legislative Decree 194/2005, and the quest to harmonize Community legislation with the complex national legislative system that has Framework Law no. 447/95 on noise pollution at its heart, are the

aspects that attract the greatest activity, providing opportunities reconsider the regulations and to develop them further.

Law no. 88 enacted on 7th July 2009, entitled *Dispositions enabling Italy to fulfil its obligations as a member of the European Community – Community Law,* had precisely that need in mind when it introduced, at article 11, the "*Delegation of power to the Government to reorder the regulations regarding noise pollution".* Its purpose is to guarantee that the dispositions set out in the END Directive and laws dealing with this subject are fully integrated. The government was charged that within six months of the law coming into force, it was to issue one or more legislative decrees that would address the *"reordering and reform of the prevailing regulations regarding the safeguarding of the outdoor environment and residential situations against noise pollution, the noise-control measures to be incorporated in buildings and the measurement and management of environmental noise"*[9]. The harmonization of Community and national laws, the determination the criteria to be adopted for the design, building and reconstruction of buildings and transport infrastructures are considered to be a matter of priority as is the determination of the passive acoustic requirements of buildings.

Some of the main criticisms made include: the absence of an organic treatment of legislation in this sector and the fact that the decrees set out in the Framework Law regarding implementation have not been completely implemented (the one regarding the establishing of the design criteria to be adopted in new buildings in particular). The failure to comply with the decree dealing with the criteria applicable to the passive acoustics of buildings is another, the classification of which will be covered in when UNI (Ente Nazionale Italiano di Unificazione - Italian Organization for Standardization) present new regulations along with revisions to the texts cited above.

Other critical aspects persist: the fragmented efforts made to prevent and mitigate the effects of noise pollution continue, and in this context, discussions on the nature and finality of the Action Plan introduced by the END directive could play a decisive role.

Although some signs of change are evident, especially with regard to construction, there are still inconsistencies between the different sectors. There are those, such as transport infrastructures, that generate considerable activity, whilst others attract fare less attention,

[9] Law no. 88 enacted 7 July 2009

as for example, in the ambit of territorial and acoustical planning and communications and education on environmental issues and the extent to which members of the public participate in the process.
There are still obvious inconsistencies in terms of its actual implementation status by the various sectors and in the different territorial contexts. The institutional activities carried out by the Agency System have been intensified and are heedful of the demands of the general public both in terms of controls carried out and information provided.
Analysis of the data in order to determine whether procedures prescribed by the laws governing the various sectors had been implemented, shows that in respect of previous years, up until to 30th September 2009, the situation at regional and local levels with regard to fulfilling their various obligations was stagnant, but within the ambit of transport infrastructures some obligations had been discharged. In particular, the fact that many individual regions have failed to pass laws containing measures to deal with noise pollution, as established by the Framework Law, underlines the inadequacy of the response and a fragmentation that characterises the state of affairs at national level. According to available data, there are six regions that have not yet passed such regional laws: Molise, Campania, Basilicata, Calabria, Sicily and Sardinia. It should be noted that often, deliberations by Regional Administrations have resulted in measures that deal with individual procedural matters, such as guidelines regarding the drawing up of an acoustic classification plan or the procedures for certifying an acoustic technician, and these circumvent the lack of a systematic approach at regional level.
Approval of an acoustic classification plan of the territory at local levels is a priority in terms of acoustic planning, as it defines the how the territory is used and it allows the consequent initiatives to safeguard and abate noise in critical areas. By 30th September 2009, some 41% of Italian municipalities had produced a classification compared with the 35% of 2007. There are notable different in the diverse regional situations, with higher percentages of those in the Centre North of the country (94% in Marche, 91% in Tuscany, 85% in Liguria and 71% in Piedmont) whilst the Southern and peninsular regions did far less (Sicily 1%, Sardinia 3%, whilst Molise and Basilicata did nothing at all). 48% of the population live in municipalities that have approved a zoning plan, compared with 46.4 in 2007, whilst at national level, the territorial surface now encompassed plans approved by local councils has

reached 35% compared with 32% in 2007. (Figures 5.4, 5.5, 5.6). The increased number of municipalities that have approved an acoustic classification plan is the reason that slight increases are evident in the regions, and there are a high percentage of municipalities that have already adopted a plan. This highlights the gap that exists between those areas willing to zone practically their entire respective territories, and those that cannot boast a single municipality that has produced an approved zoning plan. The percentage of Italian municipalities now classified has reached 41%, but the huge territorial differences show that the tool has not been adopted in sufficient numbers and that its use is not consistent at national levels, with only a few regions having effective policies whilst others are characterized by their inertia. Critical issues regard the public's lack of knowledge about the plan, its relative incidence throughout the country, and the state of the environment. This is due to insufficient information being provided and the excessively sectorial nature of acoustic planning which has not yet been incorporated into the principal regulations governing territorial planning or any other related plans of an environmental nature.

Acoustic classifications plan of the territory are not applied in sufficient numbers throughout Italy and nor are they evenly distributed. In some regions, policies have been seen to work, whilst other regions can be characterised by their inertia.

As of 30 September 2009, the equivalent of 41% of all Italy's municipalities had approved acoustical classifications plans: Marche (94%), Tuscany (91%), Liguria (85%), Piedmont (71%).

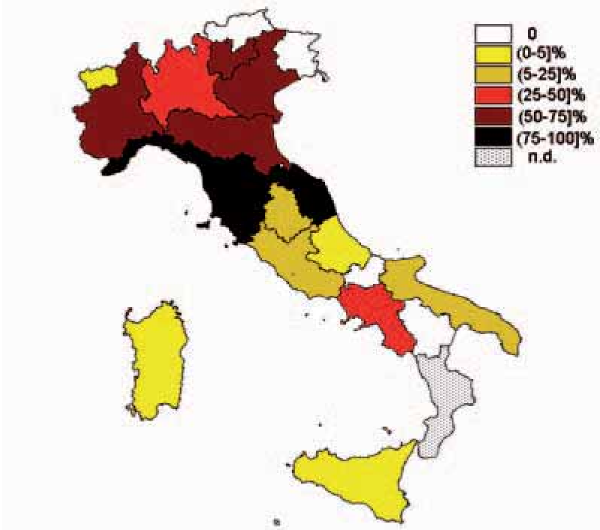


Figure 5.4: Percentage of municipalities that have approved acoustical classifications plans of the territory out of the total number of municipalities for each region/autonomous province (30/09/2009)[10]

[10] Source: ARPA/APPA data processed by ISPRA

The percentage of the population resident in municipalities that have approved zoning plans is now 48%.

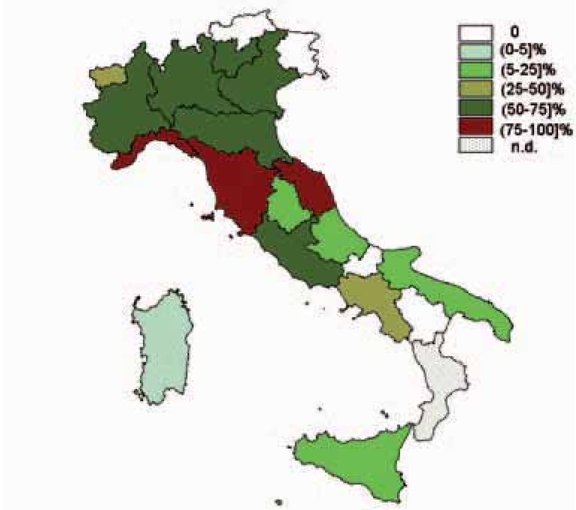


Figure 5.5: Percentage of the population residing in municipalities with an approved acoustical classification plan of the territory, out of the total population of each region/autonomous province (30/09/2009)[11]

In 2009, the percentage of the territorial surface area of municipalities that approved classifications was 35%, compared with the 32% in 2007.

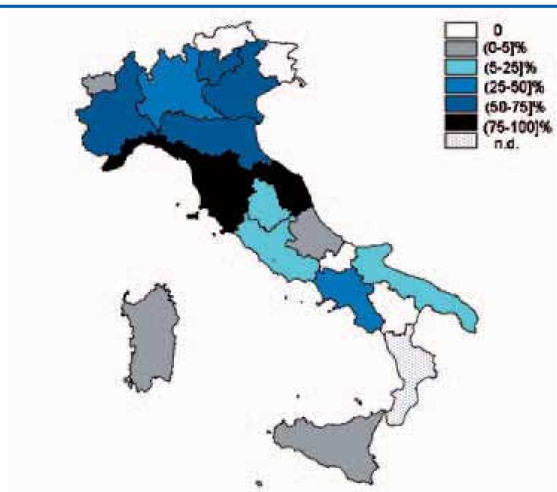


Figure 5.6: Percentage of the territorial surface area of the municipalities that have approved acoustical classifications plans out of the total surface area of the municipalities in each region/autonomous province (30/09/2009)[12]

[11] Source: ARPA/APPA data processed by ISPRA
[12] Source: ARPA/APPA data processed by ISPRA

The obligation to draw up a report on the acoustical status of municipalities at two-year intervals, established by Law 447/95, takes the shape of a document used to analyse and manage the problem of noise pollution at municipal level. Out of a total of 149 municipalities with populations of more than 50,000 inhabitants, that are therefore required to draw up a report, as of 2009 only 22 (15%) had approved a report on their acoustical status. The greatest number of approved reports came from Tuscany where 11 out of 13 municipalities were compliant and in Lombardy, where there were 5 out of 15. Implementation of a municipal acoustical Noise Abatement Plan, as called for under Law 447/95, is not widespread and there are only 51 municipal clean-up plans approved. This represents only 1.5% of the 3,304 municipalities that have approved a municipal acoustic plan, most of which can be found in two regions, Tuscany, that has 38 and Emilia Romagna that has 5.

To consider what municipalities have achieved, 41% have approved an acoustic classification plan of their territory, 1.5% have adopted a noise abatement plan and of those required to produce a biennial report regarding noise levels, a mere 15% have done so.

The acoustical classification plan of the areas surrounding airports, called for under Law 447/95 on the subject of airport noise, was carried out by only 12 of the 40 main national airports, whilst they are still being elaborated/evaluated in a further 14 airports.

At present, only 12 out of 40 airports have an approved acoustical classification plan, the main tool used in planning for airport noise.

There are distinctions in the noise abatement initiatives that managers/owners of transportation infrastructures are required to take under the Framework Law. In the case of railways and most motorways, studies were completed on the critical problems presented within their respective infrastructure networks, and an initial series of mitigating actions has been drawn up and programmed, whilst similar efforts for roadways and airports are decidedly behind schedule.

As far as those who manage motorway infrastructures on a concessional basis implementing plans and carrying out initiatives aimed at containing and reducing noise in accordance with DM 29/11/2000, 18 have submitted their plans (PCAR) to MATTM and the regions/municipalities concerned. 3 have failed to present their respective PCARs, declaring that there is no need for any new initiatives along the stretches of motorway they each have in concessions, as they already comply with prevailing regulations, and only one operator has yet to prepare the PCAR regarding the stretch of motorway for which it is responsible. (Table 5.2)

Noise abatement operations regarding railways and motorways are underway, whilst airports and roadways are behind in the drawing up of plans to contain and abate noise.

Of the total kilometres of motorways operated by concessions, 94.2% have, in accordance with DM 29/11/2000 been analysed within the ambit of a PCAR. A further 3.9% are still outstanding, whilst according to declarations made by the pertinent operators, 1.9% do not require any action to be taken.

Table 5.2: Presentation of Plans by those operating motorway concessions, detailing initiatives aimed at containing and reducing noise in accordance with DM 29/11/2000[13]

PCAR	km	%
Presented	5,230.30	94.2
Yet to be presented	218.00	3.9
Declared unnecessary by the operator	106.60	1.9
TOTAL	**5,554.90**	**100**

It would seem that in this current phase, concentrating efforts on the harmonisation and co-existence of methods and instruments to prevent and mitigate noise pollution is what is required, using the opportunities provided by the legislation that addresses reorganizational issues and incorporates other critical aspects that have persisted for far too long. This legislation also strengthens awareness of the internal dynamics of the country and within the ambit of the European Community.
The instruments used in the prevention, planning and noise abatement processes contained within national laws and those introduced by European Directive 2002/49/EC, must be made more effective and incisive. They must also be accompanied by the provision of correct, clear and comprehensive information on the subject to the public - and the effects of noise pollution on man and the environment in particular.

NON-IONISING RADIATION

The problem

The prolonged exposure to electromagnetic fields is believed to be potentially dangerous to human health.

Interest in electromagnetic fields has grown significantly and in line with the frenzied development of new telecommunication systems whose installations have spread across urban areas in a capillary manner, raising doubts and concerns about how dangerous they might be. The intensification of the electricity transmission network resulting from the increased demand for electric energy, as well as the urbanization of areas previously un-

[13] Source: ISPRA

inhabited, characterized by the presence of long distance power lines or radio/television antenna, have also contributed to confusion about the possible effects on health when living close to such installations for an extended period of time.
This predicament, made worse by the public perception that it could be a health risk, must be tackled in a coherent, clear and transparent manner if pointless panic, a response that current medical knowledge would deem unjustifiable, is to be avoided.
As of today, despite the huge strides made to safeguard public health, both in terms of the legislation passed and in technical-scientific expertise, there continue to be heated social clashes between the public and consumer associations on the one hand, and those running the plants on the other. Local government administrators are caught in the middle, often along with the control agencies that act as mediators and provide the public with support without, however, losing sight of the rights of plant owners.

Main sources of EMF

The sources of electromagnetic fields can be divided into two main categories: low frequency fields (0-300 Hz) or ELF *(Extremely Low Frequency*) fields, essentially caused by systems for the production, distribution and use of electric energy (electric power lines, substations, home appliances etc.), which, in Italy, are based on the constant industrial frequency of 50 Hz, and high-frequency fields (100 kHz - 300 GHz), or RF (*Radio Frequency)* fields, caused by radio and telecommunications plants (radio, TV, cell phones, radar).
In terms of radio and television plants (RTV) and radio base stations (RBS), the environmental impact, meaning electromagnetic emissions evaluated according to violations of the limits permitted by the prevailing legislation, shows, respectively, a decrease of approximately 1% and a 7% increase between 2007 and 2008. These percentages were calculated, for those regions that supplied complete data, by analysing data from the EMF (Electromagnetic Fields) Observatory. Analysis of the data regarding the density of RTV and RBS plants (Figure 5.7) shows that the density of the RBS plants is roughly double that of RTV plants (respectively 0.23 and 0.11 plants per km^2), whilst the density of RBS sites (0.14 sites per km^2) is around 5 times higher than RTV sites (0.03 sites per km^2).

Between 2007 and 2008 there was a recorded decrease in the violations of limits by RTV plants, and an increase of those incurred by RBS plants.

It can be seen that the RBS plants have a approximately twice density than RTV plants. There is a similar situation regarding the density of sites, in effect the density of RBS sites is five times higher than the RTV sites.

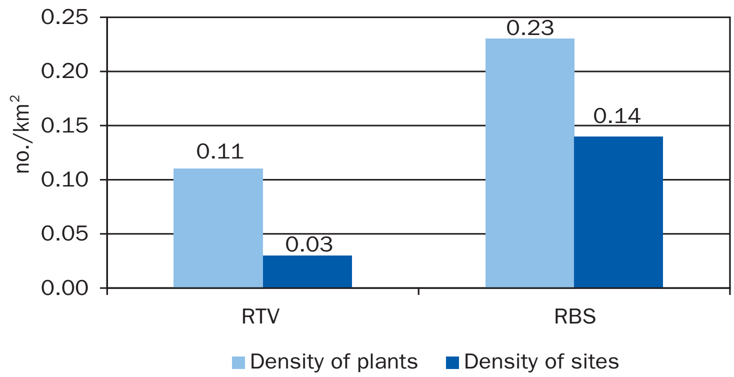


Figure 5.7: Density of plants and sites, a comparison of RTV and RBS for the regions for which complete data are available (2008)[14]

In terms of the overall power of RTV and RBS plants (Figure 5.8), clearly, the most significant environmental pressure produced by electromagnetic fields is generated by radio and television plants. The total RBS power (1,175 kW) in fact, is only around 18% of that generated by RTV plants (6,442 kW). The overall lower power levels associated with RBS plants in comparison to RTV plants means that RBS sites create, as previously highlighted, greater territorial pressure than RTV sites and this is so that the territorial coverage needed to provide a mobile phone service can be guaranteed.

The most consistent form of environmental pressure is caused by RTV plants that are just over 5 times more powerful than their RBS counterparts.

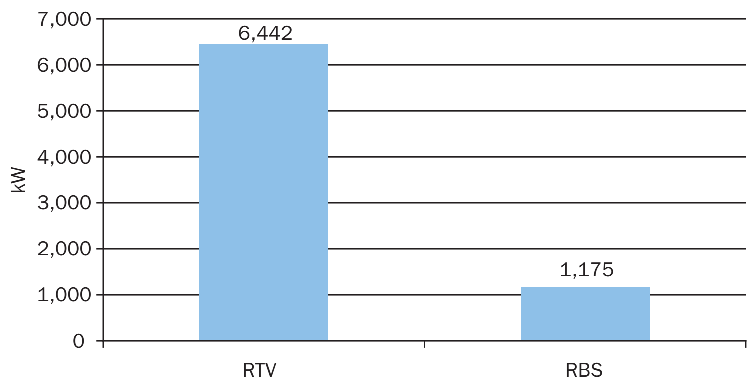


Figure 5.8: Total power, comparison between RTV and RBS for regions for which complete data are available (2008)[15]

[14] Source: ISPRA/ARPA/APPA (EMF Observatory) data processed by ISPRA
[15] Source: ISPRA/ARPA/APPA (EMF Observatory) data processed by ISPRA

In this context, another significant source of pressure is that created by high and extra-high voltage power lines (Figure 5.9).
Based on the regions that have provided complete data for the years 2007 and 2008, it can be seen that there has been a 15% decrease in the kilometres number of 200 kV power lines and 4% in those between 40 kV and 150 kV (4%) whilst there has been a slight increase (2%) in those carrying 380 kV. In 2008, medium and low voltage power lines (< 40 kV) accounted for most of Italy’s power grid. The latter represent the final stages of the production, transmission and distribution of electric energy and are therefore present in far greater numbers than power lines carrying higher voltage electricity (the kilometres of power lines carrying > 40 kW represent only 5% of the total).

It is important to remember that the intensity of electro and magnetic fields is, respectively, proportional to the operating voltage (which is fixed) and the electric current circulating in the conductors (which varies according to customer demand). Higher voltage power lines carry a greater amount of electricity and as a result, the electric and magnetic fields generated by medium-low voltage lines are, in general, smaller than those created by higher voltage power lines.

Between 2007 and 2008, there was a 15% decrease in the kilometres number of 220 kV power lines, of 4% in those between 40 kV and 150 kV, and of 2% in those under 40kV. There was however, a slight increase, equivalent to 2%, in the kilometres number of 380 kV power lines.

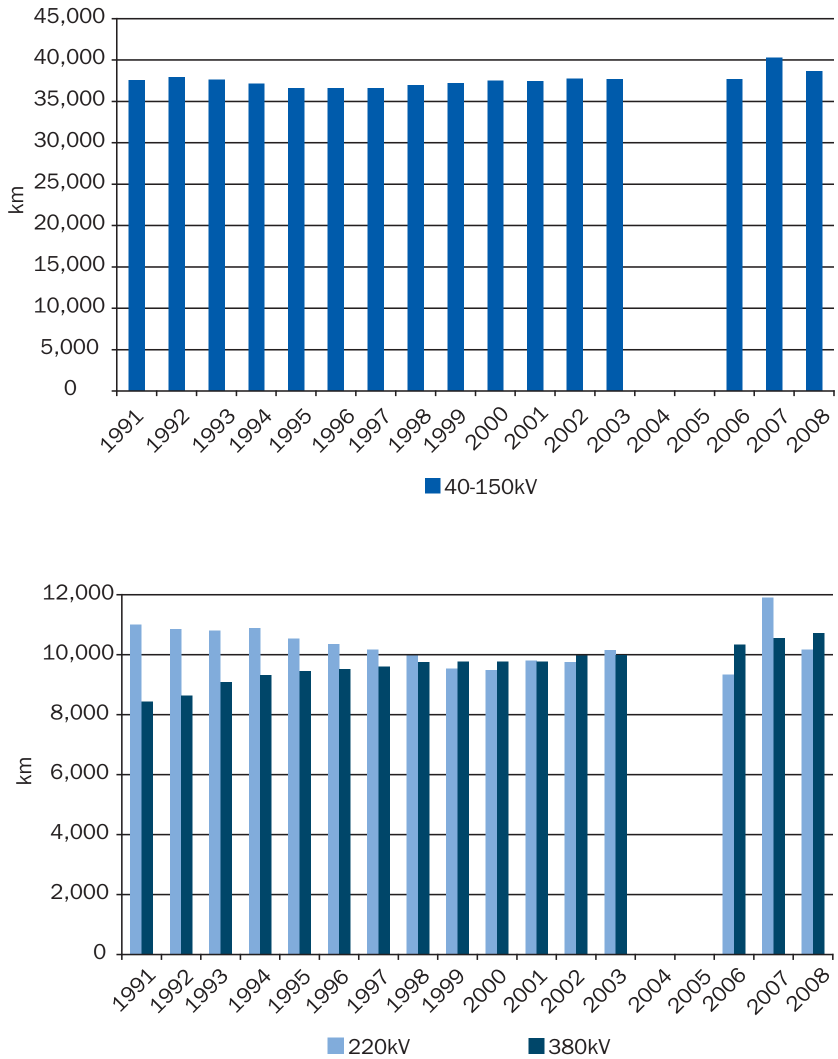


Figure 5.9: Trends in the length of high and extra-high electric power lines in Italy[16]

[16] Source: ENEL Terna, ENEL Distribuzione, DEVAL S.p.A. and the EMF Observatory data processed by ISPRA
NB: The data relates only to those regions that have provided full and complete information

Actions to limit electromagnetic pollution

In terms of both radio frequencies (RTV and RBS) and extremely low ELF frequencies, control activities are a fundamental part of the operations carried out by the responsible authorities (ARPA/APPA), and in cases where such initiatives reveal violations of exposure limits, safety levels and quality targets, those who manage or own the plants take whatever clean-up action is necessary.

Analysis of data gathered by the EMF Observatory shows that, between 2007 and 2008, there was a further decrease in the number of preliminary technical assessments regarding the authorization of both RBS and RTV plants of 17% and 2% respectively. As to the number of controls, both experimental and those using predictive models, there was a decrease of 1% for those relating to RBS and a decrease of 4% for RTV (Figure 5.10).

Carrying out controls is fundamental to the work of ARPA and APPA, which reveals if exposure limits have been exceeded.

Between 2007 and 2008, there is a decrease in the number of preventive advice for both RBS (17%) for both RTV (2%), and also a decrease in the number of controls for the RBS (1%) and for RTV (4%).

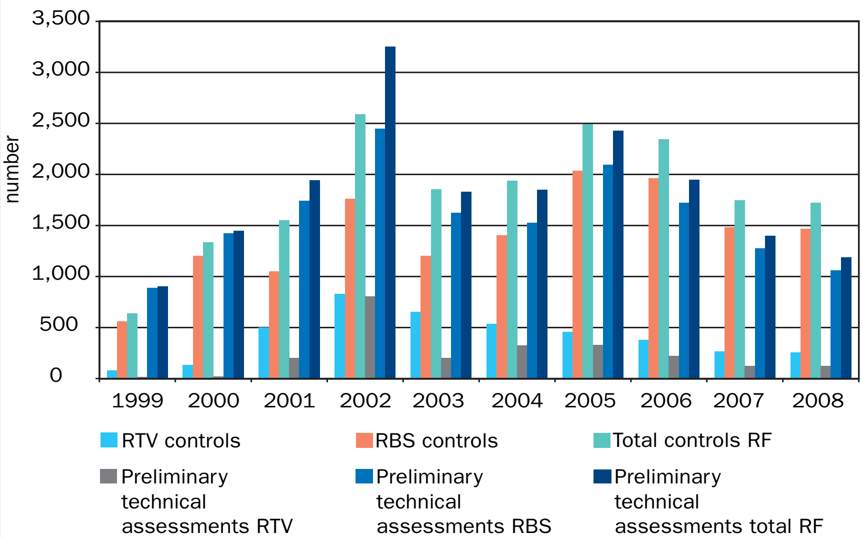


Figure 5.10: Assessments and controls carried out on RF plants in Italy, broken down by source type[17]

As to the number of preliminary technical assessments and controls regarding ELF (extremely low frequency) power lines, it can be seen,

[17] Source: ARPA/APPA (EMF Observatory) data processed by ISPRA
NB: The data relates only to those regions/autonomous provinces that have provided full and complete information

from Figure 5.11 that there was a slight reduction in the number of preliminary technical assessments and the number of controls effected (both in terms of measures taken and models based on calculations), equivalent to 1.4% and 1.8% respectively.

The number of assessments carried out between 2007 and 2008 decreased by 1.4% whilst the number of checks carried out decreased by 1.8%.

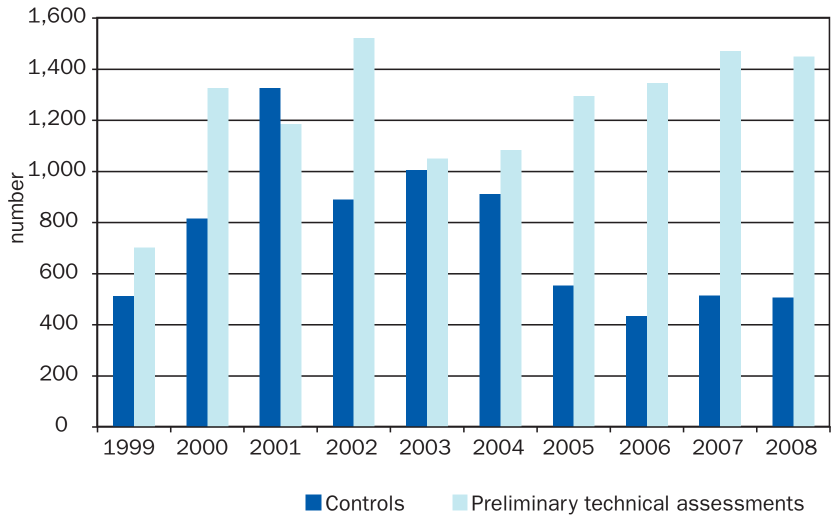


Figure 5.11: Trends in the number of preliminary technical assessments and controls of sources of ELF fields in Italy[18]

Fewer interventions were completed on RTV plants than on their RBS counterparts because the clean-up process is that much more complex.

In terms of the clean-up initiatives undertaken to date regarding violations identified through control activities, what stands out is that from 2007 to 2008, in those regions that have all the data pertaining to those two years, there was a 1.3% increase as far as RTV plants were concerned and a 3.4% increase in RBS plants. It is interesting to note (Figure 5.12) the differences between the two types of sources, RTV and RBS, with regard to the clean-up activities that have been completed and those still underway: for RBS plants, not only is the difference between the percentage of completed clean-up activities and those underway greater than that relating to RTV plants, but there are no longer any clean-up operations underway. This difference is due to the fact that, in the case of the RTV plants, clean-up activities are technically more

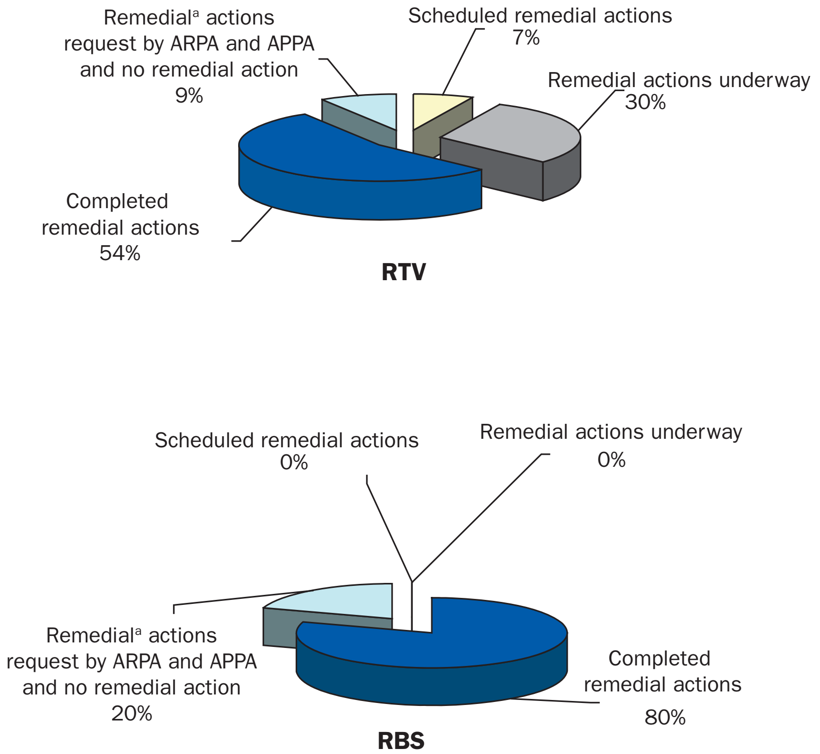
[18] Source: ARPA/APPA (EMF Observatory) data processed by ISPRA
NB: The data relates only to those regions/autonomous provinces that have provided full and complete information

complex, generally involve more plants and it frequently proves impossible to maintain the quality of service set down in the acts of concession. Conversely, in the case of RBS plants, clean-up activities generally take place immediately, are technically less demanding and costs are generally more contained.
The records of regions that have provided a complete set of data for both 2007 and 2008, show that the number of cases of "*clean-up efforts requested by regional and provincial agencies to safe-guard the environment, and no clean-up activities*", has been reset at zero as far as RBS plants are concerned, and reveal an approximate 10% increase for RTV plants. This means that these clean-up operations have not yet been scheduled by plant owners.
There is no information however about any clean-up operations involving electric power lines, and this is probably because there is no decree contained within Law 36/2001 (articles 4, c.4) that sets out the criteria for drawing up such clean-up plans.
The current Italian legislative scenario pivots around the concept of "prudent avoidance", which underlines the importance of avoiding or reducing exposure to an external agent to the minimum possible, should there be any doubts regarding its potential threat to human health. In fact, even in the absence of a confirmed cause-effect connection between exposure to electrical, magnetic and electromagnetic fields and any health consequences, the practice at national level is to consider the potential risk connected to prolonged low-level exposure over time.

Italian legislation is based on the principle of precaution and in fact takes the possibility of risks related to prolonged exposure into consideration, even when this is at low-levels.

At present, 19 regions have regulatory measures in place in compliance with current national legislation. This, combined with a legislative framework that places a special focus on safeguarding the individual and respecting the environment (the correct urban/environmental development of plants and systems, techniques for mitigating the visual impact of the same etc.), means that public awareness remains noticeably high and shows no signs of waning, meaning that social attention to the issue continues to be elevated.

In 2008, the number of completed clean-up operations (80%) carried out on RBS plants was considerably higher than those carried out on RTV plants (54%).



Note: [a] By clean-up action requested, it is those actions requested by ARPA/APPA that is intended, not those programmed by those who own the plants.

Figure 5.12: Status of clean-up activities at sites where a violation of a limit was recorded because of RTV or RBS plants (2008)[19]

ULTRAVIOLET RADIATION

Introduction

Photochemical pollution occurs on days characterized by stable weather conditions and strong sunlight. These conditions facilitate photochemical reactions produced by ultra-violet light and the formation of ozone and other substances.

Ultraviolet radiation is that which takes up the 100 to 400 nm (nanometers) range of the electromagnetic wavelength spectrum. Ultraviolet radiation is of particular importance as it interacts with Earth, especially with the stratosphere (the "hole" in the ozone

[19] Source: ARPA/APPA/APPA (the NIR -near infra-red- Observatory) data processed by ISPRA
NB: The data related only to those regions / autonomous provinces about which all figures are available

Photochemical smog is composed of substances that are toxic to man, animals and vegetation. Due to their powerful oxidising nature, these substances are also able to cause many different materials to degrade.

layer), the troposphere (photochemical pollution) and ultimately, with the biosphere (the effects on man, flora and fauna). This type of radiation can be produced by sources that can be either natural or artificial: the sun is the most important natural source, whilst a mercury steam lamp (Wood's lamp or germicidal lamp) is an example of an artificial source.
In recent years, many organizations, such as the WHO (World Health Organization), ICNIRP (International Commission for Non-Ionising Radiation Protection) and IARC (International Agency for Research on Cancer) have turned their attention to the risks that result from lengthy exposure to UV rays whether from a natural or an artificial source.
This, together with the fact that the main source of UV rays to which the world's population is exposed and which cannot in fact, be avoided, is the sun, has made it necessary to intensify efforts to provide greater information about the problem. The fields particularly concerned with this issue are:

- environmental and health research to accurately monitor UV rays from the sun and their effects over time, and to increase knowledge of the mechanisms that regulate the interaction between the absorption of UV rays and the appearance of any health problems;
- the spread of information, to make people more aware of the risks they face, often as a result of bad habits or an inappropriate life-style.

The classification of UV radiation

Around the higher wavelengths of the electromagnetic spectrum, UV radiation occurs just beyond light that is visible at a shorter wavelength perceived by the human eye to be violet in colour, hence the name "ultraviolet". At the lower limit, under 100 nm, it adjoins the area of ionising radiation. Ultraviolet radiation is generally classified as follows:

- UV-C 100-280 nm: it is the component with the most energy although it is completely absorbed by the oxygen and ozone present in the upper layers of the atmosphere. UV-Cs account for 0.5% of extra-terrestrial solar energy.
- UV-B 280-315 nm: the stratospheric ozone is the most absorbent gas of this component. It represents 1.5% of all solar energy. Thanks

to the "filtering" effect of the ozone layer, the rays that reach the earth's surface are usually of a wavelength above 290 nm.

- UV-A 315-400 nm: 80% of all UV rays are found in this range, which carries 6.3% of extraterrestrial solar energy.

For the purposes of this document, only UV rays from natural sources will be considered, or in other words, UV radiation originating from the sun.

From the description of each type of UV radiation, it follows that gases such as ozone and oxygen absorb the most damaging rays. In particular, every reduction of ozone in the atmosphere incurs an increase in the number of UV rays that reach the Earth's surface and with them, greater risks for the environment and human health. There are many factors that affect the intensity of the UV radiation that reaches the Earth's surface, but the most significant effect, which shows a direct correlation between the two phenomena, is brought about by the distribution of ozone through the atmosphere (column

The vertical profile of ozone and its effect on those components that are absorbed at lower wavelengths more than others.

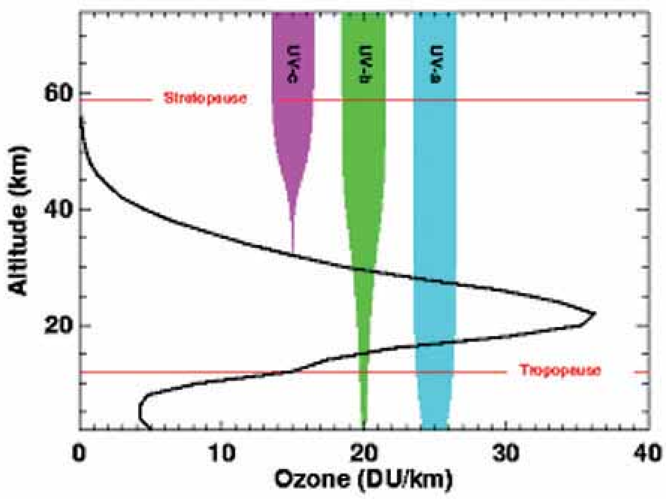


Figure 5.13: The vertical profile of ozone and a qualitative visualization of the mitigating effects of the various components of UV rays before they reach ground level[20]

[20] Source: ARPA Aosta Valley

ozone). The Figure 5.13 shows the vertical profile of ozone and its effect on the three UV bands. It explains the important role played by ozone in modulating UV rays at ground level. Theoretic studies and observations indicate, furthermore, that a 1% reduction in column ozone can cause around a 1.2% increase in the UV rays that cause biological damage at ground level.

Exposure to UV radiation: connected risks and UV index

Exposure to solar radiation is an inevitable occurrence that has both beneficial and detrimental effects on man. It cannot be denied that to expose oneself to the sun generally produces an initial sensation of well-being known as *psychological well-being*. The positive effects do not stop there. The first in-depth studies about exposure to the sun, and in particular to UV rays, were carried out as part of the fight against rickets. UV rays in fact, play a fundamental role in the production of Vitamin D3, which is responsible for the synthesis of calcium in the human body. On the other hand, countering the positive effects of a prolonged exposure to the sun, which is usually what happens if someone is trying to acquire suntan, certain negative effects have also been verified, including some that are of a serious nature. The parts of the human body most sensitive to exposure to UV rays are the skin and the eyes.

There is an optimum period of exposure that maximises the positive effects and minimises the negative effect, but this period is not the same for everyone.

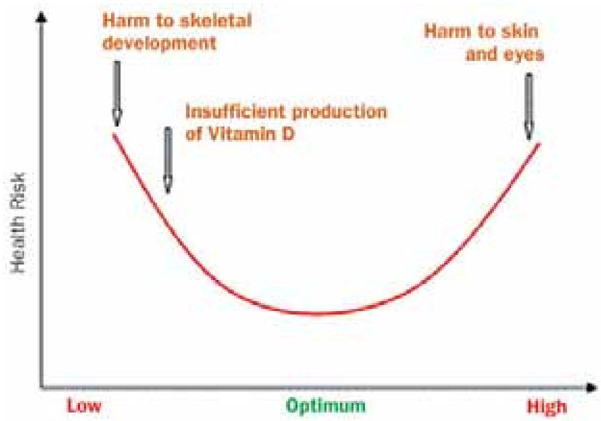


Figure 5.14: Potential health risks linked to exposure to UV rays UV[21]

[21] Source: ARPA Emilia Romagna

Damage to eyes (photo-kerato-conjunctivitis) has also been proven, and studies are underway to determine whether exposure to the sun also weakens the immune system.

People do not have an intrinsic photo type, as the degree of skin trauma due to repeated exposure to the sun is also a factor.

The cause and effect relationship between excessive exposure to solar radiation and skin problems like redness, photo-dermatitis, aging and even cancer is now clear. The UV component and UVB in particular, is one of the major causes of these problems. Damage to eyes (photo-kerato-conjunctivitis) has also been proven and studies are underway to verify whether excessive exposure also weakens the immune system. The Figure 5.14 shows the subjective relationship between the consequences and the length of exposure. It can be noticed that there is an optimum period of exposure that maximises the positive effects and minimises the negative. It should be pointed out however, that this optimum period of exposure is not the same for everyone.

In fact, light-skinned people tan and get sunburned far more easily that those with a dark skin. Information regarding ideal exposure time must, in fact, always keep skin type in mind and be modified accordingly. There is a skin photo type (SPT) classification that shows how skin reacts to ultraviolet radiation in accordance with a person's physical characteristics (colour of hair, eyes and skin) and an individual's capacity to acclimatise – or not – to the sun. Six photo types can be identified:

I People with very pale skin, red or blonde hair and pale coloured eyes who never tan and always burn;

II Children up to the age of one who have pale skin and eyes as well as blonde hair who they occasionally tan and usually burn;

III People with moderately dark skin, blonde-light brown hair and brown eyes who tan slowly and may burn;

IV People with relatively dark skin, dark brown hair and dark eyes who they tan easily and rarely burn;

V People with dark olive coloured skin, dark hair and eyes who burn and acquire a deep tan;

VI People with black hair, eyes and skin who quickly acquire a deep tan.

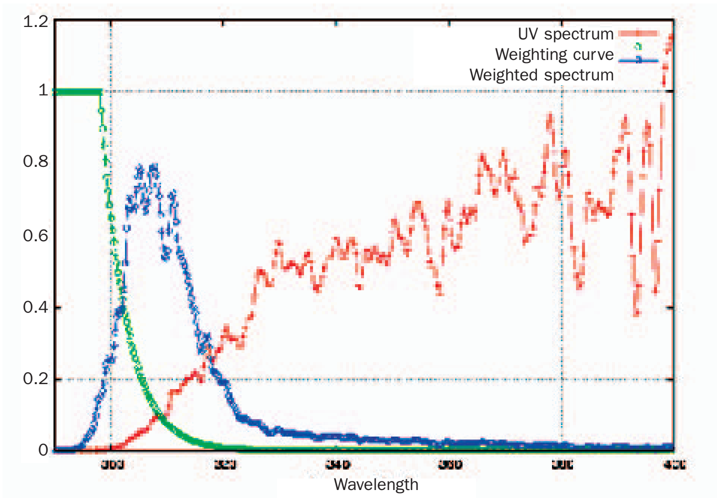
Most Italians are classified as types III and IV.

Each photo type can be characterised by a minimum level of erythema (skin irritation), which establishes the amount of exposure necessary to incur the minimum visible sign of irritation. This depends on factors such as wavelength, the intrinsic sensitivity of the exposed skin and previous periods of exposure.

The qualitative definitions described above can be referred back to a quantitive evaluation linked to the lowest level of exposure that irri-

tates the skin. This lowest level is known as the *minimum erythemal dose* (MED). Values are determined by experimenting first on unprotected skin (MED u) and then on skin that has been protected by products such as suntan cream (MED p). A MED is defined as being the actual amount of UV able to cause human skin to visibly redden even if it has not previously been exposed to the sun.
As people's sensitivity to UV radiation is not the same, the MED of different European nationalities varies from between 200 and 500 (J/m^2). Average thresholds are calculated according to the photo type of provenance: 200 for photo type I, 250 for photo type II, 350 for III and 450 for photo type IV. Information is usually based on the MED p, which is related to the protection afforded by suntan cream in which a number that relates to a recommended exposure time describes the protection factor. This information can be misleading unless a dermatologist, following the examination of a particular individual, endorses it. The fact that the phrase "total protection" once used to advertise certain creams is now illegal is not something that happened by chance. There is also a risk that people will be convinced that certain practices are acceptable, whereas in fact they should be modified or discontinued, as they are in fact what incur the biggest risk of all.
As far as UV rays from artificial sources are concerned, reference is made to an article written by the International Agency for Research on Cancer (IRAC) who studied the risk factors of products used by millions of people as they tanned. Published in the Lancet Oncology magazine in 2009, it would be hard to misinterpret the statement *"the use of tanning devices* (beds & lamps*) is carcinogenic to humans"*. The same article also reports that the risk of melanoma, a dangerous form of skin cancer, increases by 75% if the use of such tanning devices starts before 30 years of age.
The degree of damage depends on the biological effect, which is determined by a weighting equation that represents the biological response to UV radiation and the length of exposure. Consequently, it is important to inform any individual who is intent on acquiring a suntan about the potential harm that over-exposure could cause. The Figure 5.15 shows the relationship between UV radiation (the red curve) with the erythemal weighting equation (the green curve) thus showing the radiation level that causes biological damage to the skin (blue curve).

The wavelengths that cause erythema fall within the range of UVA radiation and in part within the UVB range too.
Furthermore, the erythemal weighting curve shows that the epidermis is particular sensitive to low wavelengths. Of these, only those within the UVB range cause harm in that there is no UVC at ground level (cf red curve). This is why UVB is the most dangerous type of radiation even when present in only small amounts. By taking into consideration all contributing factors over a unit of time, it is possible to calculate the level that affects the skin. This value rounded up or down to a whole number, provides the UVI index.



Note: The blue curve represents the composition of the other two; the area that subtends the curve represents the amount of energy that is absorbed by the skin within the unit of time indicated.

Figure 5.15: The state of UV radiation at ground level (red curve) of the erythemal weight (weighting curve in green) and of the radiation that is biologically harmful to skin (blue curve)[22]

This index was developed as part of a collaborative effort between the World Health Organization (WHO), the United Nations Environment Programme (UNEP), World Meteorological Organizations and the International Commission on Non-Ionising Radiation Protection (ICNIRP). The UVI defined as weighted radiation, with an erythemal weight function (the ponderal curve) relative to the 280-400 nm spectral interval divided by 25 mW m^{-2} only provides information about the possible effects on the skin and does not take individual characteristics into account. Although it does not give any direct information about the possible effects on the eyes, these are taken into consideration in any recommendations made in association with the UV index, as it is also germane to the protection of the eyes.
In addition to this numeric classification, the values in the index are also organized according to the degree of risk incurred, and by associating different colours to the various categories of exposure obtained

[22] Source: Conference transcripts: "Monitoring and forecasting the Ultraviolet Index", Matera 20 June 2008

in this way; the chart produced is immediately understandable. The various categories have also been associated with a series of countermeasures to be adopted as UVI levels increase in order to limit exposure. An easily understood graphic has been devised to describe these precautions, intended to make the message more easily accessible to the public at large. As UVI can be measured or calculated on a second by second basis with mathematical models and irradiation at ground level depends on the time of day, its progression varies over time. The WHO has therefore deemed it necessary to suggest, in order to provide information in a uniform manner, that it should be the maximum daily level that is communicated, calculated as an average over a 30-minute period. If continuous data is available however, the WHO suggests that the average UVI be calculated every 5 or 10 minutes and that this information be used to show its progress over a period of time. The maximum daily UVI level is usually calculated over a four-hour period around solar noon, a time that varies from country to country, according to geographic location and whether or not summer time is adopted, but it is usually between 12 noon and 2 p.m. Furthermore, unless specified otherwise, UVI should be calculated on the basis that the sky will be clear, but whoever is responsible for the forecast may choose to calculate the information when conditions are overcast too.

Standardising the UVI index has provided an immediately understandable tool with which to inform the public about UV radiation. Correct information can only be provided if the UVI value is combined with a person's photo type.

The Figure 5.16 shows an international classification of the UVI index using numbers and colours from the lowest ranges (UVI =1-2, green) through to the highest range (UVI=11, purple).

The values of the UV index provide a way in which people can be informed of potential risks incurred by exposure to UV rays.

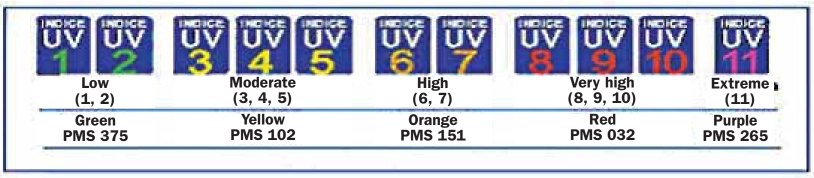


Figure 5.16: The numeric and colour coded classification of UV index values intended to make people take protective measures[23]

[23] Source : http://www.epicentro.iss.it/problemi/uv/uv.asp

The UV index according to photo type provides information about the potential risks that prolonged exposure to the sun may incur. It can be seen that those with lighter coloured skin are most likely to burn even when the UVI index is as low as 6.

In addition to this numeric classification, index values have been grouped together according to photo types and the associated risks (Figure 5.17).

UV index	Photo-type			
	I	II	III	IV
1 2	Low	Low	Low	Low
3 4	Medium	Low	Low	Low
5	High	Medium	Low	Low
6	Very high	Medium	Medium	Low
7	Very high	High	Medium	Medium
8	Very high	High	Medium	Medium
9	Very high	High	Medium	Medium
10	Very high	High	High	Medium

Figure 5.17: Possible risk incurred by exposure to UV rays[24]

It can be seen therefore, that the fundamental importance of making members of the public aware of the UVI index increases as conditions become even more extreme and the danger or potential danger from excessive exposure to UV rays rises accordingly. It is normal for such conditions to be present in the latitudes within which Italy lies both in the summer and in areas with high levels of snow in the winter.

The epidermis is sensitive to only some of the rays to which it is exposed.

The measurements of the UV index represent an evaluation of the amount, or in other words, the quantity of energy that strikes a surface over a unit of time. In this case, where it is the effects on man that are of interest, the surface in question is the skin (epidermis) that is exposed to the sun (the epidermis). The amount needed to cause irritation (an erythema) varies according to the characteristics of a particular skin type. Information regarding how to protect oneself and avoid the damage incurred by prolonged exposure to the sun must refer to both the UVI and photo type if it is to be useful.

[24] Source: ARPA Friuli Venezia Giulia

Available data

Over the last two years, ISPRA, in accordance with the agency system, has collected and collated all available data and information provided from across the nation.
Considering that to date, Italy has only limited experience on this issue, the limited data available obviously lacks uniformity and is extremely variable. Never the less, it does underline the country's commitment this innovative subject.
The Figure 5.18 clearly shows that only two branches of ARPA (Aosta Valley and Piedmont) regularly carry out monitoring activities, and that a third (Basilicata) is able to provide forecasts based on mathematical models. There are six Agencies nationwide that provide informative bulletins and carry out monitoring activities of one type or another. Interest in the subject matter throughout the agency system however, can be seen from the various UV related activities that are in fact carried out by 19 of the 21 agencies.

Two branches of ARPA (Aosta Valley and Piedmont) adopt criteria and procedures that are in line with European standards. A total of 19 out of 21 branches carry out UV related activities.

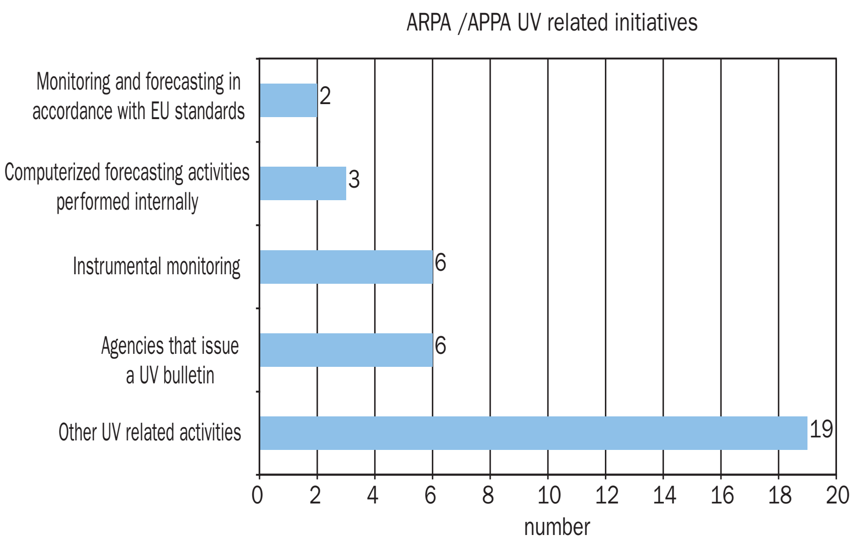


Figure 5.18: UV related activities carried out by ARPA/APPA[25]

[25] Source: ISPRA

The data that follows regards only the regions of the Aosta Valley and Piedmont in that to date; they are the only regions who have adopted methods and procedures in line with European standards. The purpose of the activities carried out by the Aosta Valley branch of ARPA is to:

- Evaluate the medium and long-term trends regarding solar UV radiation at ground level in relation to variations in stratospheric ozone. They are joined, in this task, by the Physics Department of Rome's "La Sapienza" University, which has a consolidated experience in the study of ultraviolet radiation, and can boast of almost twenty year's worth of records of data obtained by the University's own campus-based station.
- Obtain data that will contribute to a more in-depth understanding of the interaction between the UV component of solar radiation and the atmosphere, which will also lead to a greater understanding of the dynamics of photochemical smog.
- Evaluate the effects of exposure to solar UV radiation on a large number of people who are, for either professional or leisure reasons, involved in activities carried out at altitude. This is another area of collaboration with Rome's "La Sapienza".

UV radiation is measured at three locations in the Aosta Valley:

- Saint-Christophe (570 m.a.s.l.- *meters above sea level*);
- La Thuile - Les Granges (1,640 m.a.s.l.);
- Plateau Rosa (Valtournenche, 3,500 m.a.s.l).

Saint-Christophe is located on the valley floor, characterized by its lower height and less frequent occurrences of snow that settles. La Thuile - Les Granges is a typical mountain location and its higher altitude is susceptible to climatic conditions and solar radiation, which is also determined by the more extensive presence of snow throughout the year. It is also not far from the ski-area that is very busy during the winter season. Plateau Rosa, finally, is a typical Alpine glacier area that is subject to extreme climatic conditions and the presence of snow throughout the year.

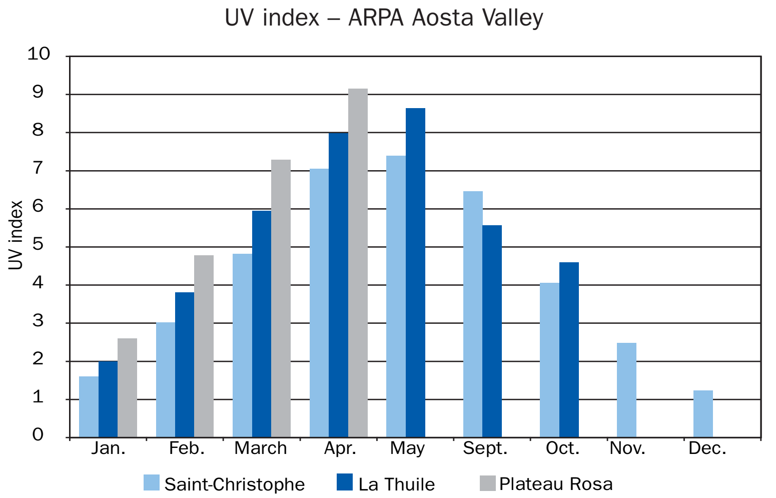


Figure 5.19: UV index, maximum value by month (2008)[26]

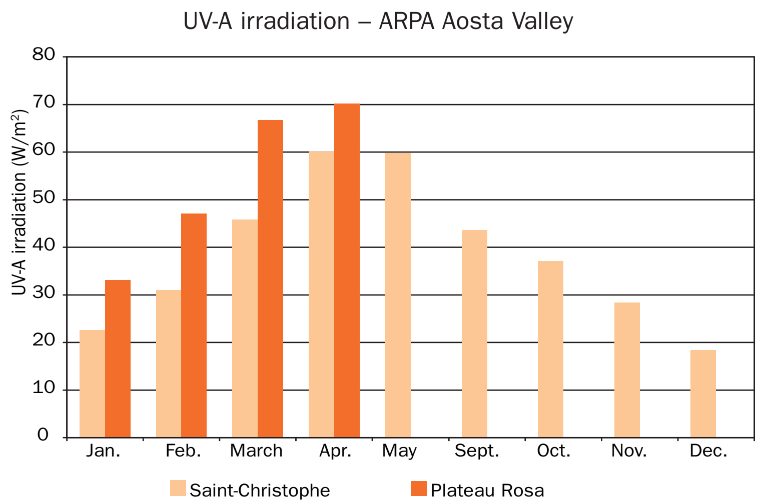


Figure 5.20: Ultraviolet irradiation in the UV-A range, maximum value by month (2008)[27]

Levels of UVI show a steady increase between January and the end of May, and the highest values are recorded at the Plateau Rosa site, which is located at altitude and is usually covered in snow. This highlights how factors such as local albedo, altitude and orography affect index values. The situation regarding irradiation values is analogous.

[26] Source: ARPA Aosta Valley
Note: Data for June, July and August is missing as that is when the radiometers were being calibrated

[27] Source: ARPA Aosta Valley
Note: Data for June, July and August is missing as that is when the radiometers were being calibrated

The Figure 5.21 below shows examples of the UV index throughout the Aosta Valley area as shown in the forecast bulletin posted on the Agency's website.

The highest values are recorded at the highest altitudes, which confirms the findings of the data collected.

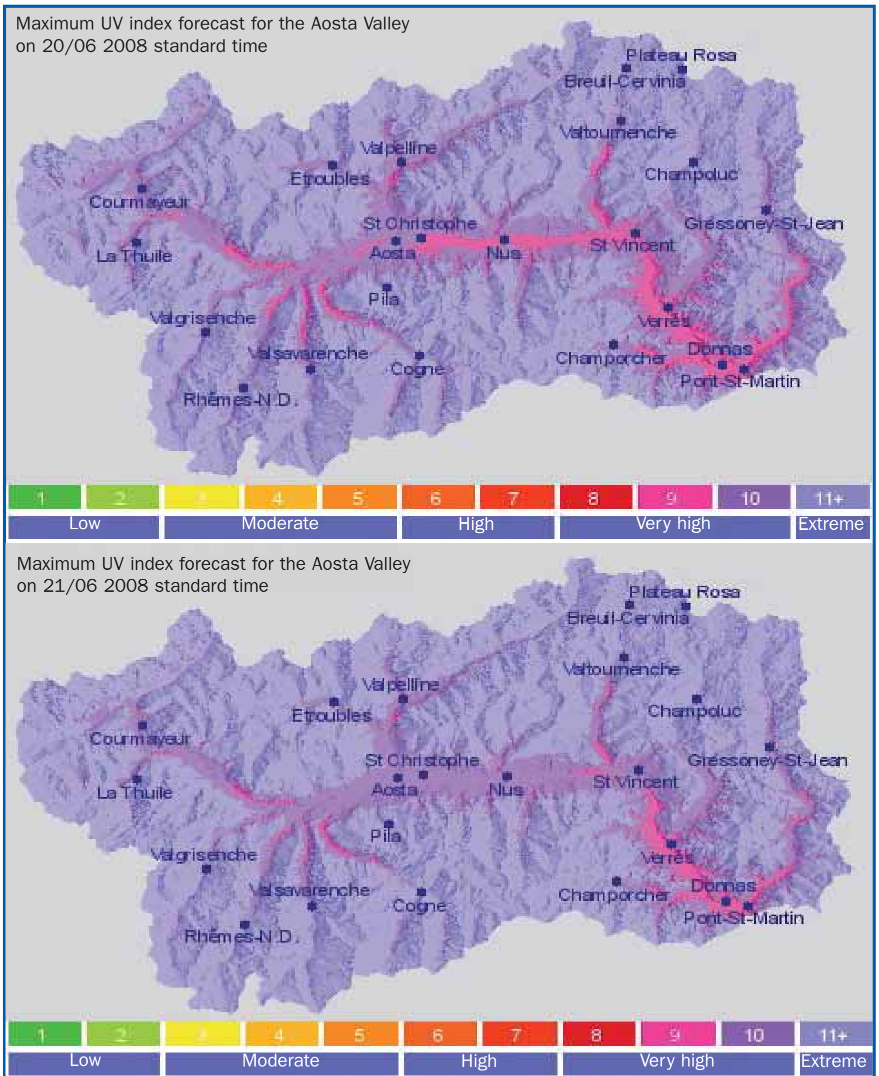


Figure 5.21: Example of a forecast notice for the moments immediately before and after the summer solstice (between 20 and 21 July)[28]

[28] Source: ARPA Aosta Valley
Note: Data for June, July and August is missing as that is when the radiometers were being calibrated

Piedmont is the second region to create a monitoring network that conforms to European standards. As to the disposition of the stations in Piedmont that measure UV: two have been established at a height of 270 m.a.s.l.in the headquarters of the Regional Centre for Ionising and Non-Ionising Radiation in Ivrea, in the Province of Turin, and there is another, at a height of 214 m, in the CNR Headquarters in Pallanza on Lake Maggiore. A third is located in Sestriere, in the Province of Turin at a height of 2,035 m.

Monitoring activities in both Sestriere and Pallanza only began at the beginning of August 2009 due to problems in calibrating the equipment. The graphs below show the maximum values in the UV index (Figure 5.22) and the highest irradiation values (Figure 5.23) recorded by each radiometer during the month of September. The results show that the highest irradiation and UVI values were recorded at Sestriere on 1st September 2009 at 11.45 CET and on the same day at Pallanza at 11.30 CET.

The highest irradiation and UVI values were recorded in Sestriere on 1st September 2009 at 11.40 CET and, in Pallanza, also on 1st September 2009 at 11.30 CET.

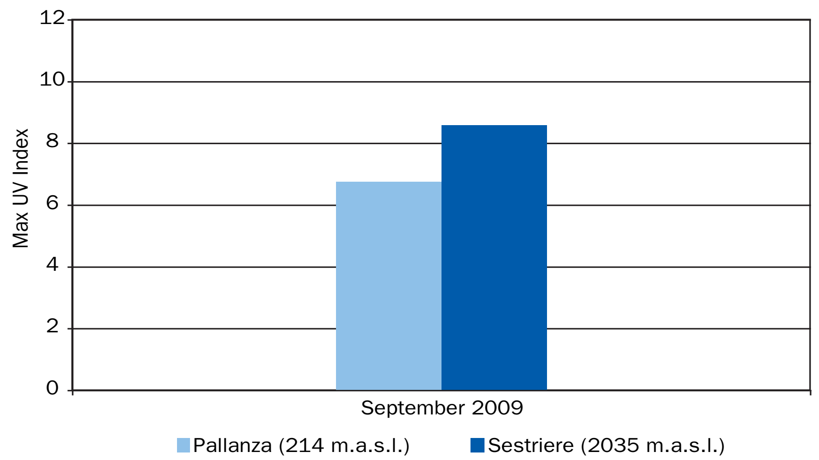


Figure 5.22: The highest UV index value recorded in September at Pallanza (at 214 m.a.s.l.) and Sestriere (at 2,035 m.a.s.l.)[29]

[29] Source: ARPA Piedmont

It can be seen that to date, the values of the location situated at a higher altitude are greater than those recorded in the other.

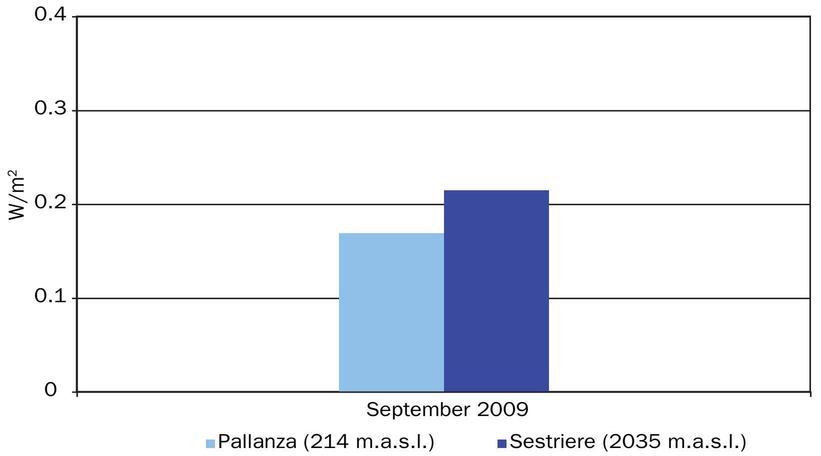


Figure 5.23: The highest irradiation value recorded in September at Pallanza (at 214 m.a.s.l.) and Sestriere (at 2,035 m.a.s.l.)[30]

A third graph, (Figure 5.24) below, shows the highest UV irradiation values recorded monthly during 2008 at Capanna Margherita and Colle Bercia, whilst the fourth (Figure 5.25), shows the highest UVI values recorded by the station in Ivrea during 2009.

The highest values were recorded in April in Colle Bercia and in May in Capanna Margherita. The latter consistently recorded higher values than the former except in the month of November.

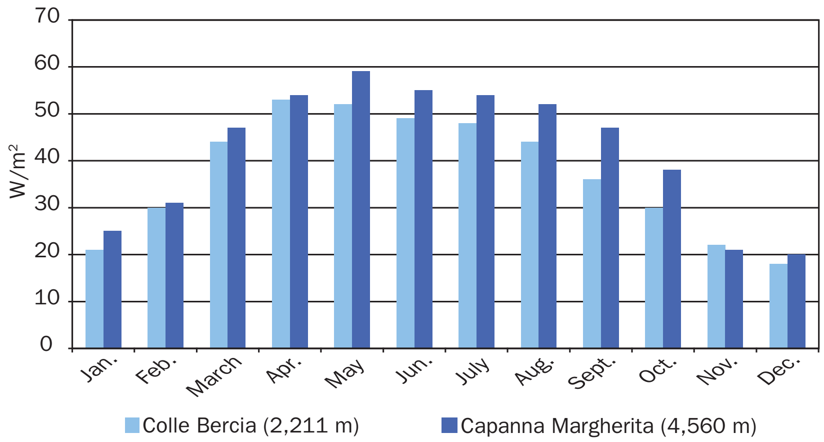


Figure 5.24: Totals of the highest monthly values of UV irradiation recorded in 2008 at Capanna Margherita (4,560 m.a.s.l.) and at Colle Bercia (2,211 m.a.s.l.)[31]

[30] Source: ARPA Piedmont
[31] Source: ARPA Piedmont

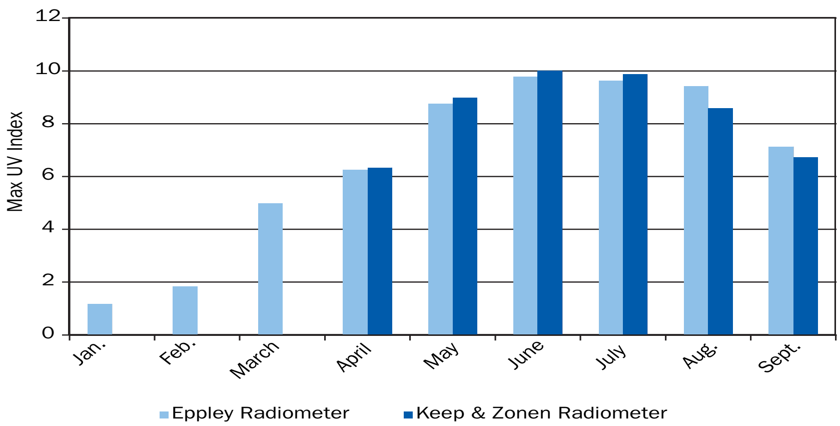


Figure 5.25: Highest UV index values recorded monthly during 2009 at Ivrea (214 m.a.s.l.) using 2 different radiometers[32]

The highest values recorded are in the months of June and July. Studying the graph closely shows that there is great similarity between the UV index values recorded by the two radiometers during the period April-September 2009 in that the difference between the two measurements is consistently less than 5%.

After an initial experimental phase, forecasting the UV index throughout Piedmont officially began on 1st July this year, with the publication of a daily forecast on the ARPA website: www.arpa.piemonte.it.
An example of this forecast bulletin can be seen in Figure 5.26.

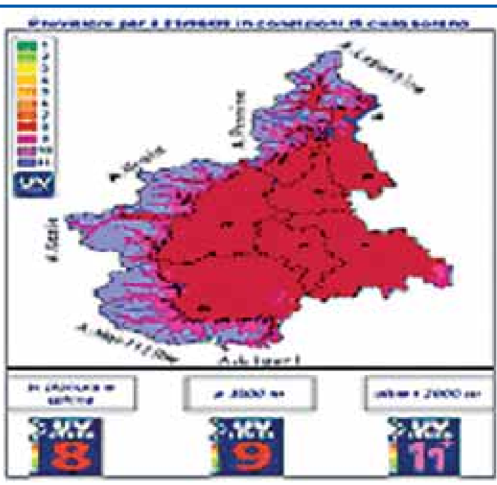


Figure 5.26: Bulletin forecasting the regional UV index released on 21 June 2009[33]

It can be seen that the UVI index value increases in line with the height above the plains. It follows therefore that forecasts made in Piedmont also show how the UVI index in effected not only by the irradiation at ground level but also by local factors such as height and albedo etc.

[32] Source: ARPA Piedmont
[33] Source: ARPA Piedmont

Other instances of the systematic gathering of data can be found in Friuli Venezia Giulia, where ARPA has three monitoring stations in two different coastal locations (Trieste and Grado), and one in the mountains (Mt. Zoncolan) equipped with an automatic filing system for the data collected. Due to calibration problems however, they are not currently operational. The APPA agency based in the autonomous Province of Bolzano also operates a station, sited on the Renon plateau, which measures irradiation weighted according to the erythemal equation but that data is not yet publically available. Both the Veneto and Emilia Romagna have a few stations from which they obtain data used for UVI index forecasts, which are then made available to the public on a fortnightly basis on the Agency's site. ARPA in Tuscany and Sicily each produce a UV index forecast in collaboration with third parties, which includes the level of protection to be used in relation to phototype (the Promote project, with ESA and other, private partners). In Sardinia, a bulletin on sun exposure times is provided as part of the privately funded CERU (Correct Exposure to Ultraviolet Radiation) project. This collaborative project involves Deutscher Wetterdienst, the Regional Agro-meteorological Service for Sardinia (S.A.R), a member of the National Research Council (CNR) as are fellow partners, the Bologna branch of the Institute of Atmospheric and Climate Sciences and the Sassari section of the Institute for Bio-molecular Chemistry. Lazio has recently established a prototype station to monitor UV rays in collaboration with ENEA (the Italian National Agency for New Technologies, Energy and Sustainable Economic Development). UV rays will be measured here at ground level in order to quantify the flow of ultraviolet radiation in relation to its effects on man. Initiatives that will provide the appropriate safeguards will follow. The Region of Basilicata publishes a UV index forecast on its website. Furthermore, it has been organizing campaigns to raise awareness of UV index values since 2005.

IONISING RADIATION

The problem

The general public often associate the term "ionising radiation" with the fear of the effects that this type of radiation has on health. The first image that these words conjure up, is associated with the direct effects of acute exposure, similar to burns, such as that of the explo-

sion of nuclear bombs in Hiroshima and Nagasaki. Technically speaking, these burns are defined as "deterministic" effects and are the result of extreme exposure. Other fears concern the effects of less severe exposure that are not immediately noticeable but that manifest themselves over time or in future generations and they are often associated with the risk of cancer formation. A clear example of this is the fears that surfaced following the accident involving the Soviet nuclear reactor in Chernobyl and they are associated with the consequences of the entire population of a town being exposed. These effects are technically known as "stochastic", or in other words, probabilistic, in which the probability of them to occurr depends on the severity and duration of the exposure. It must also be stressed that in the collective imagination, ionising radiation is nearly always only associated with the production of nuclear energy, including the treatment and disposal of the waste it generates. The fear that incurs is often caused by a preconceived idea that totally fails to take into account the costs and benefits associated with this form of energy when compared to other technological means of energy production, even if the associated health and environmental risks are borne in mind. However, there are cases in which the exposure to ionising radiation is generally accepted, such as for medical, diagnostic or therapeutic purposes. In such cases, any resulting risks are perceived to be more than outweighed by the benefits that those undergoing such treatments experience.

"Justification" is one of the fundamental principles adopted in safeguarding the general public and the workforce from radiation. Any activity that subjects either the general public or the workforce to exposure, must in fact be justifiable once costs and benefits have been weighed up and other alternatives have been considered. What is more, the level of exposure must be "optimized" or in other words, reduced to the lowest levels that can reasonably be achieved.

A further consideration regards the entity of any exposure to which the population is generally subjected, compared to the exposure as described above. If atomic bombs and nuclear incidents are excluded in fact, then any exposure that results from activities associated with energy production is by far inferior to any that results from natural sources. There are sources of ionising radiating both in the cosmos and on the earth's crust, as well as within our own bodies, that are responsible for levels of exposure thousands of times higher than that

Ionising radiation is almost always only associated with the production of nuclear energy although in fact, exposure to ionising radiation is also a medical, diagnostic or therapeutic procedure. In such instances, the risks involved are considered to be more than outweighed by the benefits incurred by those that undergo such treatments.

These considerations point out the need to find out more and to increase awareness of the repercussions of being exposed to sources of ionising radiation. Therefore, evaluating the risks and benefits associated with all sources of radiation becomes easier and is better understood.

produced by the nuclear industry. The main source of exposure to ionising radiation occurs in a domestic setting and in other indoor situations, where people spend most of their time. In fact, there is a natural gas present in the air in all these locations, called radon, which is generally the main source of the risks that everyone has to face. In some cases, it reaches such high levels of concentration that on the cost – benefit scale mentioned above, the associated risks are considered unacceptable and taking action to restore healthy conditions to the living environment is highly recommended or even obligatory. These considerations point out the need to find out more and to increase awareness of the repercussions of being exposed to sources of ionising radiation.Therefore, evaluating the risks and benefits associated with all sources of radiation will become less difficult and better understood.

Radon exposure

A national overview of the situation with regard to radon exposure was obtained following an investigation carried out in the 80s and 90s, which, because of the characteristics of the phenomenon, is still valid (Figure 5.27).

High concentrations of radon (Rn-222) have been noted in Lazio and Lombardy. The difference between these regions and the others is due to the high uranium content in the rocks and soils and their diverse permeability.

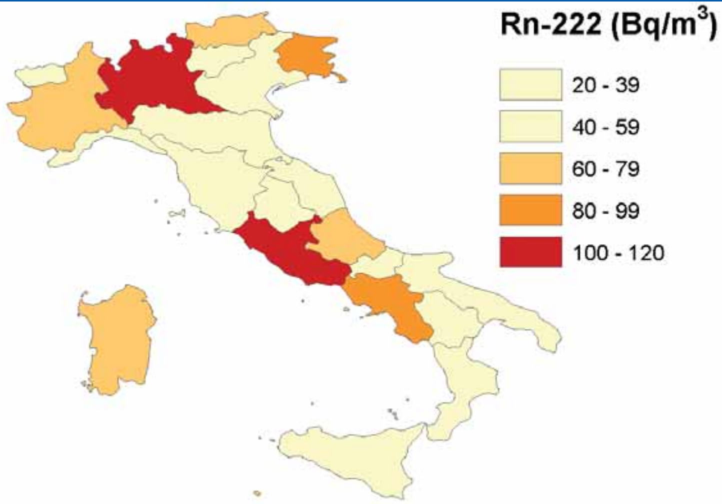


Figure 5.27: Map of Rn-222 concentration in homes shown by region and autonomous province (the choice of scale used is of purely exemplary value) (1989-1997)[34]

[34] Source: F. Bochicchio 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

As to the response to this investigation, the problem of protecting the workplace from radon exposure was legally addressed with the enactment of the Legislative Decree no. 241 in 2000 that modified and integrated an earlier decree, no. 230 of 1995. The Decree sets out the obligations of both those in charge of workplaces and of the regions. The latter in particular are charged to identify the areas most likely to suffer high concentrations of radon activity. Pending the determination of the criteria to be used to identify these areas and the methods to be adopted in that process, some regions and some ARPA/APPA started studies and investigations that will allow to classify areas according to the likelihood of high concentrations of radon being present. The regions in which such studies began are shown in Figure 5.28.
In conclusion, information on the decontamination efforts

Figure 5.28: The regions (in green) in which studies/initiatives aimed at identifying areas at risk of radon have been underway since 2002[35]

Pending the determination of the criteria to be used to identify the areas with high concentrations of radon and the methods to be adopted in that process, some regions and some of ARPA /APPA started studies and investigations that will allow to classify areas according to the likelihood of high concentrations of radon being present.

[35] Source: ISPRA, ARPA/APPA

carried out in Italy in places where there is a high concentration of radon is still sketchy and erratic, whether in regard to domestic situations or the work place.

Controls on environmental radioactivity

In Italy, controlling levels of radioactivity is organized at three levels: local, regional and national.

Environmental radioactivity monitoring is organized, in compliance with both Italian law, under Legislative Decree 230/95 and its subsequent modifications, and European legislation as well, through a combination of networks that operate at three distinct levels: local, regional and national. Local networks are responsible for environmental radioactivity monitoring programmes on nuclear plants; regional networks are in charge of monitoring the level of radioactivity in the environment and foodstuffs in their respective territories, whilst national networks provide an overall picture of the situation in Italy and are responsible for collecting data and responding in the event of any anomalies. The diagrams below show the trend of Caesium-137 concentration in the airborne particulate, in the wet and dry deposition and in cow's milk

The diagram shows the contamination peaks associated with the arrival in Italy of the "Chernobyl cloud" (April 1986) and of the fall-out that resulted from an incident in a Spanish foundry in Algeciras (June 1998) which was much more noticeable in northern Italy. Levels recorded in recent years have remained stationary and well below the reporting level established by the EU (30 μBq/m³).

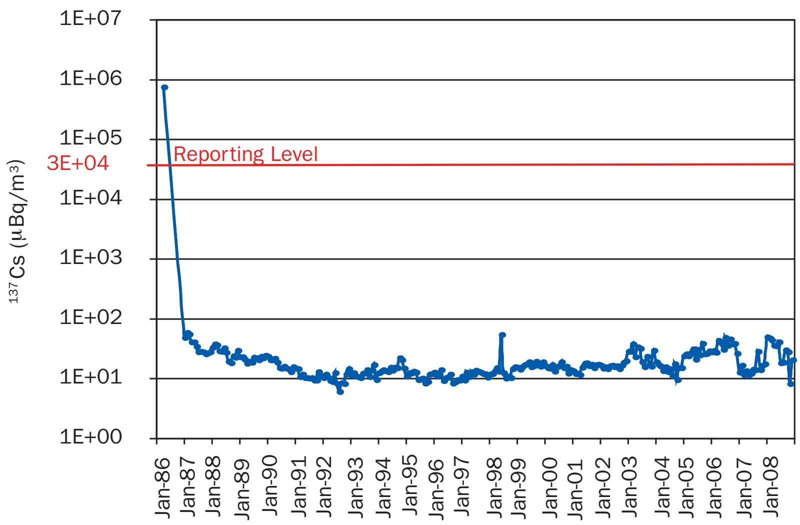


Figure 5.29: Trend of Cs-137 concentration in the airborne particulate in Italy[36]

[36] Source: ISPRA/ARPA/APPA data processed by ISPRA, gathered by ISPRA's environmental radiation laboratory service, *OECD-ENEA, 1987, The Radiological impact the Chernobyl accident in OECD countries,* Paris - ISPRA

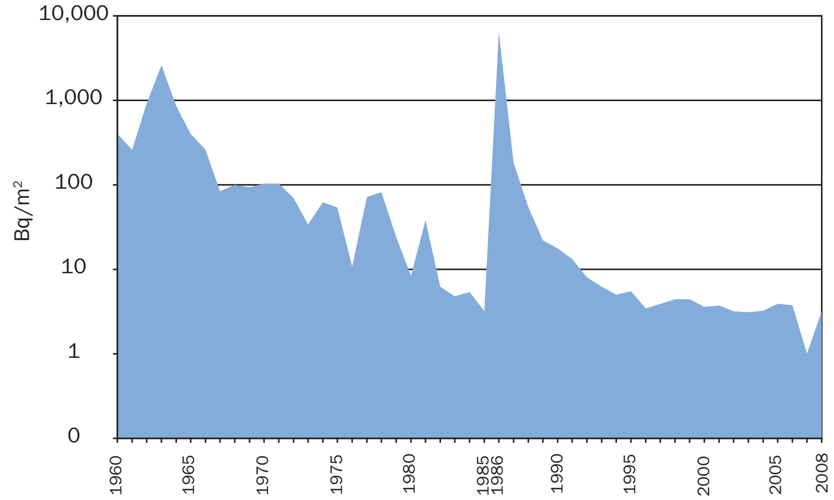


Figure 5.30: Trend of wet and dry deposition of Cs-137 in Italy[37]

This diagram highlights the high Cs-137 concentration associated with tests carried out in the atmosphere in the 50s and 60s as well as the peak that resulted from the Chernobyl accident in 1986. Since then, there has been a steady reduction in contamination levels.

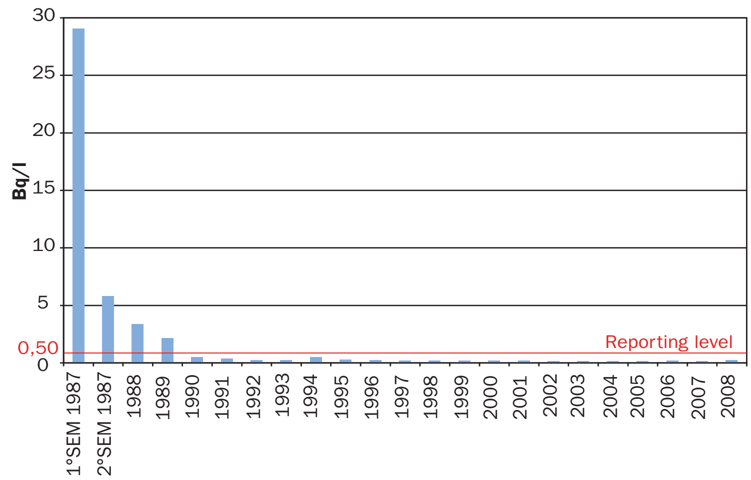


Figure 5.31: Trend showing the concentration of Cs-137 in cow's milk in Italy[38]

This diagram reveals ever-decreasing levels of contamination in cow's milk that is today, approximately two orders of magnitude less than it was in 1987, the year after the fallout from Chernobyl, whilst levels have been below the reporting level established by the EU (0,5 Bq/l) since 1990.

[37] Source: ISPRA/ARPA/APPA data processed by ISPRA, gathered by ISPRA's environmental radiation laboratory service, *OECD-ENEA, 1987, The Radiological impact the Chernobyl accident in OECD countries,* Paris - ISPRA

[38] Source: ISPRA/ARPA/APPA data processed by ISPRA, gathered by ISPRA's environmental radiation laboratory service, OECD-ENEA, 1987, *The Radiological impact the Chernobyl accident in OECD countries*, Paris - ISPRA

over a period of years (Figures 5.29, 5.30 and 5.31).
The answer to obtaining an overall view of the situation in Italy is provided by the pursuit of a network-monitoring programme.
Table 5.3 shows the scores given during the evaluation of nationwide monitoring carried out from 1997 onwards that is based on methodology elaborated for the ECOEHIS (*Development of Environment and Health Indicators for EU countries)* project.
The evaluation of each of these matrices was based on all the following aspects: frequency of measurements taken, the sensitivity of these measurements, territorial coverage of controls, regularity of monitoring, the organization and participation in intercomparison exercises on a nationwide basis.

The score given to the national monitoring programme is satisfactory, even if the coverage of the entire national territory has to be improved.

Table 5.3: Evaluation of the state of monitoring carried out over national[39]

Year	Score	Finding
1997	15	satisfactory
1998	17	satisfactory
1999	13	insufficiente
2000	17	satisfactory
2001	17	satisfactory
2002	17	satisfactory
2003	17	satisfactory
2004	17	satisfactory
2005	17	satisfactory
2006	17	satisfactory
2007	17	satisfactory
2008	17	satisfactory

Key: Quality levels: unsatisfactory 0- <15; satisfactory 15- <21; good 21<25

The score given to the national monitoring programme is satisfactory, even if the coverage of the entire national territory has to be improved.

[39] Source: ISPRA/ARPA Emilia Romagna data processed by ISPRA

ENVIRONMENT AND HEALTH
Prevention in a changing world: the determinants of health and environmental strategies of adaptation

Introduction

The effects of climate variability and change (Figure 6.1) will impact on the quality and availability of natural resources, biodiversity and territorial stability acting also as amplifiers of pre-existing environmental vulnerabilities. These environmental effects will generate risky conditions for the health and wellbeing of the population. An adaptation of the current environmental and health prevention systems is therefore required to cope with these changes. It is indeed necessary to re-think the way in which prevention, surveillance and monitoring activities are planned, organized and implemented as well as the response capacities to emergencies aimed to reduce negative impacts on the exposed population.

The observed effects of climate variabilty and change will impact on the quality and availability of natural resources, biodiversity and territorial stability acting also as amplifiers of pre-existing environmental vulnerabilities.

Increase of average global temperatures:
- Increase of maximum temperatures during hot days
- Increase of minimum temperatures during cold days
- Increase of the annual number of hot days
- Increase of the frequency, duration and intensity of heat waves.

Gradual changes in rainfall:
- Increase of the frequency, duration and intensity of dry periods and droughts
- Variations of the duration, localization and intensity of rainfall and snowfall.

Increase of the frequency and intensity of extreme meteorological events:
- Increase in the annual frequency of very strong winds, torrential rains, anomalous waves and floods often associated to tropical storms and tornadoes.

Major meteorological vulnerability:
- Increased instability of seasonal meteorological schemes
- Variations in the beginning and end of growing seasons.

Sea level rise:
- Flooding of human settlements
- Salinization of coastal ground water.

Figure 6.1: The effects of climate variability and change[1]

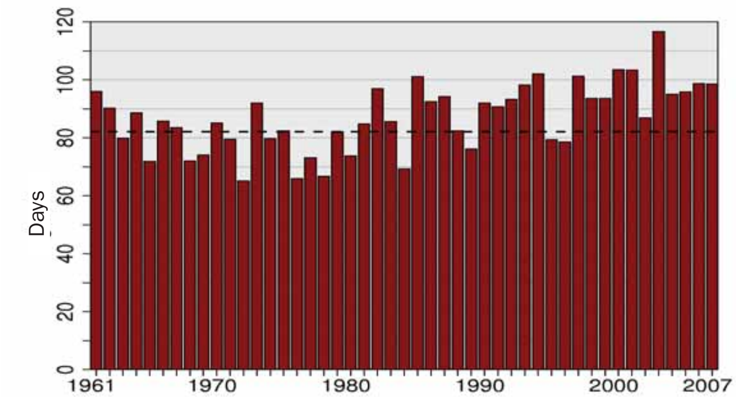
[1] Source: FAO data processed by ISPRA

It is well known that health risks from climate change and variability are not only related to mortality or morbility due to heat waves but they also regard many other potential health effects mediated by environmental changes such as, for example increased risk of infectious diseases transmitted by water, food, vector insects, as well as other unhealthy conditions such bathing water toxicity, chemical food security and changes in distribution and quantity of allergens. A proactive approach in response to a changing environment must therefore identify and define preventive measures in adaptation plans and programmes. These should be integrated with emergency and response systems in order to reduce the adverse consequences of climate change, based on hazard and risk characterization of environment, health and sustainable well being by means of short-term strategies focused on current system vulnerabilities (including the revision of current regulations) and by medium and long term copying measures.

The impacts of climate change call for a proactive response that involves a reorganization of environmental and health prevention systems from a technological, operational and organizational point of view.

The observed data in the last decades show that also Italy is among Countries affected by meteo-climatic change and variability. Time series highlight changes in temperature patterns (Figure 6.2 and 6.3) which will contribute to increase the risk of infectious and allergic diseases as it wil be better discussed further in the text.

In Italy an increase in the number of summer days (T >25°C) has been observed over the last decades.



Note: The dashed line indicates the normal mean value calculated in the period 1961-1990. Data was collected from 49 stations of the AM network

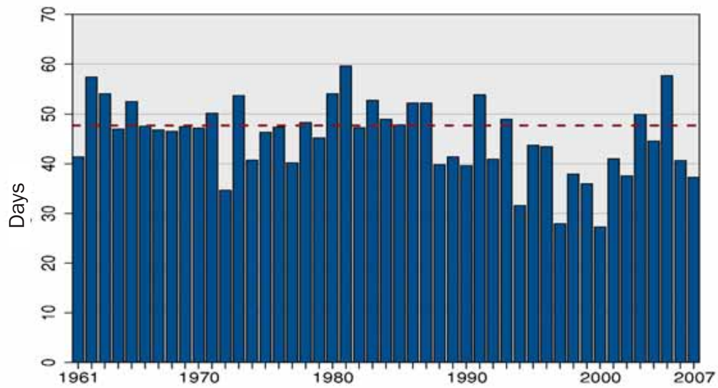
Figure 6.2: Observed data in Italy: average number of summer days[2]

Even the number of rainy days seems to have suffered a statistically significant reduction over the whole national territory, while the

Rainfall patterns are also changed.

[2] Source: ISPRA Environmental Data Yearbook - 2008 Edition

There was also a reduction of about 20% of cold days (T≤0°C) with milder winter and fall seasons.



Note: The dashed line indicates the mean average value calculated in the period 1961-1990. Data was collected from 49 stations of the AM network

Figure 6.3: Observed data in Italy: average number of cold days[3]

The results of a first national screening of health risks caused by climate change highlight emerging risk conditions.

intensity of rainfall in the Northern and Southern regions has increased at the same time. It is also reasonable to think that Italy will suffer a major increase in temperature in the years to come. An analysis of future scenarios forecasts an increase in the frequency of hot and damp days and, at the same time, a reduction in the number of cold days. The sea temperature is also expected to increase further. These scenarios also forecast a possible reduction in winter rainfall in the Mediterranean region and in Northern Italy as well as an increase in the frequency of intense rainfall patten. A first screening of the meteo-climatic and environmental conditions that will influence related emerging health risk in Italy was conducted by the National Environmental Protection Agency (APAT now ISPRA) in collaboration with the World Health Organization (*APAT–WHO 2007. Cambiamenti Climatici ed Eventi Estremi: Rischi per la salute in Italia"*). On the basis of this National assessment the Environment and Health Task Force of national experts[4]

[3] Source: ISPRA Environmental Data Yearbook - 2008 Edition

[4] WG Ambiente e Salute CNCC 2007: Bartolini G. (CIBIC - UNIFi); Bottoni P. (ISS); Braca G. (ISPRA); Bussettini M. (ISPRA); Carere M. (ISS); D'Aponte T. (University of Naples); De Maio F. (ISPRA); De Martino A. (Ministry of Health); Dell'Anno B. (MATTM); Fausto A.M. (University of Tuscia); Funari E. (ISS); Majori G. (ISS); Mancini L. (ISS); Marcheggiani S. (ISS); Martinelli A. (ARPA Umbria); Menne B. (WHO); Miraglia M. (ISS); Morabito M. (CIBIC , UNIFi); Onorari M. (ARPA Tuscany); Orlandini S. (CIBIC, UNIFi); Raineri W. (ARPA Liguria); Rieti S. (ISPRA); Romi R. (ISS); Scala D. (ARPA Tuscany); Sinisi L. (ISPRA); Spizzichino D. (ISPRA); Tuscano J. (ISPRA); Wolf T. (WHO)

established within the framework of the Italian National Conference on Climate Change (CNCC 2007), elaborated specific proposals of measures to support environmental adaptation strategy for the prevention of emerging related health risks. More detailed information can be obtained from the ISPRA publication[5].

Health risks and adaptation of environmental prevention: emerging critical issues and suggested measures

Influence of climate change on vector arthropods and vector borne diseases

In the last few years, meteo-climatic changes have facilitated, not only in developing countries but also in many developed countries an increase in the distribution of many arthropod species potential vectors of diseases. that are very sensitive to environmental and meteo climatic conditions, in particular:

a) Infectious agents and their related vectors are typically sensitive to environmental conditions in terms of survival, reproduction and exponential multiplication of the pathogen;
b) Vectors, being ectothermic organisms (i.e. they cannot regulate their own body temperature), are particularly sensitive to external temperature. Therefore, their biological cycle is strictly regulated by external factors (temperature/humidity).

In addition to meteo-climatic factors, other environmental vulnerabilities can influence the distribution of vectors such as habitat and biodiversity loss, land use, pesticide use and lack of natural predators.

The changes in average temperature and humidity patterns facilitate the distribution of arthropods, potential vectors of viral, bacterial and parasitical diseases.
In addition to meteo-climatic factors, other vulnerabilities can influence the distribution of vectors such as habitat destruction, soil utilization, pesticide utilization and loss of natural predators.

The Tiger Mosquito. Different species of Culicidae[6] permanently live in Italy. Among these *Aedes albopictus*, better known as the tiger mosquito, is a potential carrier of the arbovirus that causes viral diseases (Bluetongue, West Nile, Chikungunya and Dengue).

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[5] Cambiamenti Climatici, salute e strategie di adattamento: criticità e proposte operative", ISPRA
[6] *Culex Pipiens* e *Aedes aegypti*. The latter does not currently exist in the Mediterranean basin but could be re-introduced in Southern Europe in the next few years due to meteo-climatic changes in course

The tiger mosquito was introduced in Italy in the early 1990s and by now is well establisehed over national territory. Its health relevance in is that it can potentially become vector for over 20 types of arboviruses.
In its native Countries from Southern China to South East Asia and Africa, the vector is a carrier of dengue (DEN), yellow fever and Japanese encephalitis.

In August 2007 in Emilia Romagna occurred an outbreak of over 200 cases of Chikungunya virus transmitted by the infected tiger mosquito.

In August 2007 in Emilia Romagna, particularly the province of Ravenna, occurred an outbreak of over 200 cases of Chikungunya (a virus from the *Togaviridae* family transmitted by the tiger mosquito) whose endemic area is normally found in different regions of Asia and Africa.
This was the first case in Italy of an outbreak caused by a virus transmitted by the tiger mosquito.
In Italy, the species is already established up to the Alpine regions[7] and its expansion towards the North has reached a peak level.
Up to 2007, the tiger mosquito was observed in many European countries such as Albania, Bosnia Herzegovina, Croatia, Greece, Montenegro, France, Holland, Serbia, Slovenia, Spain and Switzerland[8].
In the last few years the tiger mosquito has also become a "competent vector" carrying other viral diseases such as the West Nile fever (some cases were also recently observed in Italy) and Dengue.
The main meteo-climatic determinants for its settlement are the reduction of average cold temperatures (milder winters and autumns), the reduced quantity and frequency of rainfall and the shorter duration of daylight hours. Figure 6.4 describes the areas for possibile establishment of the tiger mosquito based on 5 different climate scenarios (Source: ECDC).

The Phlebotomus and Leishmaniasis.

Sandfly (Phlebotomus). Leishmaniasis is an infectious disease caused by a protozoan parasite, the *Leishmania infantum.* It is transmitted to humans through the bite of an infected female of

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[7] Romi R. (2001a), *Aedes albopictus* in Italy: *an underestimated health problem.* Ann. Ist. Super. Sanità, 37(2): 241-247
[8] *European Center for Disease Prevention and Control (ECDC) Meeting Report* | Paris, 22 October 2007
Consultation on vector-related risk for chikungunya virus transmission in Europe

The future increase in the distribution of the tiger mosquito in Europe is influenced by meteo-climatic scenarios (temperature and rainfall).

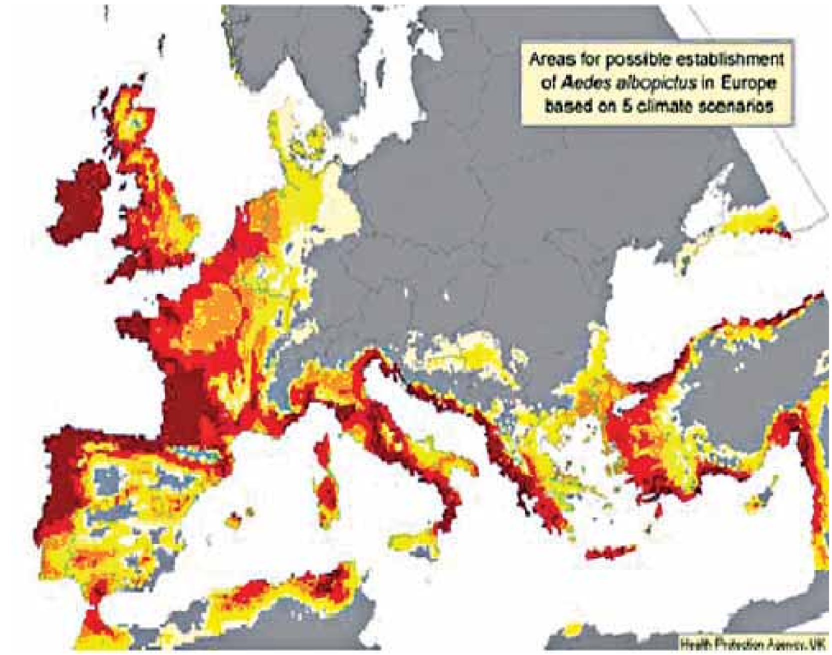

Figure 6.4: Potential Areas of interested by tiger mosquito in Europe based on 5 climate scenarios[9]

sandfly (Phlebotomus). Both vector's activity and the development of the protozoan parasite in the vector[10] are influenced by temperature.

In Italy, the disease affects humans in two forms: Zoonotic Visceral Leishmaniasis and Sporadic Cutaneous Leishmaniasis. The average increase of temperature could favour the spread of both Zoonotic Visceral Leishmaniasis (ZVL)[11] and its vectors, the Phlebetomus[12],

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[9] Source: ECDC, 2007
Note: Scenario 1 (light yellow) = 450 mm annual rainfall, -1°C isothermic January; Scenario 2 yellow) = 500 mm - 0°C; Scenario 3 (orange) = 600 mm - 1°C; Scenario 4 (red) = 700 mm - 2°C; Scenario 5 (brown) = 800 mm - 3°C

[10] Bates PA. *Interazione fly Leishmania sabbia: progressi e sfide. Curr Opin Microbiol.* 2008 Jul 11. [Epub ahead of print] PMID: 18625337. Bates PA. *Trasmissione di promastigotes Leishmania metacyclic dalla sabbia phlebotomine mosche.* Int J Parasitol. 2007; 37 (10) :1097-106

[11] The most common reservoir are dogs, while the main vector is the *Phlebotomus perniciosus*

[12] Hematophagous diptera belonging to the Psychodidae family, *Phlebotomus* genus

According to the WHO, the endemic area of Leishmaniasis has expanded since 1993. Currently, it is endemic in 88 countries of the five continents.

The Phlebotomus and the arbovirus.

The ticks.

even in unaffected areas of Northern regions (where only some sporadic cases of dog Leishamiasis had been recorded), as well as an increase of incidence in in already endemic areas . The other form of disease, Sporadic Cutaneous Leishmaniasis (SCL), is caused by dermotrophic species of *Leishmania infantum*.
According to the WHO, the endemic area of Leishmaniasis has expanded since 1993. Currently, the disease is endemic in 88 countries of the five continents with a total of 12 million diseased and over 350 million people at risk. In the Mediterranean area, during the whole course of the 1990s, there was a alarming increase of Zoonotic Visceral Leishmaniasis human cases . According to the Istituto Superiore di Sanità (National Health Institute), the annual incidence in 2000 was of about 200 cases/year while today we count an average of 500 cases/year.
In Italy, Phlebotomus vectors also carry the arbovirus belonging to the *Flebovirus* genus of the *Bunyaviridae*[13] family. Other two floboviruses were isolated in the 1970s and 1980s. The first is the Toscana virus[14], an agent of central nervous system infectious disease (mainly benign Meningoencephalitis). This virus has been found in at least 3 regions of central Italy (Tuscany, Marche and Abruzzo) and more than 100 species of this virus have been identified in the *Phlebotomus perfiliewi* and *Phlebotomus perniciosus*[15]. The second identified virus is Arbia virus, isolated in same vectors[16] in Tuscany and Marche. It didn't affect any humans so far.

Non-Insect Arthropods (ticks). Many diseases can be also transmitted by non-insect arthropods such as ticks. Among them are the *ixodidae* - or hard ticks - that are vectors of a large variety of

[13] Nicoletti L., Ciufolini M.G., Verani P. (1996) *Sandfly fever viruses in Italy*. Arch. Virol. Suppl., 11: 41-47
[14] Verani P., Lopes M.C., Nicoletti L., Balducci M. (1980), *Studies on Phlebotomus-transmitted viruses in Italy*. I: *Isolation and characterization of a sandfly fever Naples-like virus*. In: Vesenjak-Hirjan J, ed. Arboviruses in the Mediterranean Countries, Zbl Bakt.Suppl 9. Stuttgart: Gustav Fischer Verlag; pp.195–201
[15] Verani P., Ciufolini M.G., Nicoletti L. (1995), *Arbovirus surveillance in Italy*. Parassitologia, 37(2-3): 105-108
[16] Verani P., Ciufolini M.G., Caciolli S., Renzi A., Nicoletti L., Sabatinelli G., Bartolozzi D., Volpi G., Amaducci L., Coluzzi M., Paci P., Balducci M. (1988), *Ecology of viruses isolated from sand flies in Italy and characterized of a new Phlebovirus (Arbia virus)*. Am. J. Trop. Med. Hyg., 38(2):433-439

agents carrying infections that can affect both cattle and humans. From this point of view, there are two kind of ticks of health relevance in Italy: the dog tick, *Rhipicephalus sanguineus*[17], and the forest tick, *Ixodes ricinus*[18], also called sheep tick. The increase of average temperature could have different impact for these two main vectors and on the incidence of the transmitted pathogen. *Tick Borne Encephalitis* (TBE) is caused by an arbovirus of the *Flaviviridae* family and is transmitted by ticks (mainly *Ixodes Ricinus*) that act both as vectors and virus reservoir[19]. In Italy, TBE exists in the region of Friuli Venezia Giulia which has already adopted a vaccination plan for the population at risk. The disease is more widespread in Europe, even if there are fewer cases than Lyme disease. Lyme Borreliosis is caused by an infection from Spirocheta, a bacterium (Borrelia burgdorferi) that is transmitted to humans through the bite of infected ticks of the *Ixodes* genus. The infection, of bacterial origin, mainly affects the skin, joints, nervous system and internal organs. Symptoms can sometimes be serious and persistent and if it is not treated with drugs it will become a chronic diseases. The Italian regions that are mainly affected are Friuli Venezia Giulia, Liguria, Veneto, Emilia Romagna and Trentino Alto Adige (Autonomous Province of Trento). Some sporadical cases have also been identified in the Central and Southern regions and the major Islands.
Milder winter temperatures, caused by climate change, could facilitate the geographical distribution of Lyme Borreliosis in higher altitudes and latitudes. In Europe, Lyme Borreliosis currently records at least 85,000 cases per year and has a growing impact in many countries such as Finland, Germany, Russia, Scotland, Slovenia and Sweden.
Although not all the listed vectors are potentially pathogen carriers (i.e. infected), epidemiological data indicate that the risk is increasing. This represent a public health issue related to the diffusion of certain infectious diseases and must therefore be faced through a systematic environmental preventive

A variation towards milder winter temperatures, caused by climate change, could favour the expansion of Lyme Borreliosis in the higher altitudes and latitudes.

[17] Vector of rickettsial diseases and in particular of *Rickettsia conorii*, the agent of Botonous fever
[18] This is the vector of the TBE virus, which is the agent of the so-called Tick Borne Encephalitis and of the *Borrelia burgdorferi* s.l., which is the agent of Lyme disease or Lyme Borreliosis
[19] Source: EECDC, 2009

Adjustment measures must provide specific environmental action.

activity aimed at controlling the natural populations of vector arthropods.

The spreading out of these populations is caused by very different environmental and social conditions (urban, rural and coastal environments; wetlands; natural protected areas; etc.), which therefore require specific knowledge and approaches. It is evident that any action aiming to the control of these arthropods population should include a detailed assessment of the specific local environmental conditon together with an assessment of the short and long term impacts both on existing species and biodiversity.

The arthropod vector management issue should therefore be included in management, conservation and protection of biodiversity programmes, approaching also local relevant human activities.

The main critical issues for a adequate risk management are:

- Geo-referenced and quantitative knowledge of both species and environmental infected reservoirs;
- Efficiency of eco-compatible biological methods for the vector control.

A priority objective in preventing vector-transmitted diseases, not only endemic but also newly introduced, is the assessment of the arthropod diffusion risk.

The achievement of this first objective requires:

- Identifying and locating vector arthropod populations, both autochthonous and allochthonous, involved in the transmission of plasmodes (Anopheline mosquitoes), leishmanias (Phelbotomes), arboviruses (tiger mosquito and ticks), filarials (tiger mosquito), rickettsias and bacteria (ticks);
- Constant monitoring of the dynamics of both vector species populations and possible reservoirs, with respect to the progress of climate events.

Environmental prevention

The identification and location of vector arthropod populations and their monitoring require the following working stages:

- Determination of the distribution and density of foci where arthropods with health relevance in the territory develop. This

is done by catching them with appropriate systems (there are different ones according to the considered vector species);
- Characterization and mapping of the vector species' distribution areals by GIS software, with respect to the epidemiology of the transmitted diseases;
- Identification of the transmission risk of pathogens carried by these arthropods by defining areas with highest risk;
- Assessing environmental, climatic and anthropic parameters that could activate their potential as vectors of pathogenic agents harmful to humans;
- Construction of local health risks maps taking in account the impact of climate change and weather events (floods, water shortage and overheating) on populations of different vector species. Such maps will be realized through statistical associations between data on the distribution and density of foci and environmental and climatic variables.

The mapping of foci where potential vectors of pathogens may develop is therefore a prevention tool both during emergency stages of events and in planning ad hoc measures.

The mapping of foci where potential vectors of pathogenic agents develop is therefore a prevention tool both during the emergency stage, the forecasting of events and in planningand adopting ad hoc measures.

The latter can be classified into short and long term actions.
Siggested short term action are:
- To assess the need of different measures according to different local environmental sites;
- To considere the strategies that need to be implemented, which should take into account risk maps, environmental protection, conservation of biodiversity and social factors;
- To implement focused action aimed to restraint vector populations by techniques based on previous assessment;
- To verify the efficiency of adopted measures;
- To monitor vector populations (by distribution and density) and possible pathogens in areas at risk.

Long term action includes:
- To plan strategies to control vectors within the framework of an integrated environmental management;
- Training environmental operators with adequate skills so that they can be involved in integrated monitoring programmes;
- Implementing an information programme for managers and citizens in order to spread information and processed results to

all relevant local stakeholders. Information programme can be also carried out in schools and training courses can be also organized.

Influence of climate change on water and food quality and availability

Food security

About the term "*food security*" is applied when all the people, at every time, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences in order to have an active and healthy life[20]. In order to achieve food security, all four components (i.e. availability, stability, accessibility and utilization) need to be satisfied.

The changes in climate conditions can affect food security acting on all components of the food system at global, national and local level.

The most frequent and intense extreme events (such as droughts, increase in sea level and irregular seasonal rainfall patterns) are already showing immediate impacts on food production, food distribution infrastructures, incidence of food emergencies, and food availability for survival and and health lives, both in rural and urban areas (Figure 6.5).

[20] FAO, *Climate Change And Food Security: A Framework Document*. Prepared by the Interdepartmental Working Group (IDWG) on Climate Change of FAO, 2007

Climate change can affect food security acting on all food security system components. More frequent and intense extreme events, such as droughts increase in sea level and irregular seasonal rainfall patterns, are already showing impacts on: food production, food distribution infrastructures; the increase of food emergencies; resource availability for survival and and health lives.

EFFECTS OF CLIMATE CHANGE TAHT ARE IMPORTANT FOR FOOD SECURITY

CO_2 FERTILIZATION EFFECTS
- Increase in availability of atmospheric carbon dioxide for plant growth

INCREASE IN GLOBAL MEAN TEMPERATURES
- Increase in maximum temperature on hot days
- Increase in minimum temperature on cold days
- Increase in annual occurrence of hot days
- Increase in frequency, duration and intensity of heat waves

GRADUAL CHANGES IN PRECIPITATION
- Increase in frequency, duration and intensity of dry spells and droughts
- Changes in timing, location and amounts of rain and snowfall

INCRREASE IN FREQUENCY AND INTENSITY OF EXTREME WEATHER EVENTS
- Increase in annual occurrence of high winds, heavy rains, storm surges and flash floods, often associated with tropical storms and tornados

GREATER WEATHER VARIABILITY
- Greater instability in seasonal weather patterns
- Change in start and end of growing seasons

RISE IN SEA LEVEL
- Inundation of human habitats
- Saltwater intrusions

Figure 6.5: Effects of climate change that are relevant for food security[21]

The impacts of temperature changes will probably include:
- Changes in the suitability of land for crops and livestock;
- Changes in the conditions and productivity of forests;
- Changes in the distribution, productivity and composition of sea resource communities;
- Changes in the incidence of vectors carrying various types of epidemics and diseases;
- Loss of biodiversity and of ecosystemic function of natural habitats;
- Changes in the distribution of good quality water for farming, cattle and fish culture production;
- Loss of arable land due to the increase in aridity and the saline intrusion for groundwater depletion and sea level increase;

[21] Source: FAO, 2007

- Changes in nurishment options;
- Changes in health risks;
- Internal and international population migration.

Wellbeing systems based on agriculture, which are already vulnerable to the risk induced by climate change, can experience an increase in harvest failures, loss of cattle and fish supplies, major shortage of water and destruction of productive resources. This includes small-scale farming systems rains-depending, systems based on cattle or sheep breeding, communities based on fishing and/or aquaculture (both coastal and inland) and systems based on forest resources.

The rural populations that are mainly at risk are those living along coastal areas, alluvial plains and low river deltas, the mountains and arid or arctic areas. Among these populations there will be probably an increase in the previously existing socio-economic disequalities worsening the nutritional status of women, children, elderly as well as people with chronic diseases and disabilities.

The causal chain through which weather variability and extreme events influence human nutrition is complex and involves different factors, such as: shortage of water; salinization of agricultural land; destruction of farm products due to floods; interruption of logistics due to disasters; increase in the incidence of plant infections and/or infestation.

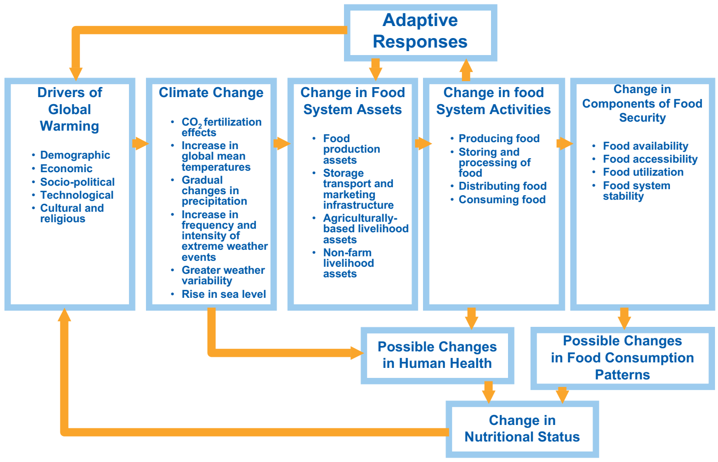

Figure 6.6: Complex interrelations between climate change and food security[22]

In temperate regions, moderate local increases in the mean temperature (from 1 to 3°C), together with the associated increase of CO_2 and changes in precipitation, could have modest beneficial impacts on farming, including wheat, maize and rice. On the

[22] Source: FAO, 2007

other hand, global warming and increase in the frequency of heat waves and droughts in the Mediterranean (which will lead to an increase in semiarid and arid pastures) will cause a reduction in cattle productivity[23].

The causal chain through which weather variability and extreme events influence human nutrition is complex and involves different factors, such as, shortage of water, salinization of agricultural land, destruction of farm products by floods, interruption of logistics caused by disasters, increase in the incidence of plant infections and/or infestations[24]. Adaptation strategies must be focused on each factor and interrelated.

Food safety

Food safety is a scientific discipline describing management, preparation, and storage of food in order to prevent foodborne diseases. These can be caused either by pathogenic agents (viruses, bacteria or prions) that contaminate food, or by environmental toxins.

Climate change together with the way in which food is produced, distributed and consumed, can potentially influence food infections in the next century.

A statistical association between diseases and temperature changes in the short term also suggests that foodborne illnesses shall be influenced by climate change in the long term[25].

Cases of fooborne diseases can be associated to extreme climate events since rain andfloods can favour the spread of pathogens. For example, fresh fruit and vegetables can be contaminated by waterborne pathogens such as the protozoes *Cyclospora* and *Cryptosporidium spp*. Shellfish can also be contaminated by enteric bacteria and viruses that can survive to water treatment plants,

Climate changes together with the way in which food is produced, distributed and consumed, can potentially influence food borne diseases in the next century.

[23] APAT - WHO, 2007. *Cambiamenti Climatici ed Eventi Estremi: Rischi per la salute in Italia*

[24] IPCC, 2007: *Climate Change 2007: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change* [Parry, Martin L., Canziani, Osvaldo F., Palutikof, Jean P., van der Linden, Paul J., and Hanson, Clair E. (eds.)]. Cambridge University Press, Cambridge, United Kingdom, 1000 pp

[25] Hall G.V., D'Souza R.M., Kirk M.D. (2002). *Foodborne disease in the new millennium: out of the frying pan and into the fire?* MJA, 177: 614-618

especially if there is a contaminated overflow that occur during floods.

Cases of food poisoning can also be related to meteorological conditions of unexpected heat that can increase bacterial replication. For example, more cases of food poisoning were reported during unusually hot summers both in the UK and in Australia. In general, salmonellosis increase by 5-10% for every 1-degree increase in weekly temperatures, for average temperatures above 5 degrees (Figure 6.7).

Cases of salmonellosis increase by 5-10% for every 1 degree increase in weekly temperatures, for average temperatures above 5 degrees.

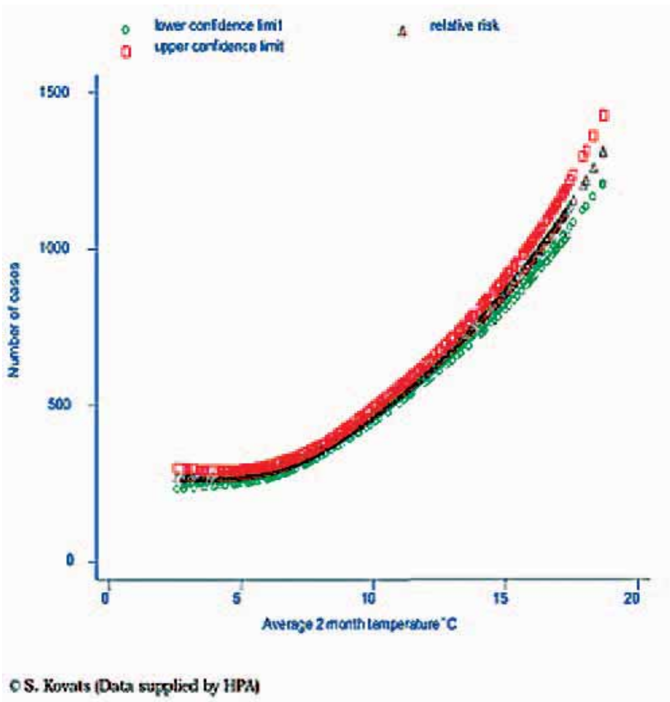

Figure 6.7: Association between cases of salmonellosis and increase in temperature[26]

[26] Source: *Health Effects of Climate Change in UK*, 2008

About one third of salmonellosis transmission cases in England, Wales, Poland, Netherlands, Czech Republic, Switzerland and Spain can be caused by temperature changes. The effect of temperature is more evident one week before the disease, highlighting the importance both of inadequate food preparation and of its storage. Indeed, both the lack of hygiene and the poor control of the temperature during the production, processing, transport, preparation and conservation of food can interact enabling the proliferation of pathogens.
Epidemics caused by waterborne pathogens have been connected to extreme climate events, whose frequency is expected to increase in the decades to come. Furthermore, many cases of gastroenteritis caused by waterborne and foodborne pathogens (especially diseases caused by salmonella and *Campylobacter*) show distinct summer recurrence patterns. Although behaviour patterns could be related to seasons (e.g. preparing barbecues or swimming in the summer) the association between hotter temperatures and diseases highlights that the rate of waterborne and foodborne diseases increases as temperatures rise[27].
In the CASHh report (Climate Change and Adaptation Strategies for Human Health in Europe) epidemiological studies were conducted to describe and quantify the effect that temperature has on foodborne diseases. Data provided by observation laboratories in different European countries confirmed the presence of salmonella (Italy did not participate in the study).
Microscopic filamentous fungi can develop on a large variety of plants and can lead to the production of highly toxic chemical substances, commonly called mycotoxins[28]. The most widespread and studied mycotoxins are metabolites of some types of mould such as *Aspergillus, Penicillium* and *Fusarium*. Contamination caused by fungi can take place during almost all the stages of the food chain (harvesting, storage and transport). Fungi colonization and diffusion are favoured by environmental conditions and

[27] Greer A., Ng V., Fisman D. (2008). *Climate chage and infectious diseases in North America: the road ahead. CMJA*, 178(6)
[28] Toxins, originating from fungi and miceti, can produce mycotoxins poisoning by food consumption

nutritional components, as well as other factors such as infestation by insects or weeds. The biosynthesis of mycotoxins is influenced by quite unique conditions, such as: climate and the geographical location of the cultivated plants,farming practices, storage and types of substratum.

For the moment we can only make forecasts on the basis of acquired knowledge about the key environmental conditions favouring main fungi and/or toxins.

So far we can only make forecasts on the basis of acquired knowledge about key environmental conditions favouring main fungi and/or toxins production. For example, an increase in contamination from *Aspergillus flavus* could be particularly relevant for maize, which is the main crop in Italy affected by these toxins. Indeed, in 2003 there was an unusual peak in maize contamination by aflatoxins due to high temperature and extreme drought. Tons of maize got destroyed due to the presence in food and animal feed of an unacceptable level of these toxins. Fortunately, the impact on human and animal health was minimized thanks to the rapid alert system managed by control authorities. The optimum temperature for the development of toxins a range between 15 and 30 °C. The production of fumonisins has been associated to the dry climate during the grain filling period and the late seasonal rains, so the climate changes that are expected to take place in Italy probably will help the production of toxins.

Climate change can influence insects' capacity to affect plants, altering their ability to tolerate winter, their distribution on farming land and insect varieties.

Climate change can influence insects' capacity to affect plants, altering their ability to survive winter season, as well as their distribution on farming land and insect varieties. We have very little examples of interrelations existing between fungi/mycotoxins and insect attacks on agricultural plants. In almonds and pistachios, high contamination by aflatoxins is associated to damages deriving from larvae of Navel orange worm, while high levels of aflatoxins in maize are almost always associated to damages due to insects, particularly by European corn borer, *Ostrinia nubilalis* (meal moth). Contact between food and infestant species (especially flies, rodents and cockroaches) is temperature sensitive. The activity of flies is mainly influenced by temperature rather than by biotic factors. It is probable that in temperate countries, which have warmer climate conditions and milder winters, the quantity of flies and other infestant species will increase during the summer months, with an early appearance of infestants in spring.
H*armful Algal Blooms* (HABs), which produce toxins, can also

cause human diseases through the consumption of contaminated shellfish. Seawater warming can therefore contribute to the increase of contaminated shellfish or coastal fish, leading to a growth in the distribution of diseases such as ciguatera, an intoxication caused by ciguatoxin (toxin produced especially by *Gambierdiscus toxicus* microalgae).
Vibrio parahaemolyticus and *Vibrio vulnificus* are responsible for no viral infections related to fish consumption in USA, Japan and South East Asia. Their abundance depends on coastal waters salinity and temperature . In 2004, a significant outbreak due to the consumption of oysters contaminated by *V. parahaemolyticus* occurred, which was related to the presence of unusually high temperatures in the coastal waters of Alaska.
The chemical security of waters and food during long periods of drought is also worth it to be considered. A higher concentration of chemical pollutants in waters used for human consumption is forecasted (since a water shortage is followed by a poor dilution effect). Furthermore, increase of plants infestation and temperature lead to both a higher use of pesticides (which degradation is increased by higher temperatures) and a more frequent utilization of new synthesized molecules.

The environmental controls network and the management of biological and chemical contamination

The mitigation of health risk scenarios to prevent contamination of water and food must keep into account new emerging health risks.
The adaptation strategy must on one hand revise environmental control and monitoring protocols and, on the other hand, promote specific action on different determinants such as agricultural practices and the performance of water services (i.e. safer management of water provision, water treatment and sewage services). Their performance is extremely vulnerable during floods, droughts and temperature increases, contributing to increase microbiological and chemical pollutant load in water bodies and soil, also compromising the burdensome water management and protection policies.
The technological and management challenges imposed by climate

The adaptation strategy must on the onehand revise environmental control and monitoring protocols and, on the other hand, promote specific action on different determinants such as agricultural practices and performance of water services, water treatment and sewage services. Technological and

management challenges are: guaranteeing the functioning of existing structures; eliminating management failures of inefficient ones; planning the safe use of new water sources in case of drought; preventing the unavailability of acceptable water quality during flood emergencies.

change: to protect optimal functioning of existing structures; to eliminate management failures of inefficient ones; to plan safe use of new water sources in case of drought or contaminated groundwater; to prevent the unavailability of safe water quality during flood emergencies.
In this regard, ISPRA chairs the international *Task Force on Extreme Weather Events*[29] which, through integrated adaptation measures (involving environmental operators, health services and network managers), has the duty of developing guidelines for the management of the new major environmental risks in order to protect health by improving the performance of water and sewage services during extreme climate events. The draft guidelines[30] are already available on the web site:
http://www.unece.org/env/water/meetings/documents_TFEWE.htm

Climate change, airborne pollens and fungal spores

Climate change has caused an anticipation of the spring pollen season in the Nothern hemisphere. It is therefore reasonable to believe that allergies from pollens (such as allergic rhinitis) have a concomitant seasonal variation.

Climate change has a significant impact on airborne pollens, as reported in the fourth Report of the Intergovernmental Panel on Climate Change (IPCC) WG II.
Climate change has caused an anticipation of spring pollen season in the Nothern hemisphere[31]. It is therefore reasonable believe that allergies from pollens, such as allergic rhinitis, will have a concomitant seasonal variation[32].
While there is a wider presence of some species of pollens, it is still not clear whether even the allergenic content of these pollens has changed, a phenomenon that would surely have important

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[29] The Task Force was inserted in the working programme 2007-2009 of the Water and Health Protocol at the UNO-ECE Convention on Water. Our Ministry for the Environment holds the leadership and ISPRA chairs the Task Force
[30] UNO-ECE Guidelines on Water Supply and Sanitation in Extremes
[31] D'Amato G., Liccardi G., D'Amato M., Cazzola M. (2002).*Outdoor air pollution, climatic changes and allergic bronchial asthma*. Eur. Respir. J., 20: 763-776
[32] Burr M.L., Emberlin J.C., Treu R., Cheng S., Pearce N.E. - ISAAC Phase One Study Group. (2003). *Pollen counts in relation to the prevalence of allergic rhinoconjunctivitis, asthma and atopic eczema in the International Study of Asthma and Allergies in Childhoo*d (ISAAC). Clin. Exp. Allergy, 33(12): 1675-1680

effects on the exposed people[33]. Some studies also show an increase in the exposure to fungi spores and bacteria[34].

Changes in the spatial distribution of natural authoctonous species[35], as well as the introduction of new allergenic species, increase the sensitization of genetically prone individuals. The appearance of new invasive plants (such as Ambrosia) is an important allergy risk for the population living in parts of the world where these plants have raised their distribution[36]. For instance, many laboratory studies show that increase in both CO_2 and the temperature produces a greater quantity of Ambrosia pollen and extends the pollen season, also increasing some plant metabolites that can have a negative impact on health[37].

These changes particularly affect species that bloom in late winter and spring.

Many specific studies have actually highlighted in the last few years a growing anticipation in the blooming period of many allergenic plant species and families, such as Birch[38], *Compositae*[39], *Urticaceae*[40],

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[33] Beggs P.J. and Bambrick H.J. (2005), *Is the global rise of asthma an early impact of anthropogenic climate change?* Environ. Health Persp., 113: 915-919

[34] Harrison R.M., Jones A.M., Biggins P.D., Pomeroy N., Cox C.S., Kidd S.P., Hobman J.L., Brown N.L., Beswick A. (2005), *Climate factors influencing bacterial count in background air samples*. Int. J. Biometereol., 49: 167-178

[35] Cecchi. L., Morabito M., Domeneghetti M.P., Crisci A., Onorari M., Orlandini S. (2006), *Long-distance transport of ragweed pollen as potential cause of allergy in central Italy*. Ann. Allergy Asthma Immunol., 96(1); 86-91

[36] Taramarcaz P., Lambelet B., Clot B., Keimer C., Hauser C. (2005), *Ragweed (Ambrosia) progression and its health risks : will Switzerland resist this invasion*? Swiss Med. Wkly., 135: 538-548

[37] Rogers C., Wayne P., Macklin E., et al (2006*), Interaction of the onset of spring and elevated atmospheric CO_2 on ragweed (Ambrosia artemisiifolia L.) pollen production.* Environ. Health Persp.,114:865-869. Mohan J.E., Ziska L.H., Schlesinger W.H., Thomas et al (2006), *Biomass and toxicity responses of poison ivy (Toxicodendron radicans) to elevated atmospheric CO_2*. Proc. Natl. Acad. Sci. USA, 103: 9086-9089

[38] Van Vliet A.J.H., Overeem A., De Groot R.S., Jacobs A.F.G., Spieksma F.T.M., (2002). *The influence of temperature and climatic change on the timing of pollen release in the Netherlands*. Int. J. Climatol., 22: 1757-1767

[39] Stach A., Garcia-Mozo H., Prieto-Baena J.C., Czarnecka-Operacz M., Jenerowicz D., Silny W., Galan C. (2007), *Prevalence of Artemisia species pollinosis in western Poland: impact of climate change on aerobiological trends, 1995-2004*. J. Investig. Allergol. Clin. Immunol., 17(1): 39-47

[40] Frenguelli G., *Interactions between climatic changes and allergenic plants.* Monaldi Arch. Chest. Dis., 2002, 57(2): 141-143

Graminaceae[41], *Juniperus ashei*[42] and *Cryptomeria japonica*[43].
Studies highlighting increases both in the concentration and persistence of fungal spores in the atmosphere are also very interesting[44] (PTCP Ravenna, 2006). Some fungal spores (Alternaria, Epicocco, *Cladosporium, Aspergillus, Penicillum*, etc.) can not only cause allergic manifestations but also be responsible for plant diseases, thus requiring the use of additional chemical treatments that will increase the contamination risk of food and farm products for human consumption. Outdoor fungal spores can also penetrate into indoor environments and (due to the favourable temperature and humidity conditions) can reproduce throughout the whole year.
Climate change can also modify the dispersion of plant pathogen (bacteria, fungi and parasites), making some stressed hosts more prone to attacks from new pathogens.
In terms of impact, airborne pollens of some plants can be responsible for the occurrence of allergic diseases, known as pollinosis[45]. These pathologies generate high social costs, both direct (pharmaceutical expenses, health assistance expenses, loss of working days, etc.) and indirect (loss of the patient's and his family's productivity, loss of school days, etc.). It has been calculated that at least 7-8% of Italian population suffers from clinical manifestations of pollinosis. Pollinosis is more frequent in the second and third decades of life, without significant differences between the two genders. A comorbility between rhinitis and asthma is frequently found (40-80% of patients suffering from asthma have rhinitis and 20-40% of rhinitis sufferers also have asthma). These

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[41] Burr M.L., Emberlin J.C., Treu R., Cheng S., Pearce N.E. - ISAAC Phase One Study Group. (2003). *Pollen counts in relation to the prevalence of allergic rhinoconjunctivitis, asthma and atopic eczema in the International Study of Asthma and Allergies in Childhood (ISAAC).* Clin. Exp. Allergy, 33(12): 1675-1680
[42] Levetin E. (2001). *Effects of climate change on airborne pollen.* J. Allergy Clin. Immunol., S107:S172
[43] Teranishi H., Katoh T., Kenda Y., Hayashi S. (2006). *Global warming and the earlier start of the Japanese-cedar (Cryptomeria japonica) pollen season in Toyama*, Japan. Aerobiologia, 22(2): 90-94
[44] Ariano R., Bonifazi F. (2006). *Aerobiologia ed allergeni stagionali.* ECIG
[45] Pollinosis is the most common allergopathy. It includes all clinical manifestations (eye, nose and lung) that occur in people who have become sensitive to pollens of some families of plants or trees

pathologies are supported by a common inflammation process of the respiratory system. Climate change also influences the quality of air, changing its composition (ozone, particulate matter, etc.) and therefore infuencing possible interactions with pollens and/or allergies[46]. Major climate variations produce an increaseof pollens and fungal spores that together with variations in the quality of air (in terms of ozone, other gases and PM), will amplify the negative influences on the functionality of the respiratory and cardio-circulatory system.
It is generally known that air pollution, and the Western life style are responsible for the increase in both allergic respiratory failures and cases of bronchial asthma. Many studies report a higher incidence of allergies in the urban population with respect to the rural one[47].
Experimental studies show that some pollutants interact with allergens inhaled with pollinic microgranules, causing a higher sensitization in allergic individuals and an exacerbation of symptoms[48].
Furthermore, exposure to pollutants seems to reduce mucociliary clearance, increase oxidation stress and stimulate the production of proinflammatory cytokines favouring allergens inhalation[49]. Indeed, in Mediterranean urban areas of the there are not only pollutants, such as (NO_2, PM_{10} and $PM_{2,5}$) but also high concentrations of ozone (O_3), which is a significant irritant for respiratory system. High concentrations of this pollutant are indeed, associated with an increase in asthma attacks, since ozone raises the levels of inflammatory cells and of proinflam-

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[46] The case of Atlanta is well-known, when during the 17 days of the Olympics in 1996 the traffic blockage caused a significant reduction in the ozone levels and of asthmatic cases in children (Friedman et al., 2001)

[47] D'Amato G. (2000), *Urban air pollution and plant-derived respiratory allergy*. Clin. Exp. Allergy, 30: 628-636 14. Ishizaki T., Koizumi K., Ikemori R., Ishiyama Y., Kushibiki E. (1987) *Studies of prevalence of Japanese cedar pollinosis among residents in a densely cultivated area.* Ann. Allergy, 58: 265-270

[48] Namork E., Johansen B.V., Løvik M. (2006), *Detection of allergens adsorbed to ambient air particles collected in four European cities*. Toxicol. Lett., 165(1): 71-78

[49] D'Amato G., Cecchi L., Bonini S., Nunes C., Annesi-Maesano I., Behrendt H., Liccardi G., Popov T., Van Cauwenberge P. (2007), *Allergenic pollen and pollen allergy in Europe*. Allergy, 62: 976–990

Various epidemiological studies (also conducted in Italy) show that the prevalence of allergic respiratory diseases has considerably increased all over the world in the past decades.

matory mediators in asthmatic patients[50].
Several epidemiological studies[51,52] (also conducted in Italy) show that the prevalence[53] of allergic respiratory diseases has considerably increased all over the world in the past decades. Studies conducted by the American College of Allergy in 2002 show that 15-20% of the population in the United States suffers from allergies and that in most cases the first symptoms appear at schoolgoing ages. Even in Europe, more than 20% of students suffer from allergies and the most common clinical manifestations are atopic dermatitis, rhinitis and hay fever. Asthma must be considered as the main clinical manifestation for its severity , long-term effects and mortality[54].

The Italian Study in Young Adults (ISAAC study) found a strong connection between climate and asthma. An increase in the prevalence of asthma is found where temperature range is smaller and where annual mean temperature is higher.

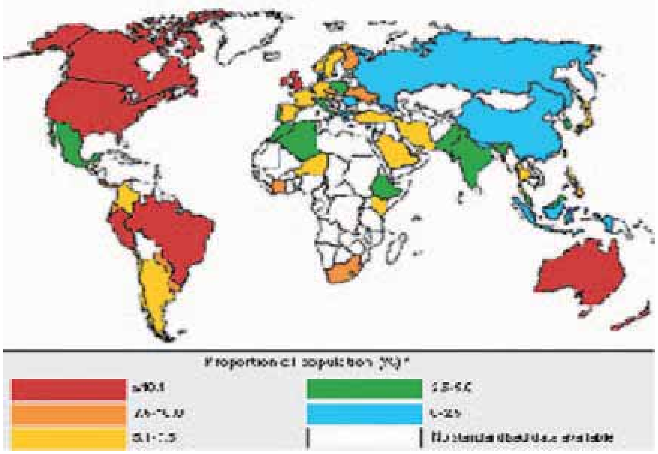

Figure 6.8: Global map of the clinical prevalence of asthma[55]

[50] Bayram H., Sapsford R.J., Abdelaziz M.M., Khair O.A. (2001), *Effect of ozone and nitrogen dioxide on the release of proinfiammatory mediators from bronchial epithelial cells on nonatopic, nonasthmatic subjects and atopic asthmatic patients in vitro.* J. Allergy Clin. Immunol., 107: 287–294
[51] ECRHS (1996), *Variations in the prevalence of respiratory symptoms, self reported asthma attacks and use of asthma medication in the European Community Respiratory Health Survey (ECRHS).* Eur. Respir. J., 9(4): 687-695
[52] ISAAC (1998), *Worldwide variation in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis and atopic eczema.* Lancet, 351: 1225-1232
[53] Prevalence: this measures the number of individuals of a population who, at a given moment, are affected by the disease. This indicator is calculated in relationship to the total number of cases of the disease and the population at risk.
[54] Strachan D., Sibbald B., Weiland Set al (1997), *Worldwide variations in prevalence of symptoms of allergic rhinoconjunctivitis in children: the International Study of Asthma and Allergies in Childhood (ISAAC).* Pediatr. Allergy Immunol., 8(4): 161-176
[55] Source: Masoli M, Fabian D, Holth S., *Global Burden of Asthma*; GINA

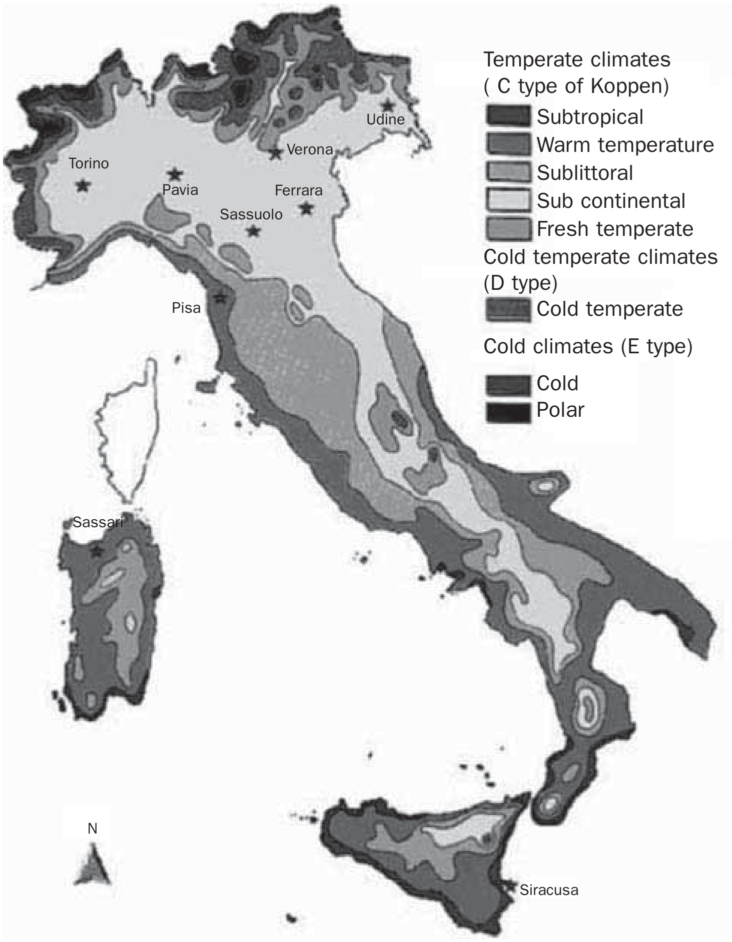

Figure 6.9: Association between climate and asthma[56]

In Italy pollen allergy is estimated to represent about 40% of allergic diseases but it shows an high local variability as summarized in the table below:

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[56] Source: Zanolin, E., Pattaro, C., Corsico, A. *et al.*, *The Role of climate on the geographic variability of asthma, allergic rhinitis and respiratory symptoms: results from the Italian study of asthma in young adults.* Allergy, Vol. *59 (3)*

In Italy pollen allergy is estimated to represent about 40% of allergic diseases but it shows an high local variability as summarized in the tableIn Italy. The different territorial distribution of plants that produce pollens can partially explain the strong sensitization differences in the different regions of Italy.

Table 6.1: Prevalence of pollinosis in Italy[57]

Pollen	North	Centre	South, Islands and Liguria
	% prevalence		
Graminaceae	75	60	40
Urticaceae (Pellitory)	30	40	60
Compositae (Artemisia)	25	15	10
Ambrosia	30	7	2
Chenopodiaceae	1	2	14
Plantaginaceae (Plantago)	4	4	9
Birch	33	13	5
Alder	36	8	7
Hornbeam	34	26	4
Hazel	34	16	4
Cupressaceae	9	28	20
Olea	5	10	25
Fagaceae	7	15	10

The different territorial distribution of plants that produce pollens can partially explain the strong differences in population sensitization in the different regions of Italy. On the basis of these considerations we can state that the expected areal variations of allergenic species can also determine a variation in the prevalence of the various allergies.

Cases of pollinosis are increasing among the European population.

Cases of pollinosis have increased among the European population too, as emerges from many researches conducted in the last few years [56, 58].

This phenomenon can be explained by various factors, such as a more accurate diagnosis and the introduction of new allergens in the diagnostic panels of routine allergological tests. Even improvement of diagnostic techniques and new scientific evidence are phenomena that may have contributed to identifying a growing number of allergic patients. Some manifestations have only recently been identified as pollinosis. For example, twenty years ago pollen allergy from cypress was considered a “minor pollinosis” while

[57] Source: *Aerobiologia ed allergeni stagionali* Ariano e Bonifazi (2006) data processed by ISPRA

Note: Prevalence is the number of individuals of a population who, at a given moment, are affected by the disease. This indicator is calculated in relationship to the total number of cases of the disease and the population at risk

[58] D’Amato G., Spieksma F.T., Liccardi G., *et al.* (1998), *Pollen-related allergy in Europe*. Allergy, 53(6): 567-578

currently it is the third cause of pollinosis in central Italy.
Even sensitization to fungal spores has a fairly high prevalence in the allergic population, even if this can vary from region to region. An European study highlights an average prevalence of 9.46% of sensitization to Alternaria and Cladosporium, with a variability ranging from the 3% observed in Portugal to the 20% observed in Spain. In an Italian study on Alternaria, instead, while the global prevalence is of 10.5% the observed prevalence ranged from 1.8%, observed in Turin to 29.3% observed in Cagliari[59].
As described above, the importance of pollen allergy is related to the duration and intensity of pollen seasons, the frequency and concentration reached during peaks and the quantity of allergens. On these determinants, temperature variations and rainfall changes could alter the duration and the beginning of the growth season of pollinator plants. the duration of the pollen season in Europe has shown an average increase of 10–11 days in the last 30 years[56].
Many studies show that early blooms are related to the species' behaviour. Indeed, annual species anticipate budding more than perennial ones and those pollinated by insects anticipate it more than those pollinated by wind. In general, early blooming and the peak season of pollens are more pronounced in species that bloom in the early months of the year.
It has been highlighted that climate change can facilitate the dispersion and colonization of species of different plants in new geographical areas[56]. Many international experimental studies show the existence of a relationship between climate change and physiological and biological plant processes. This relationship is sometimes clearly manifested bymigrations of plant species both in altitude and longitude[60]. Infact, in a longer time span, climate change can facilitate the geographical distribution of some plant species in new areas that become climatically suitable. For example, forest species can

As described above, the importance of pollen allergy is related to the duration and intensity of pollen seasons, the frequency and concentration reached during peaks and the quantity of allergens. In this point of view, temperature variations and rainfall changes could alter the duration and the beginning of the growth season of pollinator plants.

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[59] Corsico R., Cinti B., Feliziani V., et al (1998) *Prevalence of sensitization to Alternaria in allergic patients in Italy.* Ann. Allergy Asthma Immunol., 80(1): 71-76
[60] APAT – Agenzia per la protezione dell'ambiente e per i servizi tecnici. (2003). Le relazioni tra cambiamenti del clima ed ecosistemi vegetali. Rapporti APAT 32/2003. http://www.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Rapporti/Documento/rapporti_2003_32.html

The variation of wind regimes can have important consequences on airborne pollens and therefore on the exposed population. Indeed, wind is responsible for long distance pollen transport, which can be moved also to regions where there aren't plants producing pollens.

move to higher altitudes and/or Northern latitudes. These variations can create new allergies or increase sensitization in population of different geographical areas. For example, the transfer of olive tree cultivation to Northern regions could change the prevalence of olive pollen sensitization in Northern Italy.
Climate change also involves other aspects, such as variation of wind regimes. This could have important consequences on airborne pollens and therefore on the exposed population. Indeed, wind is responsible for long distance pollen transport, which can be moved also to regions where there aren't plants producing pollen. Some researchers believe that the expected variation in wind regimes, related to the current climate change, can have important consequences on these phenomena and ultimately cause the presence of new pollens (and new allergic manifestations) in many Italian regions[61].

The expected increase in extreme events such as storms can have consequences on allergic manifestations. Thunderstorms, when pollens and spores are in the air or even deposited on the ground, have been identified as causes of sudden allergic crisis deriving from the sudden release of large quantities of paucimicronic allergenic particles caused by the breakage of pollens and fungal spores by osmotic shock during the storm. The phenomenon, known as *"thunderstorm asthma"*, was found by several researchers in some Countries such as England[62], Australia[63] and Italy[64].

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[61] Cecchi. L., Morabito M., Domeneghetti M.P., Crisci A., Onorari M., Orlandini S. (2006), *Long-distance transport of ragweed pollen as potential cause of allergy in central Italy*. Ann. Allergy Asthma Immunol., 96(1); 86-91
Zauli D., Tiberio D., Grassi A., Ballardini G. (2006), *Ragweed pollen travels long distance. Allergy Asthma Immunol.,* 97: 122-123
[62] Davidson A.C., Emberlin J., Cook A.D., Venables K.M. (1996), *A major outbreak of asthma associated with a thunderstorm: experience of accident and emergency departments and patients characteristics.* BMJ, 312: 601-604
[63] Girgis S.T., Marks G.B., Downs S.H., Kolbe A., Car G.N., Paton R. (2000), *Thunderstorm-associated asthma in an inland town in southeastern Australia. Who is at risk?* Eur. Resp. J. 16: 3-8
[64] D'Amato G., Liccardi G., Viegi G., Baldacci S. (2005), Thunderstorm-associated asthma in pollinosis patients. BMJ, http://bmj.bmjjournals.com/cgi/eletters/309/6947/131/c

As explained above, the effects of climate change and, in particular, temperature increase create optimal conditions for the growth and diffusion of fungal spores in the air, which will be released for longer periods in the atmosphere increasing the sensitization risk in the population and/or the occurrence of plant diseases.

Environmental prevention: What do we know? What should we do?

Is is necessary to strengthen local knowledge, implementing aerobiological monitoring of pollens and integrating it with a fungal spore monitoring system. In general, there are two ways of collecting information on pollens and airborne fungal spores in a territory:

- Specific environmental monitoring (aerobiological monitoring);
- Census/mapping of the existing species, including their characterization in terms of significant requirements for health.

In Italy, a project entitled *Rete nazionale di monitoraggio dei pollini e delle spore fungine di interesse allergenico, agronomico e ambientale* (National monitoring network of pollens and fungal spores of allergenic, agronomic and environmental interest - RIMA) is currently running. It is promoted by ISPRA and regional environmental protection Agencies network (ARPA/APPA), in collaboration with the Associazione Italiana di Aerobiologia (Italian Aerobiology Association - AIA), which collects the results of aerobiological monitoring activities carried out in Italy and disseminate information through shared channels. However, monitoring activities do not adequately cover the national territory and there is a poor identification of spores[65]. It is therefore necessary to extend the monitoring network not only by activating pollen and fungal spore sample stations in strategic and priority positions identified according to specific characteristics (plant coverage, territorial utilization, climate zones, etc.), but also using forecast models of airborne biological particles diffusion.

The informations on airborne fungal spores obtained through the network not only prevents their negative effects on health, but are also useful in controlling cryptogamic diseases, preparing

It is necessary to strengthen local knowledge, implementing aerobiological monitoring of pollens and integrating it with a fungal spore monitoring system.

[65] For example, the National Agency's system has at least eight Agencies that map pollens and some species of fungal spores

specific treatments for crops, protecting the environment (air, soil and groundwater) and improving both producers' and consumers' health at the same time.
It would also be useful to define and realize a mapping of urban green able to provide useful information(harmfulness, allergenicity, etc.) on plants existing in public areas such as leasure parks, school garden in order to protect citizens' health.
The awareness of operators working in this sector (such as family doctors, public park employees, etc) and of population should also be increased by means of training courses and information spreading obtained from the integrated management of monitoring networks. This would involve data dissemination during critical seasonal pollinosis periods and the activation of preventive alarm systems identifying the presence of pollens, to be combined with alerts on air pollutants and integrated with aerobiological and local meteorological forecasts.

Conclusions

Health risks and climate change are a well known issue in scientific literature and are widely reported and documented in various national and international government report and assessments.
The management of emerging risks related to new meteo-climatic scenarios can be faced by depicting specific responsibilities to the single sector that influence environmental determinants of health.
But adaptation actions must, in any case, be integrated together, otherwise the adopted measures will be inefficient to control risksand adverse health effects not compatible with a healthy sustainable development.

CHAPTER 7

ENVIRONMENTAL RISK

NATURAL RISK

ANTHROPOGENIC RISK

The definition of environmental risk must take into account the interaction between risks of natural origin and anthropogenic risks, as regards the vulnerability and value of the resource exposed to danger.

The seismic risk and the hydro-geological risk have been the most recurrent in Italy, in the period 2008-2009.

Natural events can be either of exogenous or endogenous origin.

Introduction

The human species has always been exposed to a large number of dangers caused by natural events, such as volcanic eruptions, earthquakes, tidal waves, floods, drought, landslides, etc. Given the massive human interventions in the environment, it is difficult, or even impossible, today, to distinguish between risks of natural origin and anthropogenic risks. Moreover, on the one hand, the development of new and powerful technologies applied to the production of energy, goods and services has considerably improved the quality of our life. On the other hand, new sources of so far unknown hazards have emerged.
The definition of environmental risk must therefore take into account the interaction between such risks, as regards the vulnerability and value of the resource exposed to danger, In fact, the risk (R) is the product of the following three parameters: $R = P * V * E$, where P indicates the hazard level, that is the probability that a given event will occur at a given magnitude in a given area and within a certain interval of time, V indicates vulnerability, that is the liability of a resource exposed to suffer a damage as a consequence of given calamitous event, and E indicates the exposure, that is the value of the full set of elements at risk inside of the exposed area. Risk is expressed in terms of economic value of the potential risk for human lives, infrastructures, historic, architectonic, cultural and environmental resources.
For reasons of clarity, in the present chapter the risk of natural origin is treated separately from anthropogenic risk. Among the risks of natural origin, it has been decided to address the topics of seismic risk and hydro-geological risk, which have been the most recurring events, in Italy, in the period 2008-2009.
It should be noted that the components of natural risk addressed herein directly involve the geo-sphere, while the components of anthropogenic risk regard industrial activity.

NATURAL RISK

Natural events that are likely to give rise to conditions of risk can be subdivided into two main categories of underlying causes: events of endogenous origin (including for instance volcanic eruptions, earthquakes, etc.), set off by forces within the earth, and

those of exogenous origin (including floods, landslides, avalanches, etc.), occurring on the terrestrial surface. The magnitude and frequency of such events may range within a wide scale. Certain phenomena tend to occur in a sudden and extreme way, while others operate more slowly and continuously (subsidence is a typical example). Both types of events are likely to cause serious damages on man and human interests and activities.
The concept of natural risk should, therefore, be understood as an interaction between the processes of instability that "naturally" occur in the territory remodelling its shape, and human assets, whether physical or economic, social or environmental. The interaction between the natural events referred to above and anthropic activities is reciprocal: inappropriate modes of use and management of the territory frequently result in an amplification of disturbances underway or in the triggering of new ones.

An inappropriate use of the territory by man may amplify disturbances underway or trigger new ones.

Seismic risk

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 Apennine chain, opening of the Tyrrhenian basin) make Italy one of the countries facing the greatest seismic danger. A similar level of hazard, combined with the widespread presence of exposed elements (urban centres, infrastructures, and the architectonic, artistic and environmental heritage), and the noteworthy vulnerability of the same, creates conditions of high to very high risk for extensive sectors of Italian territory. The areas facing the greatest seismic risk 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 7.1).

Italy faces one of highest levels of seismic hazard of any European country.

The areas facing the greatest seismic risk are found in the Friuli area along the central-southern spine of the Apennine range, along the Calabrian edge of the Tyrrhenian and in Southeast Sicily.

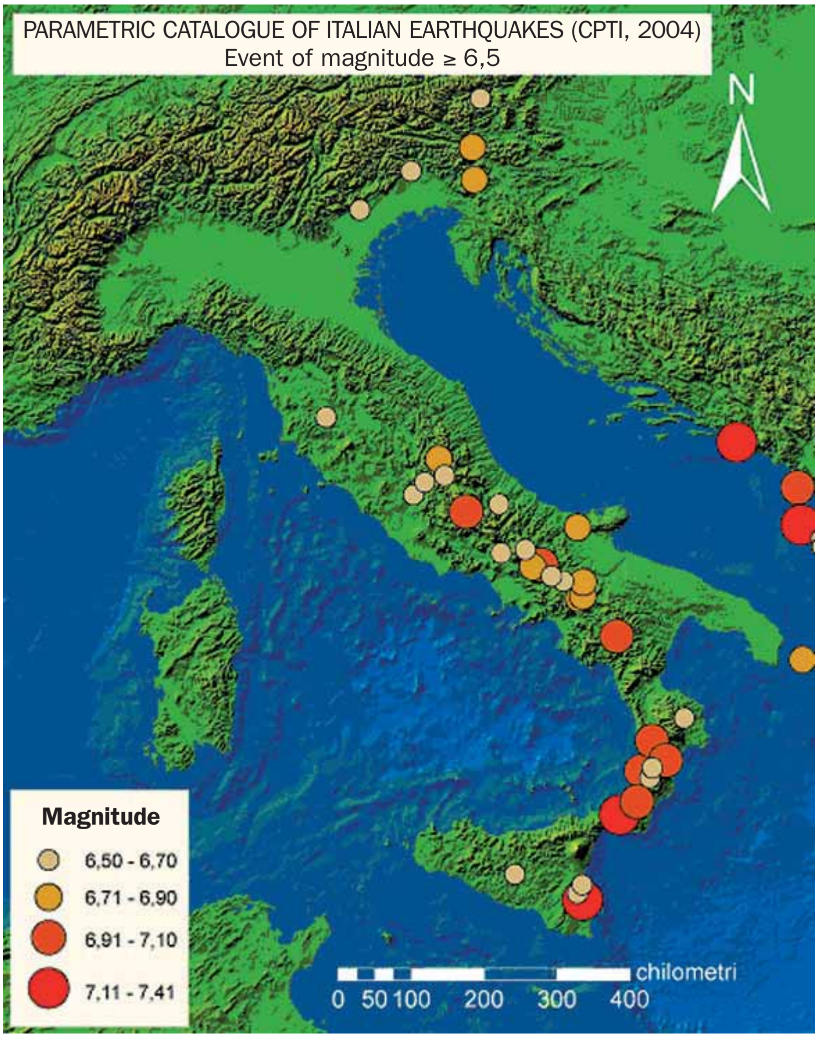

Figure 7.1: Distribution throughout the national territory of the major seismic events of the past (magnitude≥ 6.5)[1]

Seismic events of local magnitude (ML) greater than 2, occurred on the national territory from January 1st 2008 to September 30th 2009, are shown in Figure 7.2. The figure also shows the main characteristics of earthquakes of local magnitude ML >5. In 2008, only three events exceeded such threshold: one occurred not far from the Calabrian coast, with a noteworthy depth of the epicentre,

[1] Source: Parametic Catalogue of Italian Earthquakes – INGV data processed by ISPRA

which caused no significant damage; two other events occurred in the Frignano area, where they caused damages to some bell towers, churches, and some structures, toppling chimneys and eaves. No damages to people were registered.
In 2009, the most significant events occurred in the area of L'Aquila. The seismic event of April 6th of ML = 5.8 and Mw = 6.3, caused 300 victims and serious damages to buildings, as well as to the artistic and cultural heritage. More than 50 municipalities in the Abruzzi have suffered damages that have rendered part of the buildings unfit for habitation, with the consequence that the Civil Protection Agency has had to provide for 171 emergency camps.

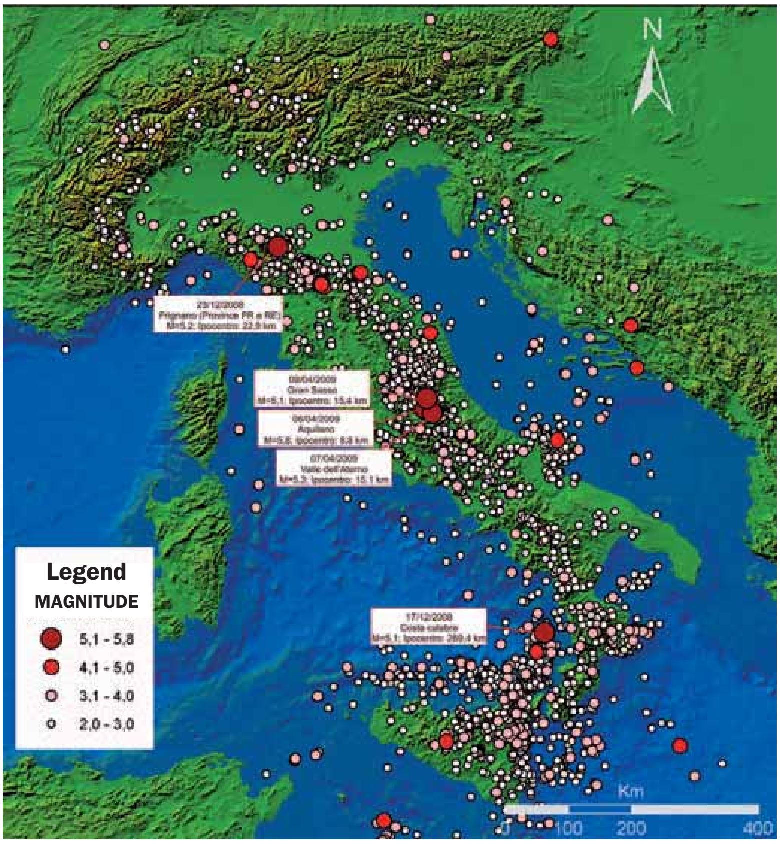

Figure 7.2: Main seismic events registered from January 1st 2008 to September 30th 2009[2]

Seismicity creates conditions of very high risk in Italy.
The event occurred in L'Aquila on April 6th caused over 300 victims and serious damages to buildings and to the artistic and cultural heritage.

[2] Source: INGV data processed by ISPRA

On April 6th 2009, at 3:33 a.m., the town of L'Aquila and surrounding areas were stricken by an earthquake of magnitude Ml 5.8 (Mw 6.3).

The sequence of the major events involved an area of about 30 km².

The seismic crisis in the area of L'Aquila (April 2009)

On April 6th 2009, at 3:33 a.m., the town of L'Aquila and surrounding areas were stricken by an earthquake of magnitude Ml = 5.8 (Mw= 6.3). The epicentre was located some kilometres southward. Other two events of M > 5 occurred on the following day (ML = 5.3; epicentre located between Fossa, San Martino d'Ocre and San Felice d'Ocre, about 10 km southeastward from L'Aquila), and after two days (ML = 5.1; epicentre located near Campotosto, about 15 km northwestward from L'Aquila). Such events of greater magnitude were preceded by hundreds of *foreshocks* of lesser magnitude, following one after another since January 2009, and were followed by several *aftershocks*. The sequence of major events involved an area of about 30 km², extended in northwest-southeast direction (Figure 7.3). The hypocentral depths registered generally range between 10 and 12 kilometres, except for the event of April 7th, whose epicentre was located at a depth of 15 km. Focal mechanisms of the seismic sequence clearly show the presence of a normal fault extended in northwest-southeast direction.

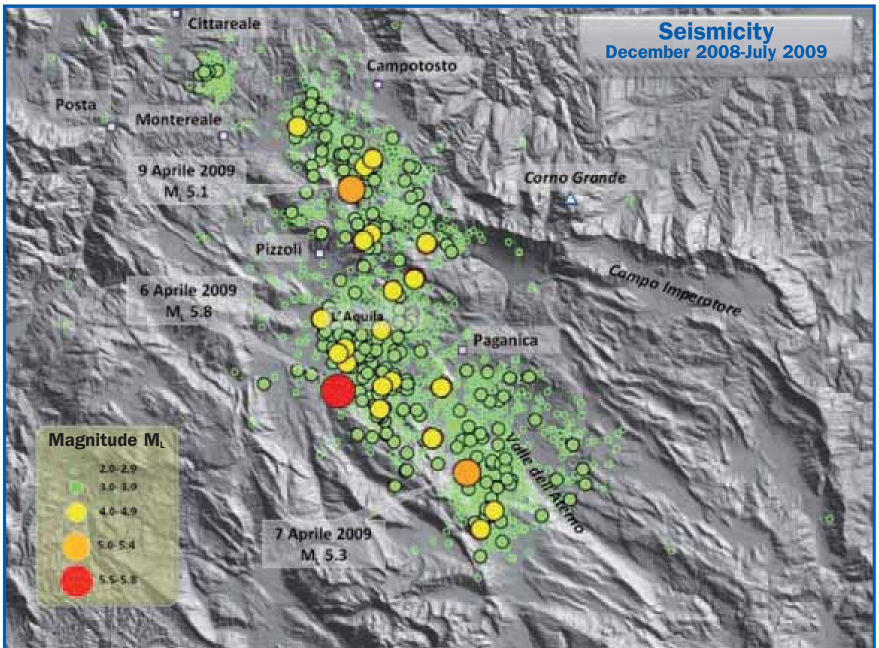

Figure 7.3: Location of the seismic sequence in the area of L'Aquila from December 2008 to July 2009[3]

[3] Source: INGV data processed by ISPRA

The scenery of damaged buildings – as results from data collected by the Quick Earthquake Survey Team (QUEST) – has immediately appeared to be irregular. The most damaged area extends in the northwest-southeast direction, and the peak value of macroseismic intensity (I ≥ 9 MCS) has been registered only in certain sites located in less severely damaged areas, with I ≤ 8 MCS. Such peak values seem to have been caused by the local seismic vulnerability, in some cases combined with evident site effects (for example, Onna and other villages in the Aterno valley, located on recent non-consolidated alluvial sediments). The epicentral area had already been stricken in the past by seismic events with moderate to high intensity. In 1461 and 1703, two earthquakes occurred with X MCS intensity. Moreover, the same area was stricken in 1349 by other two destructive events with IX-X MCS intensity, and in 1762 with IX MCS intensity. The 1703 earthquake was characterised by a long sequence of three main events following one after the other in a span of a few days, which occurred along a direction oriented north-northwest-south-southeast: the first earthquake, on January 14th (I= XI MCS), had its epicentre in Norcia and caused the destruction of many sites in southern Umbria; the second one, on January 16th (I=VIII MCS), hit a restricted area between Montereale, Cittareale, Accumuli and Amatrice; the third seismic event, occurred on February 2nd (I= X MCS), and destroyed the town of L'Aquila, killing 2,500 residents. This event caused surface faulting along the Pizzoli fault, as well as considerable secondary effects, including the deep-seated gravity deformation of Monte Marine, not far from Pizzoli, the huge landslide at Villa Camponeschi, near Posta, as well as liquefaction phenomena in the Aterno valley, near the Pizzoli mill.

The epicentral area had already been stricken in the past by other seismic events with moderate to high intensity.

Effects induced by the April 6th earthquake on the environment

The paroxysmal event of April 6th (Mw = 6.3) produced a number of effects on the physical environment, both primary (surface faulting) and secondary (slope movements, fractures, liquefaction phenomena, hydrological anomalies). Here follows a summary of the detailed report on these phenomena and their distribution on the territory[4].

ISPRA detected about 200 seismic-induced effects, over an area of about 1,000 square kilometres (extending far beyond the epicentral area).

[4] Blumetti A.M., Comerci V., Di Manna P., Guerrieri L. e Vittori E. of ISPRA (with the cooperation of some researchers of the Italian National Research Council (CNR) and of the University of the Insubria) available for consultation on the site http://www.apat.gov.it/site/_files/Inqua/2009_abruzzo_earthquake_report.pdf

Following such event, ISPRA detected about 200 seismic-induced effects, over an area of about 1,000 square kilometres (extending far beyond the epicentral area). Near Paganica, just a few kilometres east of L'Aquila, a set of discontinuous fractures was found on the ground, with a regular alignment in the N120-N140 direction. Such fractures extend for 2.6 kilometres, and present up to 10 cm dip-slips, and openings a few centimetres wide. They represent an evident intersection with the fault topographic surface associated with the earthquake (Figures 7.4 and 7.5), with a deep greater linear extension.

The fault plane along which the earthquake occurred produced a surface rupture of the soil near Paganica. Such surface faulting, indicated by the red line in the figure, can be easily detected for a length of 2.6 kilometres.

Figure 7.4: Surface rupture of the Paganica fault[5]

The rupture of the Gran Sasso aqueduct caused the opening of a trench.

The displacement occurred along such alignment on the occasion of the earthquake caused the pipeline rupture of the Gran Sasso aqueduct, and the consequent leakage of such a huge mass of water under pressure, that the jet of water (the pipeline has a diameter of 70 cm, and a capacity of 500 litres per second) dug a trench in just a few hours (shown in Figure 7.5).

[5] Source: ISPRA

Figure 7.5: The Gran Sasso aqueduct[6]

The Gran Sasso aqueduct restored, after the damages caused by surface faulting-induced displacement. The red line indicates the fracture caused by the earthquake of April 6th 2009.

Some ground fractures were found along the Paganica fault, that, during the months following the main event, have undergone an evolution, in terms of a progressive increase in the width initially observed.

Inspections were also been carried out along the other faulting areas, finding evidence of slight reactivation (of a few centimetres), near Bazzano, Pettino and Roio, most likely due to mere seismic shaking.

Seismic shaking also induced a great number of secondary effects.

Seismic shaking also induced a great number of secondary effects. Along the calcareous slopes, several landslides (fall type) have occurred, with the falling of plurimeter-sized rocks causing damages to dwellings, as well as the closure of important roads. Impressive collapses have occurred near Fossa (Figure 7.6), along the SS 17 road at San Venanzio gorges, along the SS 696 at San Potito, the Paganica-Camarda at S.ta Maria d'Apparì, and at the access road to the Stiffe cave, near San Demetrio ne' Vestini. Following the shock, Lake Sinizzo's shorelines collapsed almost all along its subcircular perimeter (Figure 7.7).

Lake Sinizzo's shorelines slided down, following the earthquake of April 6th, almost all along the perimeter.

[6] Source: ISPRA

The landslide swept away the village located downstream of the road shown in the figure, damaging buildings and motor vehicles.

Figure 7.6: Landslide (fall type) near Fossa [7]

Lake Sinizzo's shorelines (municipality of San Demetrio ne' Vestini, AQ) slided down, following the earthquake of April 6th, almost all along the perimeter.

Figure 7.7: Lake Sinizzo's shorelines [8]

[7] Source: ISPRA
[8] Source: ISPRA

Some liquefaction phenomena were also identified: sand boils were observed inside a borrow pit near the industrial area of Bazzano and Vittorito (near Sulmona).
Furthermore, hydrologic variations were registered: near Tempera, wells have suffered a dramatic decrease in their water capacity, or even dried up; in others, water became temporarily muddied.
Some springs completely dried up, others suffered from variations in their capacity, and in some cases, springs were also found hundreds of meters far from the original location.

Some liquefaction phenomena and hydrologic variations were also identified.

Measurement of co-seismic deformations using satellite data

The effects produced on the ground by a seismic event can also be evaluated using satellite data, such as for instance GPS (Global Positioning System) measurements and SAR (Synthetic Aperture Radar) data processing.
Measurements provided by permanent GPS stations, are a powerful instrument for the identification of ground deformations of tectonic and volcanic origin. Several networks especially devised for geodetic and geodynamic research are presently operating on the national territory.
In the case of L'Aquila earthquake, data provided by permanent GPS stations activated in the Abruzzi territory by public agencies, research institutes (ASI, CNR, INGV, ISPRA, DPC), public local administrations (Abruzzi Region, Umbria Region) and private bodies, were particularly useful to evaluate co-seismic deformations produced by the mainshock.
Some of the nearest stations to the epicentre belong to the GPS network activated by ISPRA in co-operation with the Civil Protection Agency.
The aim of this network is to evaluate the elastic deformation rate accumulated near the faults considered as active in the Gran Sasso area, as well as the relation between the active deformation rate obtained and the slip rates associated with faulting systems, on the basis of paleoseismological, geological and geomorphologic studies.
Preliminary processing of GPS data provided by permanent and non-permanent stations - measured in the days following the main-

The effects produced on the ground by a seismic event can also be evaluated by applying methods based on the use of satellite data.

shock – allowed to define the fault geometry responsible for the main dislocation, and to identify ground displacements produced by the earthquake of April 6th (Figure 7.8).

The bigger Figure shows planimetric displacements (blue and red arrows: displacements detected by GPS stations; yellow arrows: displacements calculated by the hypothesised fault model). In the box: vertical displacements observed (blue) and calculated (yellow), the red rectangle indicates the surface projection of the fault resulting from the inversion of GPS data (normal fault dipping SW at 50°).

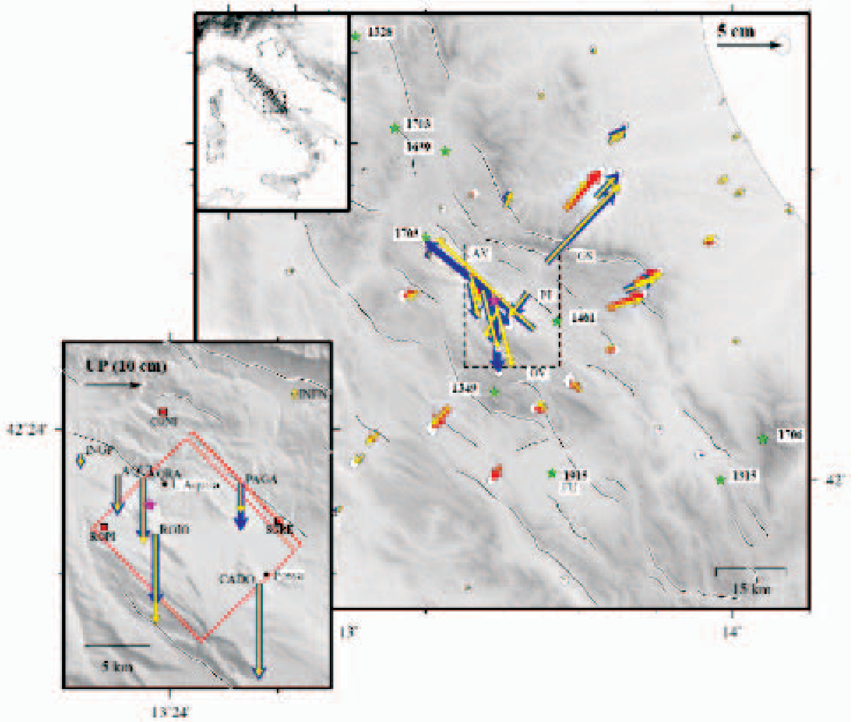

Figure 7.8: Co-seismic displacements induced by the earthquake of April 6th 2009 (Mw 6.3)[9]

Radar data analysis integrated with information available on ground deformations produced by the main shock.

Radar data analysis, integrated with information available on ground deformations produced by the main shock, provides information - in agreement with GPS data (about 28 cm near the Bazzano built-up area) – about the distribution of ground deformations over the territory surrounding the epicentral area. The maximum ground displacement, along the satellite line of sight (LOS), estimated from SAR data, is about 25 cm, as shown in Figure 7.9, where each one of the concentric elliptical fringes shows a displacement of about 29 millimetres.

[9] Source: Cheloni *et al.*, 2010

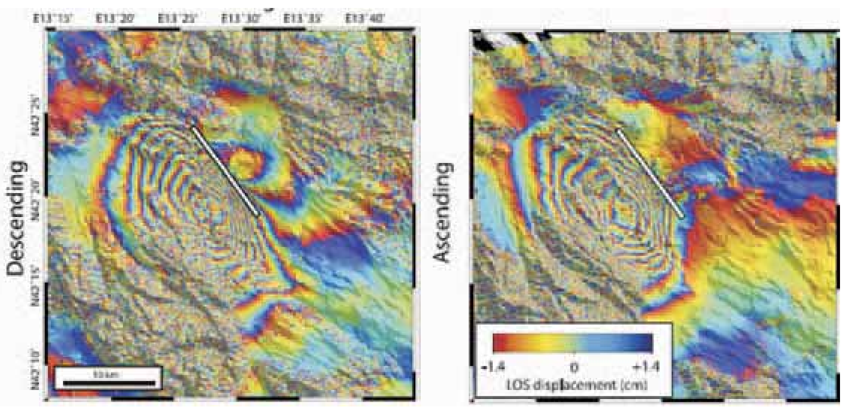

Figure 7.9: Envisat interferograms[10]

Envisat interferograms with the surface projection of the fault plane model.

Solutions

Seismic activities are outcomes of the planet's natural dynamics, meaning that there is little that man can do to control them. Nevertheless, conditions of risk can be significantly reduced through careful territorial planning and the introduction of legislative instruments that place limitations on the use of the soil and/or set technical-engineering standards. In order to arrive at effective risk mitigation, therefore, it is indispensable that the emergency approach, based on after-the-fact responses, be replaced with initiatives combining forecasting and prevention.

To limit risk situations, attentive planning and the introduction of adequate regulatory instruments are called for.

Forecasting can be carried out through specific studies of risk-prone areas, in order to determine the return period probability of events, while prevention mostly consists of making appropriate planning choices, as well as selecting and applying technical procedures designed on the basis of the knowledge obtained.

In terms of seismic risk (for the definition of risk, see the Introduction), although it is not possible to reduce the hazard component, less vulnerable buildings should be constructed in areas exposed to this risk. The seismic classification of the national territory can thus be a precious tool. Having been significantly reinforced, following the 1980 earthquake in Irpinia and, more recently, after the earthquake of 2002 in the Region of Molise, by the issue of Ordinance no. 3274 of 20 March 2003 and no.

In terms of seismic risk, less vulnerable buildings should be constructed in areas exposed to this risk.

[10] Source: R.J. Walters *et al.*, 2009

The seismic classification map provides an updated overview of the various areas of Italian territory characterised by different levels of seismic hazard.

3519 of 28 April 2006 by the Prime Minister, the classification reflects the state of the art as far as knowledge of seismic risk in Italy is concerned, and presently refers to the seismic hazard map of the national territory drawn by the National Institute of Geophysics and Vulcanology (Figure 7.10). The seismic classification map provides an updated overview of the Italian territory, subdivided into 4 areas characterised by different levels of seismic hazard (Figure 7.11), each one needing the application of appropriate anti-seismic regulations for the construction of buildings and other public works. The Ordinance no. 3519/2006 – while asserting that the new classification has to be based on the actual basic seismic hazard of the territory, regardless of administrative limits and constraints – has however provided regions with appropriate criteria to be followed for the correct classification of municipalities according to seismic hazard level. The Decree 14/01/2008 issued by the Ministry of Infrastructures, defining the new building regulations, opened a new transitional phase, that is supposed to end by June 30th 2010, in which the project architect can refer either to the previous regulation (2004 Seismic Classification plus subsequent modifications, Figure 7.11) or to the Technical Rules. These rules are, in fact, the new reference regulation for anti-seismic engineering, directly based on the "basic seismic hazard", that is on the INGV seismic hazard map (Figure 7.11). In this map, values of maximum ground acceleration a_g are given for the points of a reference grid whose nodes are located at distance not exceeding 10 km (0,05° grid), and for various probabilities of occurrence over 50 years and/or different return periods TR.

Unfortunately, a large part of the buildings in our country do not comply with anti-seismic standards, both because the stock of structures from the past has only rarely been upgraded to meet the current anti-seismic regulations, and because the marked urban expansion from the post-war period to the present suffers from a lack of attentive territorial planning, as well as the all too frequent, and deplorable, tendency to build in violation of construction codes.

The noteworthy vulnerability of the Italian building heritage is a structural problem that needs a long time to be solved, as well as the adoption of a hard policy of interventions to be planned on a national scale.

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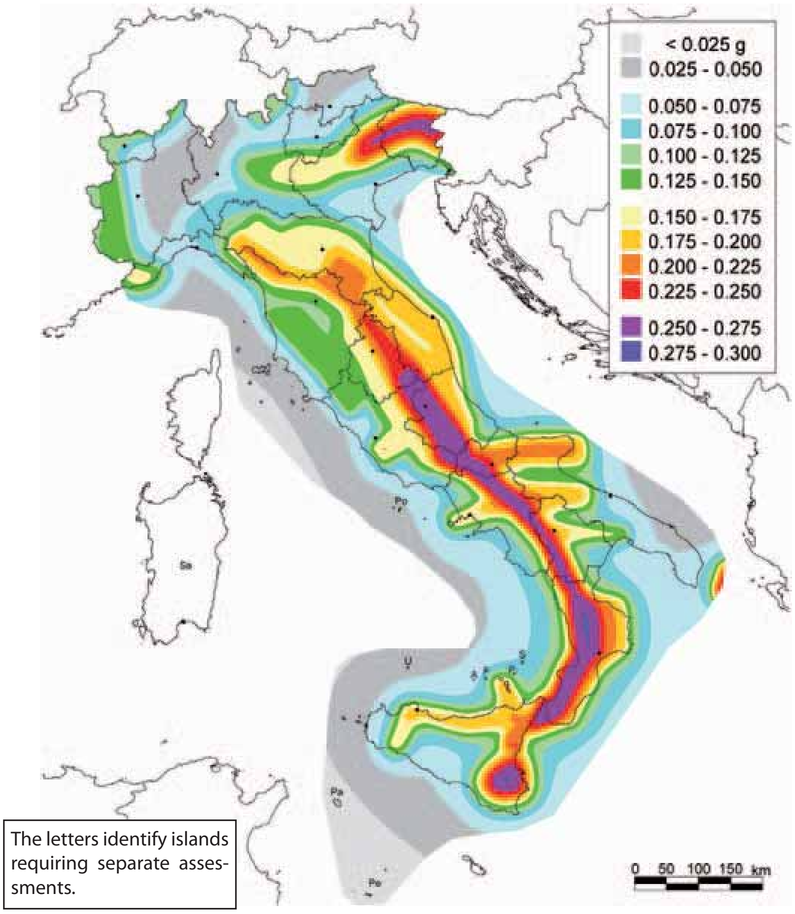

Figure 7.10: Seismic hazard map of the national territory (2004)[11]

This map presents seismic hazard in terms of maximum ground acceleration, with a 10% probability of exceedance over 50 years on rigid terrain (Vs_{30} > 800 m/s; cat. A, point 3.2.1 of DM 14/09/2005).

as the adoption of a hard policy of interventions to be planned on a national scale. Nevertheless, low cost or even cost free interventions could be implemented in terms of providing information and promoting population's direct involvement. An interesting episode occurred in the province of Frosinone in October 2009, when L'Aquila earthquake was still alive in memory. The area between Campoli Appennino and Posta Fibreno was hit by a long low magnitude seismic series (3.5 maximum local magni-

[11] Source: Ordinance no. 3519 of 28 April 2006 by the Prime Minister, Attachment. 1b Reference seismic hazard for the national territory

The seismic classification map shows Italian municipalities subdivided into four seismic areas of decreasing seismic hazard, from area 1 to area 4; these areas correspond to four classes of maximum ground acceleration presenting a 10% probability of occurrence over 50 years.

The 3S area (created for the Tuscany Region by Regional Decree no. 431/06) is based on a precautionary principle under which the municipalities in the area, classified as facing "low seismic hazard", nevertheless follow the anti-seismic planning criteria indicated for medium seismic hazard areas (S2).*

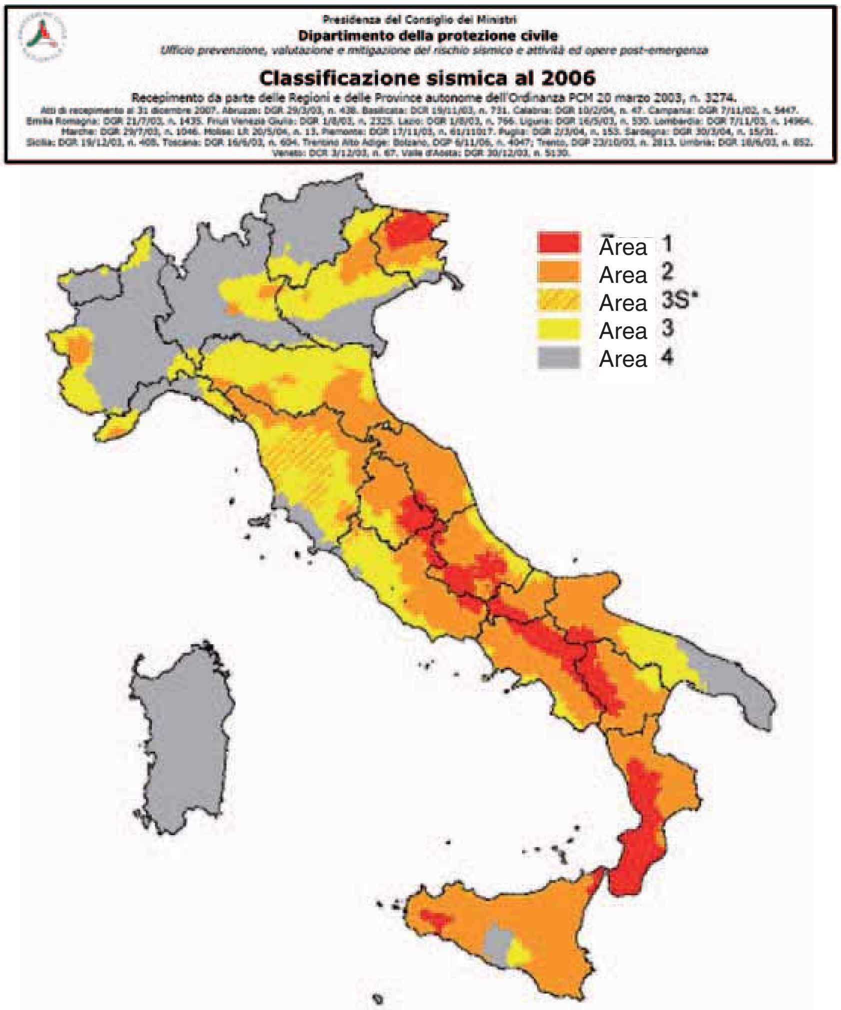

Figure 7.11: Seismic classification map[12]

tude). The apprehension and concern manifested by the citizens induced the Civil Protection Agency to set up a tent camp in the local sports ground, in order to shelter all those who considered their buildings unfit for habitation, being unsafe from the seismic point of view. Not only this is certainly a low cost operation: it also produces a great number of positive effects. In fact, the presence of a civil protection centre not only provides a lot of

[12] Source: Civil Protection Agency

citizens with a safe place to spend the night, it also helps to raise the awareness (or at least to raise the question) of the risk threatening all those who live in buildings that do not comply with anti-seismic standards. Since in any case public resources are inadequate to apply anti-seismic reinforcements to private building heritage, citizens themselves must become aware of their actual exposure to danger, in order to act personally and directly, according to one's means. In the best case scenario, a deeper awareness of the seismic risk could even become a deterrent from violation of construction codes applying anti-seismic standards. Risk awareness obviously leads to a growing demand for information by the citizens, which can even save human lives, provided it is punctual and effective. Indeed, the dissemination of accurate information can help to prevent wrong choices that could prove fatal.

The dissemination of accurate information can help to prevent wrong choices that could even prove fatal.

Last October, the apprehension for earthquake hazard in the province of Frosinone induced local government bodies to monitor the level of security in schools. As a result, several school buildings (for example, in the municipalities of Arpino, Sora, Veroli, etc.) were closed, and school activities were moved in more secure locations. The outcomes of the seismic monitoring carried out on public buildings of the Lazio Region, in the period 2004-2008, show a lot of high-risk school buildings (65.7% of all the monitored facilities). The state of alert of last October raised local bodies' awareness, encouraging more sensible behaviours. Focusing on these issues gives therefore positive results. A multiplicity of knowledge tools is available. Studies have been carried out by local agencies, regional government bodies (such as the one before mentioned), as well as by the Civil Protection Agency (for example, the 1999 Vulnerability map of public, strategical and special buildings in the regions of Abruzzo, Basilicata, Calabria, Campania, Molise, Apulia, and Sicily) on the vulnerability of public buildings, that should be taken into due consideration by local administrations in order to guarantee citizens' security.

The outcomes of the seismic monitoring carried out on public buildings of the Lazio Region, in the period 2004-2008, show a lot of high-risk school buildings (65.7% of all the monitored facilities).

Other simple precautions could also be taken in everyday life, in order to reduce one's vulnerability, such as, for instance, turning

gas off before going to bed, sleeping in the most secure area of one's home (where load-bearing beams or walls are located), eliminate libraries, bookcases and shelves from the walls near one's bed, sleeping as far as possible from windows, identifying possible forms of protection, such as a sturdy table to find shelter beneath. In Japan, for example, people always carry their own *bousai-bukuro*, that is an anti-seismic backpack, ready for use, containing a torch, some water, canned food, biscuits, working gloves, a dust mask, and if necessary other small useful things.

Geologic-hydraulic risk

The situation

In Italy the particular climatic conditions, the dynamics of hydraulic disturbances in mountain areas, combined with a peculiar geological-structural situation, determine the occurrence of disastrous events.

Landslides and flooding are among the most frequent natural disasters in the Italian territory, causing serious damages both in terms of victims and loss of material goods. The way in which they tend to occur depends on the heterogeneous character of natural environment, as well as on the variability of the parameters related to natural processes.
In consideration of the above, in Italy the particular climatic conditions (alternate long dry seasons and rainfall periods, sometimes even with intense precipitation), the hydraulic conditions in mountain areas, combined with a peculiar geological-structural situation, determine the occurrence of disastrous events. In fact, in mountainous areas and mountainsides of hydrographic basins (characterised by steep slopes often with no vegetation), erosion is particularly intense, generating surface runoff (with large amounts of materials transported), while alluvial plains are more often affected by the occurrence of extensive flooding (also due to the reduction of clear surfaces), sometimes with flash floods. Since 2002, ISPRA has carried out a systematic study on the main floods that have occurred in Italy from the post-war period to the present, publishing pluviometric data, plus information on types of flooding, numbers of individuals involved and urgent measures adopted to face the disturbances. Information analysed by ISPRA is recorded in the Environmental Yearbook database (2009 edition), containing data about the main events occurred during

2008 and 2009 (updated to October 2nd 2009), reporting data on victims, on total estimated damage, and on total estimated damage compared to GDP. The informations listed (indicating the period and location of flooding events), have been taken from the reports published by the main Italian media, while the data of figures on number of deaths and total estimated damage have been taken from ISTAT, CNR, Civil Defence Department, ARPA and local govenrment bodies.
During 2008, the precipitation trend has been generally negative, with scarce precipitation until autumn, with the beginning of a period of particularly intense precipitation lasted from November to February, characterised by average rainfall exceeding the normal seasonal trends for Italy.
Figures 7.12 and 7.13 show, respectively, data on victims and on total damage compared to GDP produced by flooding between 1951 and 2009 (updated to October 2nd). In particular, Figure 7.13 shows - with the exception of some sporadic events occurred around the 90's - a general downward trend in damage as compared to GDP until 2008 (figures for 2009 - presumably higher on account of the events occurred in the province of Messina – are not yet available). This could be attributed not only to an improvement in systems for safeguarding the territory and risk reduction, but also to a natural variability in the intensity and duration of events. Generally speaking, the severity of damages is also influenced by parameters related to territorial management, including anthropization, modifications of river courses, modifications of land use, etc.

The severity of damages is also influenced by parameters related to territorial management.

A series of widespread landslide phenomena, evolved into rapid mudslides and detritus flows, occurred in October 2009 in the province of Messina. caused 31 deaths and 6 missing.

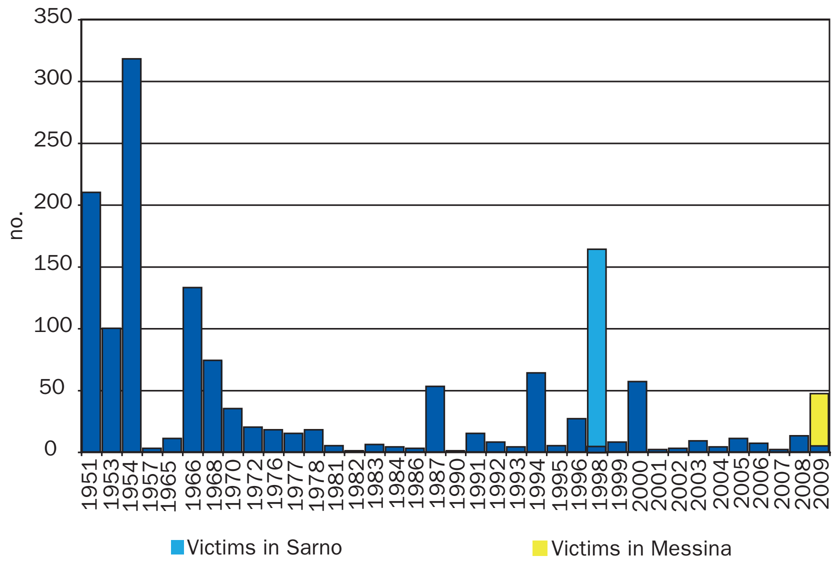

Figure 7.12: Victims of the main floods in Italy from 1951 to October 2009[13]

With the exception of some sporadic events occurred around the 90's - a general downward trend in damage as compared to GDP until 2008 has been registered. Figures for 2009 - presumably higher on account of the events occurred in the province of Messina – are not yet available.

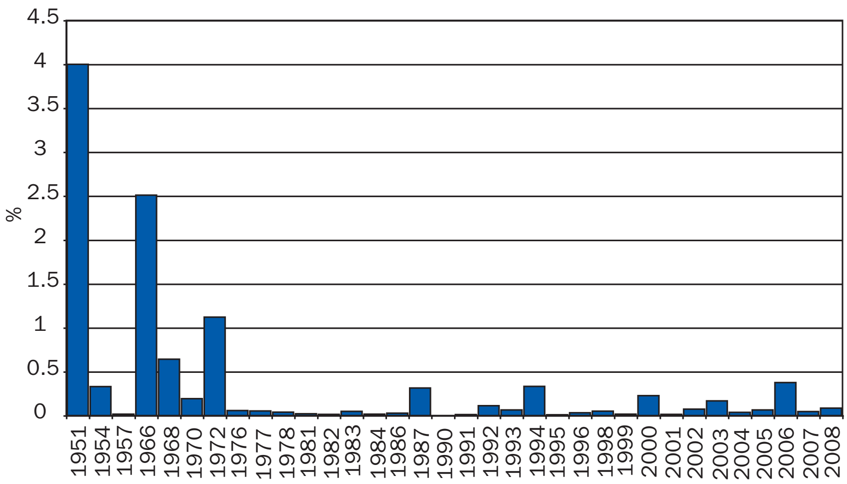

Figure 7.13: Estimated economic damage compared to GDP, for main flood events occurred in Italy from 1951 to 2008[14]

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[13] Source: Main Italian media data processed by ISPRA

[14] Source: Official sources (ISTAT, CNR, Civil Protection Agency, ARPA and local government bodies) data processed by ISPRA

The estimated economic damage amounts to over 7 billions euros for the last nine years (included 2009 partial data). This parameter is also influenced by the course of socio-economic and demographic development, whose demands have resulted in a use of the territory that does not always respect its natural role, or rather the evolutionary processes under way.
Landslides present an even more complex scenario, due to multiple combinations of geological, morphological and climatic factors that – interacting with anthropic activities - give rise to phenomena which vary greatly in terms of type, kinetic properties, ongoing development and extension of the areas involved. In terms of landslide, Italy presents an especially high risk on account of its morphological characteristics (75% of the national territory is mountainous-hilly). Landslides are the natural disasters that occur with the greatest frequency and, after earthquakes, cause the greatest number of victims and the most damage to urban areas, infrastructures and environmental, historical and cultural heritage. In the last twenty years alone, catastrophic events have occurred in the Val Pola (1987), in Piedmont (1994), in Versilia (1996), in Sarno and Quindici (1998), in Northwest Italy (2000) and in Val Canale - Friuli Venezia Julia (2003). A census carried out under the IFFI Project (Italian Landslide Inventory) has identified 485,004 landslides involving an area of 20,721 km^2, equal to 6.9% of the national territory. This Inventory – updated to December 2007 - has been carried out since 1999 by the Italian Geological Service (since 2002 by APAT, now ISPRA), in co-operation with regional governments and autonomous provinces, for the purpose of identifying and mapping landslides on the basis of a standardised and widely accepted approach.
The landslide index, equal to the ratio between the area subject to landslides and the total surface area, calculated using a grid size of 1 km, provides an overview of the distribution of landslides in Italy (Figure 7.14). The data on Basilicata, Calabria and Sicily tend to underestimate the actual situation of instability, because surveys of landslide events carried out to date have focused on areas where urban centres or major transport infrastructures are located. Data gathered by the IFFI Project show that the most frequent types of movement (classified on the basis of the preva-

Italy presents an especially high risk of landslide, on account of its geological and morphological characteristics (75% of the territory is mountainous-hilly).

In Italy, more than 485,000 landslides have been identified, involving an area of over 20,700 km^2.

Not all landslides present the same level of hazard. Landslides with extremely rapid movement and involving noteworthy volumes of rock or soil cause the greatest damage and number of victims.

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lent component of the movement) are rotational/translational slide, at 32.4%, slow earth flow, at 15.6%, rapid debris flow, at 14.5%, and complex landslides, at 11.3%. A large number of landslides present renewed activity over time; quite often, dormant periods of a number of years, or even centuries, alternate, during extreme meteorological events, with periods of remobilisation, as

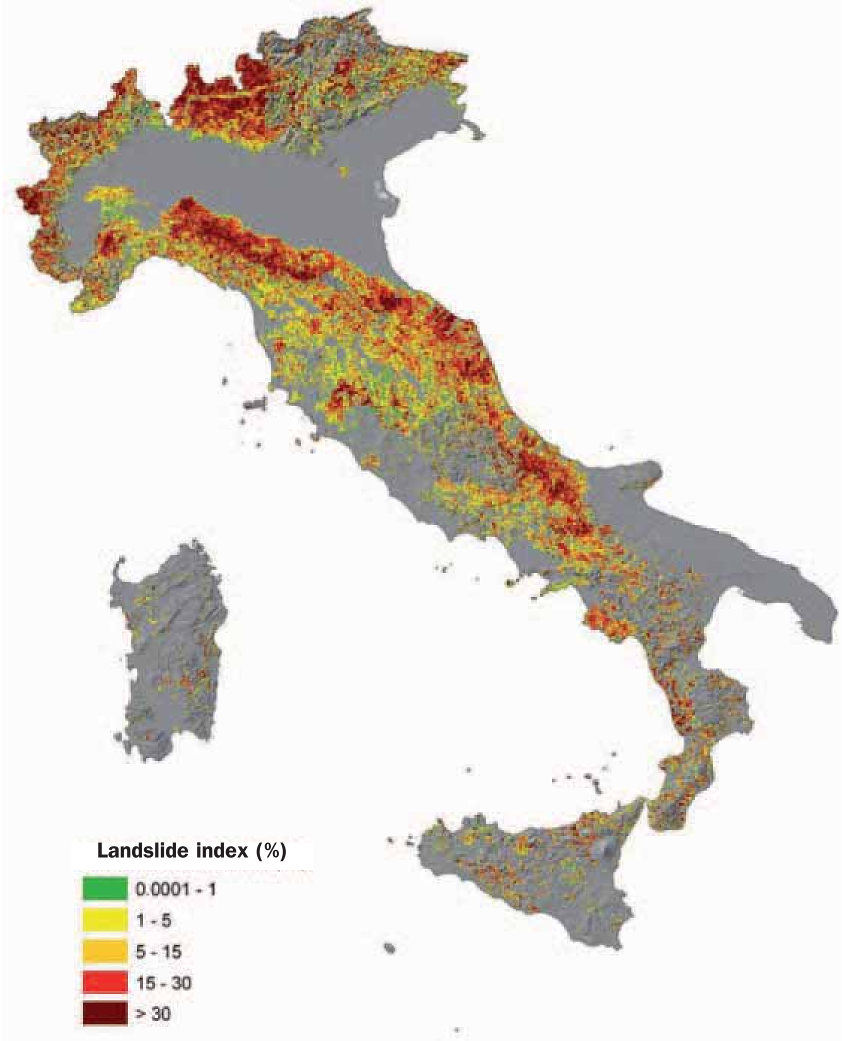

Figure 7.14: Landslide index (%)[15]

[15] Source: ISPRA

is the case for almost all landslides in the Apennine areas of the Emilia Romagna Region, characterised by slow movements. In contrast, new landslides most frequently are characterized by rapid kinetics, such as rockfalls or mud/debris flows. Not all landslides present the same level of hazard. Landslides with extremely rapid movement and involving noteworthy volumes of rock or soil cause the greatest damage and number of victims.

In order to obtain a preliminary landslide risk assessment related to the Italian territory, landslides (recorded in the IFFI database) have been overlapped with the exposed elements (infrastructures, urban centres, etc.), taken from the Corine Land Cover 2000 (Figure 7.15). Italian municipalities affected by landslides currently number 5,708, or 70.5% of the total. A total of 2,940 municipalities have been classified at very high levels of attention (intersections between landslides and continuous and discontinuous urban texture, as well as industrial or commercial areas), 1,732 municipalities at high levels of attention (intersections between landslides and the highway, railway and road networks, areas used for mining, dumping and worksites), 1,036 municipalities at moderate level of attention (intersection between landslides and arable lands, wooded territories, and semi-natural environments, green urban areas and sports and recreation areas), and 2,393 rate negligible levels of attention (municipalities in which no landslides have been registered).

Italian municipalities affected by landslides are 5,708, equal to 70.5% of the total.

Out of the 8,101 Italian municipalities, a total of 2,940 have been classified at very high levels of attention, 1,732 municipalities at high levels of attention, 1,036 municipalities at moderate level, and 2,393 call for negligible levels of attention.

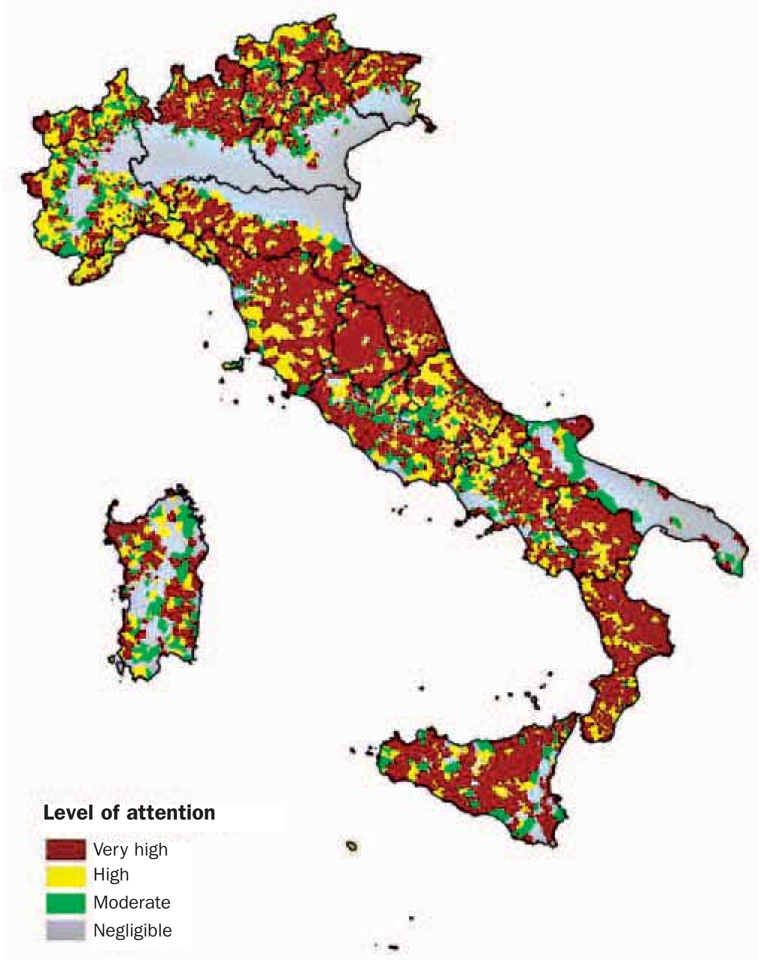

Figure 7.15: Level of attention for landslide risk, on municipality basis[16]

The estimated population exposed to landslide risk, on the basis of landslides recorded in the IFFI inventory and data gathered during ISTAT 2001 census, totals 992,403 inhabitants, equal to 1.74% of Italy's resident population. These data, grouped by municipality, show that the greatest number of individuals at risk are found in the regions of Calabria, Marche and Sicily (Figure 7.16).

[16] Source: ISPRA

The population exposed to landslide risk totals 992,403 inhabitants, equal to 1.74% of Italy's resident population.

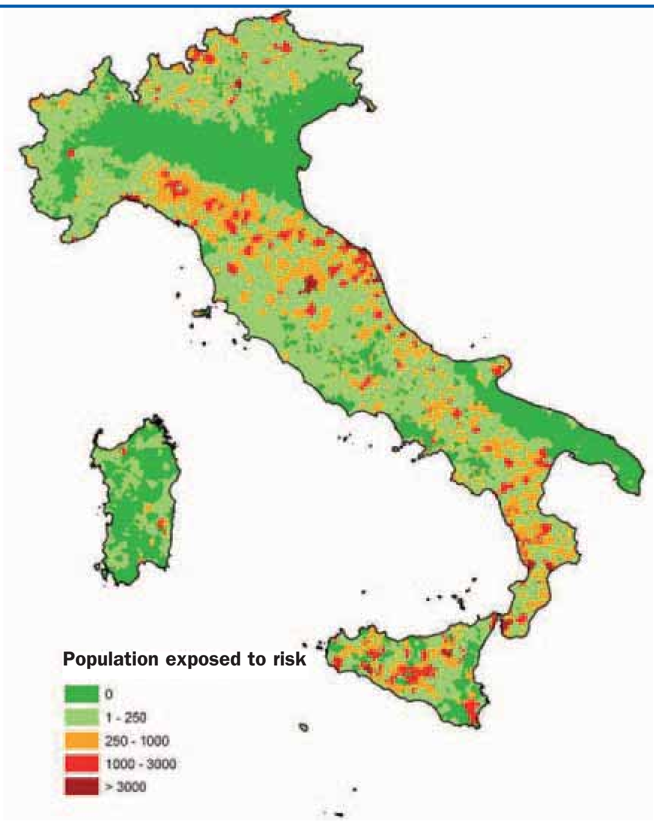

Figure 7.16: Population exposed to landslide risk[17]

In the period December 2008 - February 2009, exceptional precipitation in the whole national territory led to the occurrence of a series of landslide events that caused serious damage to urban areas, and particularly to transport infrastructures. Continuous precipitation raged over the whole period (November 2008 - January 2009), with 20 monthly rainy days registered both in December and in January. The heaviest precipitation was registered in the following periods: December 10-13; January 11-14, and January 24-28.

Moreover, precipitation in November 2008 exceeded by 67% the average of the last 208 years (average climate of the reference period - ISAC-CNR), while in December the rainfall intensity registered for the same period was more than twice as great.

In the period December 2008 - February 2009, exceptional precipitation in the whole national territory led to the occurrence of a series of landslide events, that caused serious damage to urban areas and particularly to transport infrastructures.

[17] Source: ISPRA

In January, cumulated precipitation doubled on average on a national scale, and almost tripled in the South of Italy (+172% in Sicily, +165% in the South-East, +156% in the South-West) compared with the last 30 years measurements (Observatory for Applied Agricultural Climatology and Meteorology, UCEA). In such rainfall regime, soils remained constantly rain-soaked for a long time, often near to a state of saturation, that is the critical condition determining the trigger of the disruptive events that have occurred. Almost all landslides were shallow, and characterised by limited size and high speed; reactivations of more extended and deeper landslides have also occurred, for example in Trivento and Petacciato (CB). More than 100 landslides have been identified by ISPRA (Figure 7.17), from information supplied by online daily papers and technical reports. These are only part of the events that have hit the national territory in the period under consideration. These landslides were, in fact, particularly catastrophic, in terms of loss of human lives and damages, devastating farmlands, local and/or country roads, rarely reported in the aforesaid information sources. A lot of main and secondary road networks (Highways A3 Salerno-Reggio Calabria, A14 Vasto-Termoli, A20 Messina-Palermo) and railway lines (ex. Potenza-Battipaglia, Battipaglia-Sapri, Catania-Caltanissetta) were interrupted. On January 25th 2009 a landslide invaded the roadway of A3 highway for nearly 20 meters, between the exits at Rogliano and Altilia-Grimaldi, causing 2 victims and 5 injured. Due to the critical situation in the area, the Salerno-Reggio Calabria highway remained closed for some days for about 60 km.

In 2009, other two dramatic natural events have occurred: the landslide at Cancia, in the municipality of Borca di Cadore (BL) and the mudslides in the municipalities of Messina and Scaletta Zanclea (ME).

In 2009, other two dramatic events occurred: the landslide at Cancia, in the municipality of Borca di Cadore (BL), and the mudslides in the municipalities of Messina and Scaletta Zanclea (ME). At Cancia, early in the morning of July 18th 2009, heavy rainfalls caused the triggering of a debris flow, from the south-western slope of the Antelao mountain, that determined the replenishment and the breakdown of the debris retention dam (a provisional remedial work provided by the Civil Engineering in the year 2000). Some dwellings downstream were swept away, and two people died.

On October 1st 2009, in the province of Messina, an extreme meteorological event, with rainfall of more than 200 mm over 24 hours, beated down on North-East Sicily, and hit the Ionian belt in the province of Messina between Messina (with the villages of Briga,

Giampilieri, Molino, Altolia, Pezzolo), Scaletta Zanclea and Itala. In the same area, the rainfall accumulation between 15th and 30th September 2009 was 300 mm, totalling about 500 mm in the period between September 15th and October 1st (Report on meteorological events, October 1st 2009, region of Sicily – Civil Protection Agency, 2009). It appears evident that the soil was already water-soaked, and the meteorological event of October 1st , with its exceptional rainfall, determined the trigger of a series of widespread landslide phenomena, such as rock falls and shallow slides, evolved into mud and debris flows, that swept away urban centres and infrastructures, with flows of up to 2-3 meters, causing 31 victims and 6 missing people. The interruption of the National road 114 Orientale Sicula, of the A18 highway, and of the Messina-Catania railway line have caused the total isolation of some villages, that could only be reached by sea or by air.

More than 100 landslides that caused damages to urban centres and infrastructures have been identified by ISPRA in the period December 2008 – February 2009. In 2009 other two dramatic natural events occurred: the landslide at Cancia, in the municipality of Borca di Cadore (BL), and the mudslides in the municipalities of Messina and Scaletta Zanclea (ME).

Figure 7.17: Landslide events in the period December 2008 – February 2009, and main events July-October 2009[18]

[18] Source: ISPRA

The causes

Events such as earthquakes, volcanic eruptions, landslides and flooding occur with great frequency in Italy, owing to the geological context of our country.

Disruptive events are influenced by a multiplicity of “natural” factors that are mainly tied to the special geo-morphological conformation, to the geological-structural situation of the Italian territory, as well as to the type and extension of the vegetative coverage and conditions of weather and climate.

Italy has registered a reduction in average annual precipitation, as well as an increased occurrence of extreme events.

Events such as earthquakes, volcanic eruptions, landslides and flooding occur with great frequency in Italy, due to to the geological context of our country. These extraordinary natural events contribute to shape and modify the earth’s surface. The risk of such natural phenomena depends on the probability of their occurrence, as well as on the interaction with factors related to human activities; therefore, their evolution and tendency to landslide and/or flood hazard” is influenced by the simultaneous presence and interaction of natural and anthropic factors.
Disruptive events are influenced by a multiplicity of “natural” factors that are mainly tied to the special geomorphological conformation, to the geological-structural assessment of the Italian territory, as well as to the type and extension of the vegetative coverage and conditions of weather and climate. Anthropogenic causes include, among others, a use of the territory that does not pay sufficient attention to the characteristics and the delicate natural balances of the environment. The management of the environment does not always respects the “environmental” traits of the territory, allowing planning and implementation of increasingly invasive works (such as embankments, dikes, canals, reclamation works, and retaining walls), that prevent evolution according to natural dynamics.
The natural environment evolves in a dynamic and variable way, which is not ascribable to simple models. This is also confirmed by changing climate conditions that have been characterising Italy during the last decades. In particular, the pluviometric regime – showing an average reduction in precipitation, as well as a change in their temporal distribution, with a growing occurrence of short lasting but intense rainfall events – on one hand, could have determined in some areas a reduction in the occurrence of medium-intensity floods, on the other, caused an increased occurrence of extreme events and landslide phenomena. Physical mechanisms ruling the onset and the evolution of hazard “hydro-geological events” are very complex and not linear. As a matter of fact, the correlation between pluviometric events and landslides or floods is influenced by a multiplicity of factors that set off different effects from one place to

the next, even in situations that would appear to be similar.
As it has said before, among the causes of hydro-geological disruption, anthropic factors have an increasingly important impact, linked to a use of the territory that does not pay sufficient attention to the characteristics and to geomorphologic and hydraulic balances of the Italian territory. In fact, as of the Fifties, the demands of the socio-economic development have helped to generate a constant and unrelenting deterioration of our territory. Major factors associated to slope deterioration include depopulation and abandonment in mountainous areas; in facts, the frequent fire occurrence, as well as the over-urbanisation and "cementification" in the valleys, have determined a considerable increase in run-off water, and an important reduction in time of concentration. This entails a reduced infiltration of run-off water thus implying a deeper groove in river courses and slope erosion. This is one of the major causes for the fact that sudden flood waves increasingly often propagate through very large areas.

Anthropic factors play an increasingly important role, among contributing factors of landslide and flood events.

In particular, slope instability is due to the interaction of several concomitant factors: natural events (precipitation, earthquakes) and anthropic activities. Short-duration extreme precipitation and prolonged rainfall are the most important factors for the triggering of slope failures respectively for rapid-shallow landslides, and landslides with a more deeply located sliding surface, or involving mainly clay lithotypes. Anthropic factors play an increasingly important role among contributing factors, through either direct actions, such as roadway construction, excavation or overloads, or indirect actions, including negligent maintenance of remedial works. Roadway construction works executed over the last decades in order to facilitate access to forest and woodland areas have often determined slope stability problems (Figure 7.18).

Slope instability is due to the interaction of several concomitant causes: natural events (precipitation, earthquakes) and anthropic activities.

Translational earth slide flowing near a hairpin bend in a forest road, Cervinara (AV) 15/12/1999.

Figure 7.18: Anthropic contributing factors - Translational earth slide flowing near a hairpin bend in a forest road, Cervinara (AV) 15/12/1999[19]

In hilly or flat areas, the development of intensive farming, involving land levelling and vegetation removal, generates erosion as well as rapid waterflow.

In hilly or flat areas, the development of intensive farming (often monoculture), involving land levelling, tree cutting and removal of trees, hedges and channelling, generates erosion as well as rapid waterflow, and causes an increase in sediment transport in watercourses, whose banks are no longer able to contain the flow, even in case of normal meteorological events. Moreover, in alluvial plains, in order to extend available areas, watercourses have been rectified, therefore natural meanders have been cut, and floodplains have been deprived of vegetation (the so-called planitial wood, whose function consists in slowing down flood waves). Meander rectification has caused shortening of water courses, thus entailing an increase in water speed and destructive strength. At the same time, floodplains occupation related to urban settlement, infrastructures and productive activities, as well as the

[19] Source: ISPRA

uncontrolled pilferage of building materials from dry riverbeds, have determined respectively a reduction in space for the natural water flow, and a lowering of the low-flow channel.
Repercussions of such use of the territory also influence coastal systems, as watercourses are at present one of the sources of the sediments that are necessary for the coastline balance.
In general, it could be said that the interaction between disruptive events and anthropic activities is reciprocal, with the consequence that inappropriate modes of use and management of the territory frequently result in an amplification of disturbances underway or in the triggering of new ones.

Solutions

Hydraulic and landslides hazards can be significantly reduced through careful territorial planning and normal policies combining forecasting and prevention, beyond any emergency approach based on after-the fact responses. Forecasting can be carried out through specific studies of the zones subject to risk, in order to determine the probable return periods of events, while prevention mostly consists of making appropriate planning choices as well as selecting and applying technical procedures designed on the basis of the knowledge obtained.

Conditions of risk can be significantly reduced through careful territorial planning and the introduction of legislative instruments providing limitations on the use of the soil and/or technical-engineering standards.

An urban planning approach taking into consideration natural hazards (including the effects of seismic phenomena and those produced by intense meteorological events) needs to become an essential component in the decision-making process, on both the political and administrative levels. In terms of landslide hazard, forecasting includes an inquiring phase, aimed at the census, collection and updating of information about landslide phenomena (IFFI Project, Italian Landslide Inventory), the monitoring of movements through telemeasurement systems (e.g. topographic or satellite), the identification of landslide-prone areas, and models for possible scenarios; while surveys on flood phenomena mainly consist of hydrological studies (rainfall modelling through return periods and inflow-runoff model) and hydraulic studies (analysis of flood waves evolution inside the river bed, on the basis of hydrometric levels). Prevention – in terms of risk reduction – essentially requires measures aimed at removing or attenuating envis-

aged grounds effects, whether structural or non-structural**.**
The so-called structural interventions (with relative maintenance works) include works executed in the framework of hydro-geological reclamation, whose essential function is the mitigation of hydro-geological risk, reducing the degree of hazard and vulnerability of the territory. Non-structural interventions become really effective when – in a territorial and urban planning context - they provide instruments to reduce risk-prone elements, limiting the expected damage induced by hazardous events that may occur in a certain area, and reducing risk itself. Such an intervention strategy is implemented through rules and constraints contained in planning tools at different levels (for example, in drainage basin planning), in emergency planning (quiet, early warning, attention, early warning alarm, emergency care), information and cultural training related to the various types of risks and relative behaviours.
The regulatory and planning framework for land preservation is governed in Italy by Legislative Decree no. 152/06 on "Environment Regulation", plus subsequent modifications and updating containing provisions aiming at ensuring protection and reclamation of the ground and subsoil, the hydrogeological reclamation of the territory and precautionary measures against hazard situations. Some contents of this measure were already found in Law 183/89, which "Regulated the organisational and functional framework for land protection", followed by Legislative Decree 180/98 (referred to as the "Sarno Decree", converted into Law 267/98), issued in 1998 following the tragedy in Sarno (Campania).

One of the major instruments for fighting "hydro-geological disarray" is provided by numerous intervention programmes devised for high risk areas and very high risk areas– R3 and R4 of the Extraordinary Plans.

One of the major instruments for fighting "hydro-geological disarray" (or, better yet, **"**geological**-** hydraulic**"** disarray) is provided by numerous intervention programmes devised for areas in which the greater vulnerability of the territory implies a more serious hazard for people, goods and environmental heritage (high risk areas and very high risk areas – R3 and R4 of the Extraordinary Plans). For this purpose, the Ministry of the Environment, Land and Sea has financed, since 1999, in accordance with Legislative Decree 180/98 ("Sarno Decree"), plus subsequent modifications and updates, 3,216 urgent initiatives for the reduc-

tion of hydro-geological risk, at a total cost of roughly 2,4 billion euros.
A further regulatory tool for the assessment and management of flood risk is the Directive 2007/60/EC of 23 October 2007. The “Floods Directive” aims to minimize the adverse consequences of floods – which occur with increasing frequency, due to climate change – by adopting joint cross-border policies for protection against flood risk. The Directive provides an articulated strategy consisting of a preliminary phase of flood risk assessment, followed by the establishment of flood risk maps and the development of risk management plans for areas at risk. Management plans should focus on prevention and protection against flood risk.
The dissemination of information on hydro-geological instability (landslides, floods, avalanches) among the central and local bodies of the Public Administration, as well as the general population, also plays a very important role in landslide risk prevention. Heightening the awareness of citizens also provides them with increased knowledge of the risks involving their own territory, as well as of the forms of conduct to be followed before, during and after the event. To this end, ISPRA created an on-line mapping service for the IFFI project (www.sinanet.apat.it/progettoiffi), making it possible to query the database and obtain information on landslides, in addition to visualising documents, photographs and videos (Figure 7.19). Other activities that ISPRA has carried out since 2000, include monitoring of initiatives financed in accordance with Legislative Decree 180/98, plus subsequent modifications and updates, whose data are filed in the National List of Land Defence Interventions (ReNDiS). The aim is to provide a comprehensive regularly updated framework of works and resources used in land defence, making them available to all local government bodies involved in planning and implementing such initiatives. In this context, ReNDiS is a tool for knowledge, virtually able to improve co-ordination and, therefore, the optimisation of national expenditure for land defence. Through data publishing (Figure 7.20), the National List is aimed at meeting the needs for “transparency” as regards local governments’ behaviour in terms of land defence.

The dissemination of information on landslides, floods and avalanches among the central and local bodies of the Public Administration, as well as the general population also plays a very important role in landslide risk prevention.

The on-line mapping service for the IFFI project, makes it possible to query the database and obtain information on landslides, in addition to visualising documents, photographs and videos.

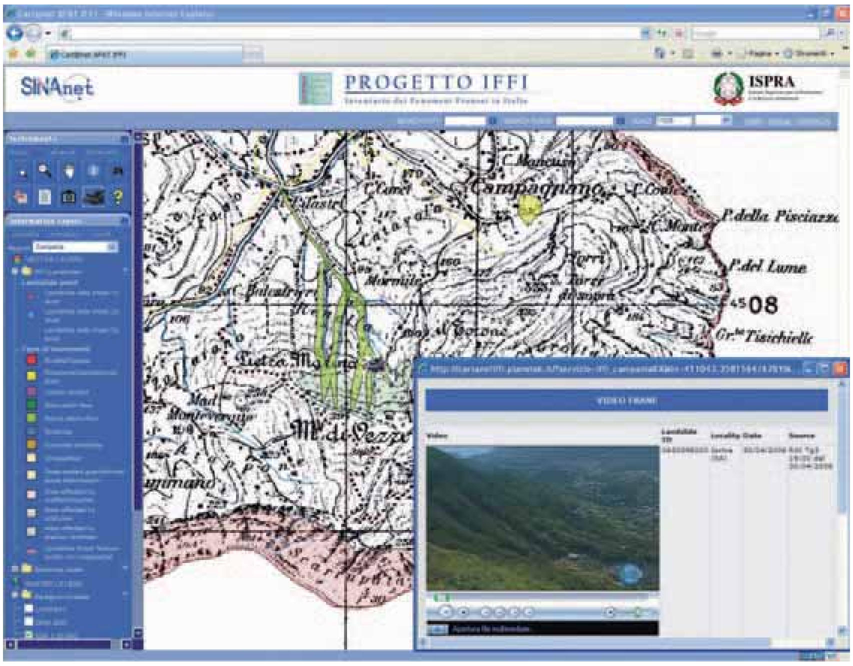

Figure 7.19: IFFI Project WebGIS[20]

ReNDiS aims to provide a comprehensive regularly updated framework of works and resources used in the land defence, making them available to all local government bodies involved in planning and implementing such initiatives.

Figure 7.20: National List of Land Defence Interventions - ReNDiS-Web[21]

Finally, taking for granted that the mitigation initiative should always have a decidedly minor value compared with the resource

[20] Source: ISPRA; www.sinanet.apat.it/progettoiffi
[21] Source: ISPRA

to be protected, it is indispensable that the emergency approach – that is extremely expensive - is replaced with initiatives combining forecasting and prevention, that could be more convenient and effective, as it has been stressed by the former UN Secretary General, Kofi Annan, in the UN Secretary General's Report for 1999: *"(…) Building a culture of prevention is not easy, however. While the cost of prevention has to be paid in the present, its benefits lie in the distant future. Moreover, the benefits are not tangible; they are wars and disasters that do not happen."*

It is necessary to overcome the emergency approach.

ANTHROPOGENIC RISK

Anthropogenic risk is defined as the risk (direct or indirect) caused by human activities that are potentially dangerous for both the environment and human life. This broad definition encompasses so-called "industrial risk" arising from activities carried out in industrial establishments.

Anthropogenic risk is either directly or indirectly tied to human activities that are potentially dangerous for human life and the environment.

A "Major-Accident Hazards Establishment" (MAH establishment) is defined as an establishment containing dangerous substances (used in the production cycle or simply stored) in quantities that exceed the thresholds established under the Seveso regulations (Directive 82/501/ EEC, plus subsequent modifications).

The handling and/or use of huge quantities of substances classified as toxic, flammable, explosive, oxiding, or dangerous for the environment can eventually lead to the occurrence and uncontrolled development of an accident posing a serious threat, either immediate or delayed, to human health (potentially inside or outside the establishment), or to the surrounding environment, due to: discharge and/or diffusion of toxic substances for the human beings and/or the environment; with fires or explosions or toxic release.

In the Eighties, the European Community took into consideration this type of establishments for the first time, in order to prevent major accidents in industrial plants, and to better protect the populations and the environment as a whole, issuing a special directive (the abovementioned 82/501/EEC, also known as the "Seveso Directive").

The Seveso Directive, plus subsequent modifications, aims at reducing major accident hazards, as well as their impact on man and the environment.

Operative application of the directive by the member states of the European Community has made clear the urgent need for updates and modifications, to the point where the Seveso Directive has been updated twice in the last years, under Directives 96/82/EC and 2003/105/EC, transposed into national law with Legislative Decrees 334/99 and 238/05.
These regulations aim at reducing the probability of accidents, as well as their consequences on man and the environment. To this end, operators of potential major-accident hazards establishments are obliged to fulfil special commitments, such as the production of specific technical and informative documentation, and the implementation of safety management systems. They must also submit to inspections and controls by the competent authorities.

The situation

ISPRA, together with Ministry of Environment, Land and Sea, collects information on major-accident hazards establishments supplied by operators to the competent authorities.

The information on major-accident hazards establishments supplied by operators to the competent authorities (including the Ministry of the Environment, Land and Sea, under the specific obligations indicated in Legislative Decree 334/99, with administrative and penal sanctions handed down in the event of failure to present the declaration, or of incorrect or incomplete declarations) are collected by the ISPRA, together with the Ministry of the Environment, Land and Sea, through the production and updating of the National Inventory of Major-Accident Hazards Activities (MAH industries), as stipulated under Legislative Decree 334/99 (Art. 15, fourth paragraph), and validated through a cross-analysis with data already in the possession of the regional governments and the regional agencies with territorial jurisdiction. Thanks to the information collected in the above-mentioned Inventory, it is possible to outline a global view of the potential danger represented by major-accident hazards establishments for the Italian territory.
When, for example, the following information is known:

- the number of major-accident hazards establishments, on a regional basis (Figure 7.21);
- the number of major-accident hazards establishments, on a provincial basis (Figure 7.22);

- the number of municipalities with 4 or more major-accident hazards establishments (Figure 7.23);

then the areas with the highest concentrations of MAH establishments can be identified, in order to implement controls and precautionary measures adequate to keeping a possible accident in any one of the establishments from involving other plants and causing serious consequences both for man and the environment ("domino effect"). For this purpose – with a view to obtaining more accurate results, thanks to georeferenced perimeters of all MAH establishments – it is possible to identify the areas in the national territory with more or less high concentration of MAH establishments, regardless of municipal, provincial or regional boundaries. Such areas can be approached applying the specific and more punctual risk assessment and monitoring criteria provided for in art. 13 of Legislative Decree 334/99, whose technical provisions are about to be finalized by the Ministry of the Environment, Land and Sea.

When the number and distribution within the territory of major- accident hazards establishments is known, it is possible to identify the areas with the greatest concentration of major-accident hazards establishments.

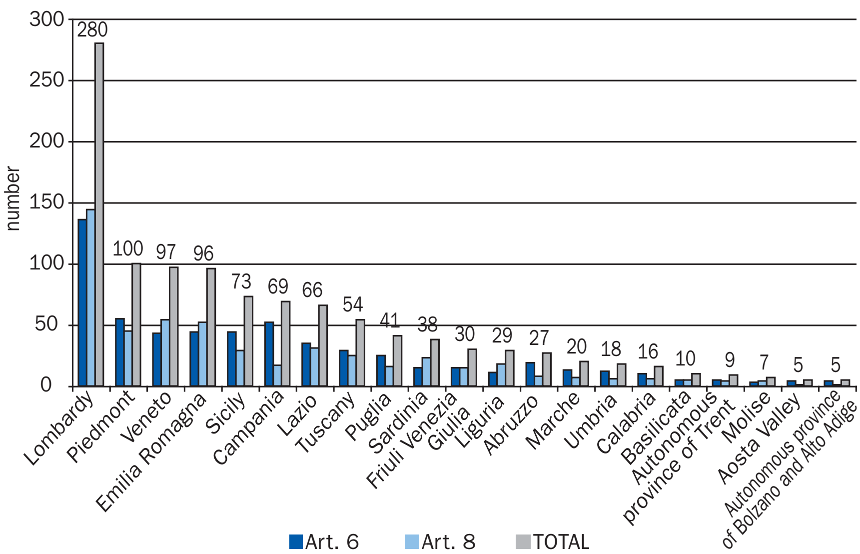

Figure 7.21: Distribution by region of establishments subject to Legislative Decree 334/99 plus subsequent modifications and updating (30/6/2009)[22]

The regions with the greatest concentration of major- accident hazards establishments are: Lombardy, Piedmont, Veneto, and Emilia Romagna.

[22] Source: Ministry of the Environment, Land and Sea data processed by ISPRA

The highest concentrations of major-accident hazards establishments are found in the provinces of Central and Northern Italy, notably Milan, Bergamo, Brescia and Ravenna in the North, and Naples in Centre-South.

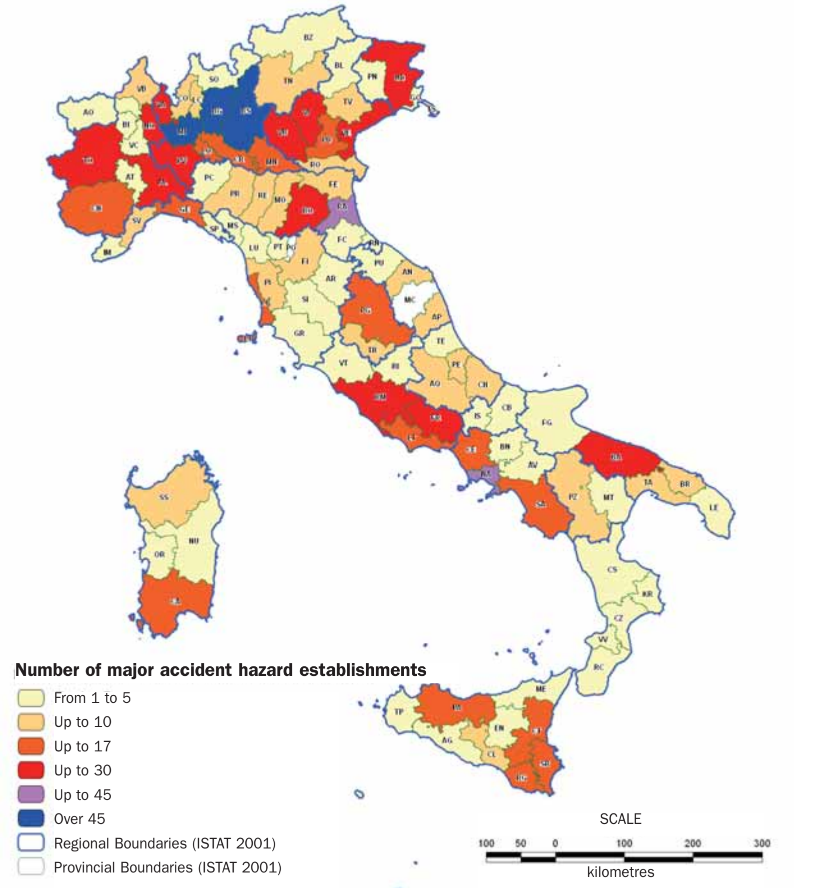

Figure 7.22: Number of major accident hazard establishments – Distribution by province (30/6/2009)[23]

When the activities of an establishment are known, then its potential risk can be identified.

An analysis of the types of establishments (Figure 7.24) also points to further considerations regarding our country's map of industrial risks. Such information makes it possible to identify the industrial activities that are most widespread among major-accident hazards establishments, as well as their distribution within the national territory. When the activities of an establishment are known, then its potential risk can be foreseen, at least in general terms. For example, storage sites for LPG or explosives, as well as distilleries and plants for production

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[23] Source: Ministry of the Environment, Land and Sea data processed by ISPRA

Municipalities with 4 or more major- accident hazards establishments include Venice and Ravenna.

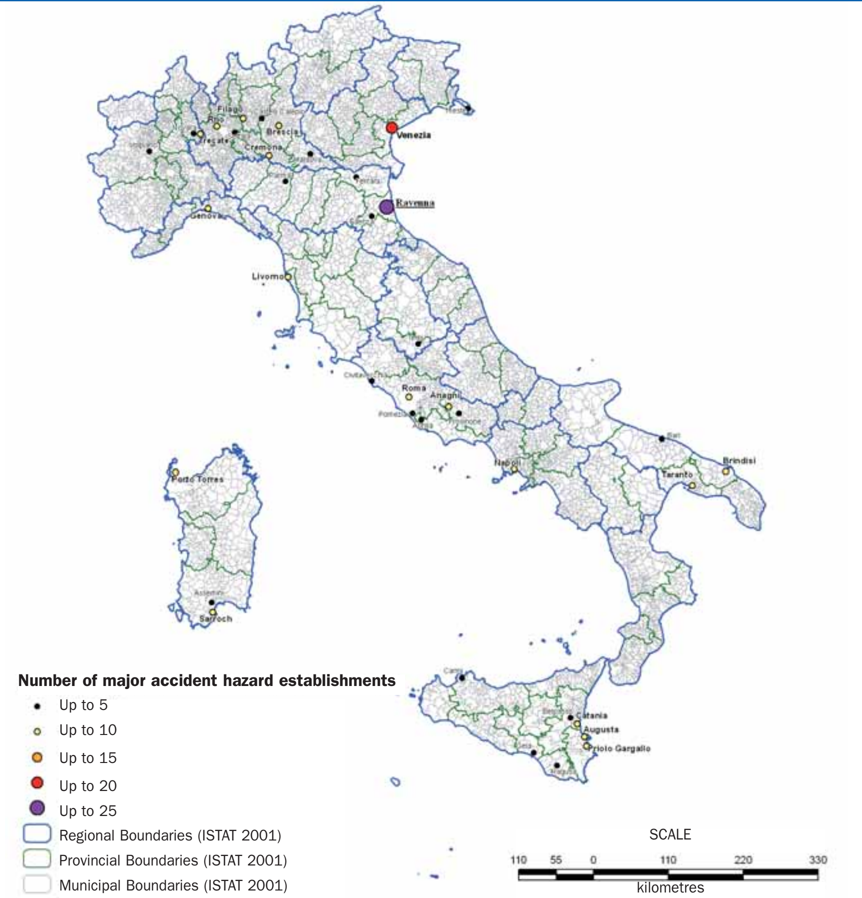

Figure 7.23: Municipalities with 4 or more mayor accident hazards establishments (30/6/2009)[24]

and/or storage of technical gases present, for instance, a prevalent risk of fire and/or explosion, with effects traceable, in the event of an accident, to radiation or overpressure of varying intensity, with possible structural damage to plants and buildings, as well as damage to human health. Chemical establishments, refineries, toxic gases and agrochemicals storage depots, are exposed not only to the risk of fire and/or explosion, as in the case of the facilities referred to earlier, but also to the risk of diffusion of toxic and eco-toxic substances, even at a

[24] Source: Ministry of the Environment, Land and Sea data processed by ISPRA

Chemical and/or petrochemical establishments, as well as liquefied gas storage facilities (mostly LPG), are the most widespread, corresponding to roughly 50% of the total number of establishments.

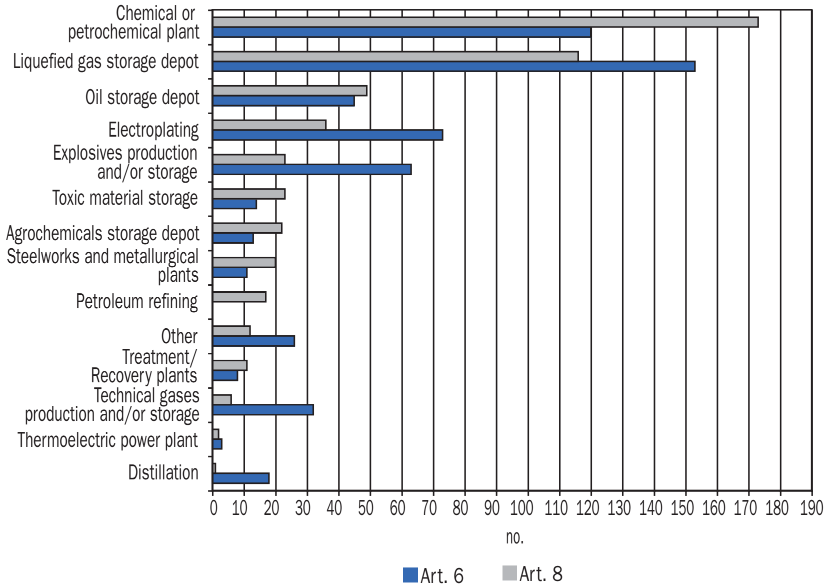

Figure 7.24: Distribution on a national basis of establishments subject to Legislative Decree 334/99 plus subsequent modifications and updating, by type of activity (30/6/2009)[25]

In Italy there is a prevalence of chemical and/or petrochemical plants, as well as LPG facilities (roughly 50%). Prevalence of chemical and/or petrochemical plants, as well as LPG facilities (roughly 50%). The former are essentially concentrated in Northern regions, while the latter are also widespread in the South.

distance, giving rise to immediate and/or delayed danger for both man and the environment. An analysis of the types of activities that are carried out on the national territory shows a prevalence of chemical and/or petrochemical establishments, as well as liquefied gas facilities (notably LPG), corresponding, when taken as a whole, to 50% of the total number of establishments. Chemical and petrochemical establishments are mainly concentrated in Lombardy, Piedmont, Emilia Romagna and Veneto. Refineries (17 plants in Italy) are distributed more or less throughout the national territory, with especially heavy concentrations in the regions of Sicily and Lombardy, which respectively contain 5 and 3 plants. A similar situation is observable with regard to mineral oil storage depots, which are concentrated near the country's major urban areas. LPG tank storage sites are currently widespread in Campania and Sicily, as well as in Lombardy, Tuscany, Veneto and Emilia Romagna. The sites of these plants are often located near urban areas, and are particularly concentrated in the provinces of Naples, Salerno, Brescia, Venice and Catania.

[25] Source: Ministry of the Environment, Land and Sea data processed by ISPRA

Such information – combined with risk scenarios, and correlated with the vulnerability level of the surrounding territory – makes it possible to produce risk maps to be used for land use planning, providing information to the public, and ensuring adequate emergency preparedness and response.

The causes

The potential danger tied to the presence of major-accident hazards establishments in Italy is comparable to that of the other major European industrial countries, though Italy presents certain peculiarities tied to the development and history of its industry, as well as to choices made in the past, notably in terms of energy supply. An example worth note is the concentration of refineries to be found in Sicily and Lombardy, as well as the development of major petrochemical complexes in the post-war period, as well as in the Po Valley (Ravenna, Ferrara), in the Venetian Lagoon (Marghera), and, starting from the Sixties and Seventies, in Southern Italy (Brindisi, Priolo, Gela, Porto Torres, etc.). Within the overall European framework of establishments at risk of accident, one of the Italian peculiarities is the impressive development of the network of LPG tank storage sites, supplying gas to the areas of the country that are not reached by the methane distribution network.
Another characteristic of the Italian situation is the presence of industrial districts characterised by a concentration of small and medium-size industries with production activities that are similar or belong to the same production chain, such as the chemical or pharmaceutical sectors in certain areas of the Lombardy Region (where 25% of major accident hazard establishments are located) and in the Pontine area, or the electroplating industry in Veneto, Piedmont and Lombardy. These establishments often operate in congested territories located near urban areas, or in any case densely populated zones, characterised by the presence of population centres that would be highly vulnerable in the event of accidents.

Solutions

The regulatory framework on the control of major-accident hazards on the European and national levels is now thorough and complete, following the passage of three subsequent directives subsequently transposed into national legislation. Procedures

One of the peculiarities of Italy is the impressive development of the network of LPG tank storage sites, supplying gas to the areas of the country that are not reached by the methane distribution network. Another national characteristic is the presence of industrial districts, characterised by a concentration of small and medium-size industries with operations are similar or belong to the same production chain.

Procedures adopted in Italy are in line with those applied in the other EU countries.

adopted in Italy are in line with those applied in the other EU countries, confirming a substantial alignment with European standards, though there is room for improvement in terms of:

- streamlining and accelerating procedures for the assessment of safety reports and the intensification of inspections and controls;
- increasing awareness of municipal administrations as regards problems tied to industrial risk, with reinforcement of the activities involved in the land use planning and the supply of information to the public;
- qualitative improvement of activities related to external emergency planning in the event of accidents.

The abovementioned improvements can be introduced, provided that the following requirements are satisfied:

- the certainty of resources being available to the municipal governments and technical agencies involved, including the introduction, as provided for under the Seveso regulation, of a system of fees to be paid by operators of major-accident hazards establishments, based on the controls carried out by the Public Administration;
- progressive decentralisation of regional controls, in accordance with provisions of the "Bassanini Law", once the presence of the competent local authorities and/or guarantees of their reinforcement have been verified, notably in Southern regions; organisation and follow-up of monitoring procedures by the Ministry of the Environment, Land and Sea;
- accurate and timely definition, on a national level, of detailed technical references and criteria, to be supplied to local authorities and technical organs responsible for control activities.

Within this framework, a point of vital importance is the enhancement of the Environmental Agencies System, which – given its role, competence and the experience acquired - can offer a valid contribution to the solution of many of the problems at issue.
Moreover, a hopeful sign is to be noticed in current updating of legislation concerning risk assessment and monitoring in areas with high concentration of MAH establishments, envisaging a major technical role to be played by ISPRA and regional agencies in terms of risk area identification, risk assessment, and intervention planning.

CHAPTER 8

SOIL AND LAND

Soil provides the necessary elements to sustain human societies, but it is too often exploited or used only as a container of production waste. There is a limited awareness of the effects caused by the loss of its functions.

Introduction

Soil is essential for the existence of living species on our planet and carries out a series of functions making it essential for maintaining the environmental balance. Despite this, it is too often perceived only in terms of support to agricultural production and as a physical base on which to develop human activities.
Soil plays a primary role in: protecting underground waters from pollution; controlling the quantity of atmospheric CO_2; regulating surface water flows producing direct effects on floods and landslides; maintaining biodiversity; nutritional element cycles, etc. Plant biomass depends on the soil's conditions with evident consequences on the whole food chain.
Soil, as an extraordinarily differentiated biological laboratory, can be considered a complex living body that continually evolves and that, under certain aspects, is far from being well known. It supplies human beings with the necessary elements for their sustenance, nevertheless it is also a non-renewable and extremely fragile resource. It is too often treated as a container for production waste or as a means of exploitation. There is a limited awareness of the effects deriving from the loss of its functions.
Soil can be affected by serious degradation processes caused by: incorrect agricultural practices; concrete and asphalt sealing, particularly on densely populated areas and where economic activities and infrastructures are concentrated; variations in its utilization and the local effects of global climate change. 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.
This resource must therefore be protected and used in an adequate way, in harmony with its intrinsic properties so that it can continue to carry out its irreplaceable and effective function on our planet.

Currently, there is a good knowledge on land use in Italy but soil data are still rather heterogeneous.

The situation in Italy

An important asset to understand soil-related factors, processes and services is to implement sustainable development and land planning policies. This strategy might be performed by combining socio-economic needs and require-

ments, also in terms of safety, with a cautious and respectful management of the natural heritage and its associated resources. Still, in Italy available information should necessarily be improved to give a thorough and harmonised outline of soil use and information.

In Italy information on soil has a long history but it is only from the 1990s that many Italian regions started to systematically collect data on soil and produce maps and databases. Despite the large amount of data on soil collected, even if not equally distributed, the information is rather heterogeneous and in many cases limits the possibility of making organic syntheses throughout the country. To try and resolve this situation, projects for harmonising soil regional information have been established. Most of the data provided below should therefore be considered approximate. They will represent the national situation but no sooner they have been completed.

Organic carbon (OC), which accounts for approximately 60% of soil organic matter, carries out an essential positive function on many soil properties. It facilitates the aggregation and stability of soil particles reducing erosion, compression, cracking and the formation of surface crusts. Organic carbon binds effectively with various substances, improving soil fertility and its control capacity and increasing microbial activity. It also makes nutritional elements, such as nitrogen and phosphorus, available to plants. Knowing the amount of OC stored in Italian soils is therefore an important element to determine their condition.

Organic carbon facilitates the aggregation and stability of soil particles. It binds effectively with various substances, improving soil fertility and its control capacity and increasing microbial activity. It provides nutritional elements, such as nitrogen and phosphorus, to plants.

For example, as far as farmland is concerned, depending on the nature of soils and climate areas in Italy, an average 2% level of OC can be considered sufficient to guarantee a soil high performance in supplying plants with nutritional elements and performing many other more important functions. Furthermore, even if the amount of carbon contained in soil and vegetation is lower than that of oceans and fossils, the role of soils is still considered more important, even because they are directly influenced by human action. Knowing the OC content stored in Italian soils is the starting point to establish the role these soils can play in reducing greenhouse gas emissions.

Figure 8.1 shows the national distribution of organic carbon in percentage into the first 30 cm of soil. The map was accomplished using data from the Italian Ecopedological Map integrated, where necessary, with those of the European Soil Database. The situation shown by the map raises some concern: about 80% of Italian soils have a presence of OC lower than 2%, while the "high" OC content class practically does not exist on the Italian territory, at least according to this reference scale. The spatial distribution traces the climatic one, with an increase in the "medium" content class in the North of Italy and along the main mountain ridges. At an higher resolution, however, the first regional maps realised within SIAS project (*Sviluppo di Indicatori Ambientali sul Suolo* - Development of Soil Environmental Indicators) framework, show an improved situation, at least in some areas of the country (Figure 8.1a).

The map was accomplished on the basis of available national data and shows how most Italian soils have low levels of organic carbon especially in farmland. However, preliminary data from the SIAS project show an improved situation in some areas.

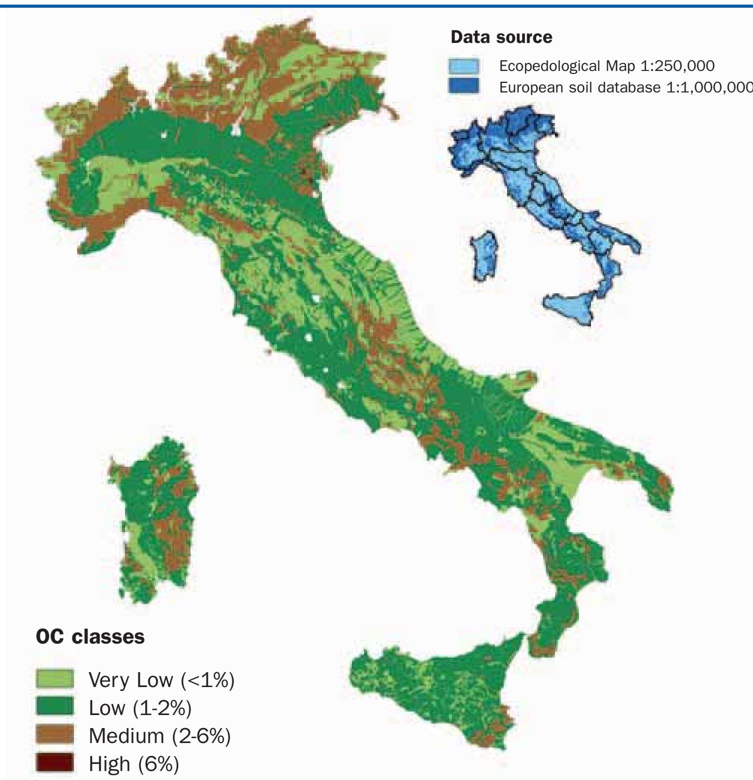

Figure 8.1: Percentage of OC in the topsoil layers of Italian soils (1988-2003)[1]

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[1] Source: JRC and MATTM data processed by ISPRA

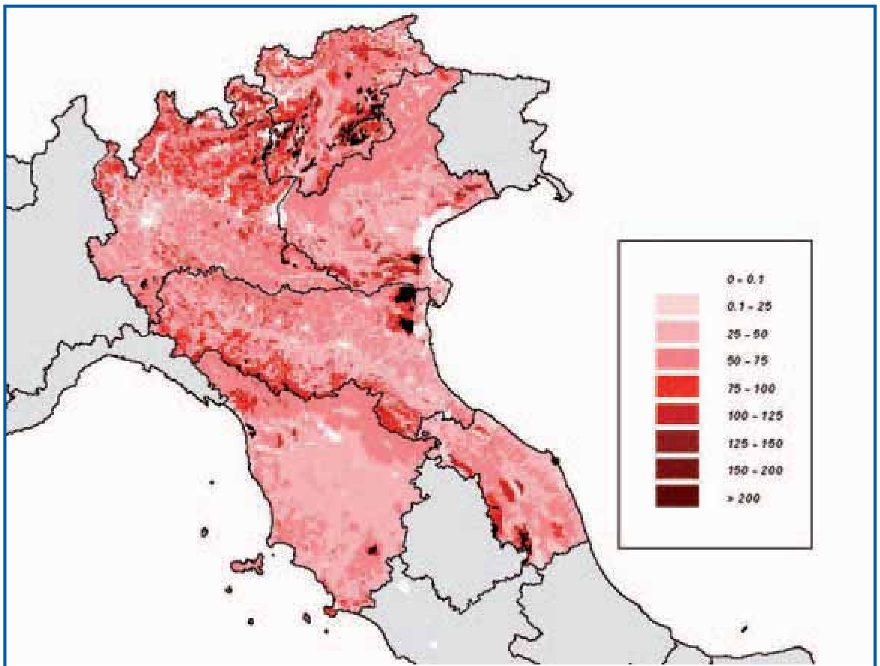

Figure 8.1a: OC content (tons/ha) in the topsoil layers (0-30 cm) of Italian soils (2008)[2]

Soil plays a key role in protecting the environment by mitigating of the negative effects of pollutants.

Soil plays a fundamental function in protecting the environment, serving as a filter and a barrier, so as to mitigate the effect of pollutant dispersion. Soil, if heavily contaminated by hazardous substances, may lose its intrinsic properties to such a level that not only its protective functions, but also its productive and ecological functions are degraded.

Impacts caused by soil contamination also involve surface and underground waters, the atmosphere and the food chain creating serious risks even human health. The economic consequences are mainly related to the need to allocate substantial financial resources for the soil's environmental reclamation and recovery. But they are also related to the value loss of contaminated areas and the need to intervene on environmental matrices that are indirectly affected by the impacts of soil contamination (particularly underground waters). An impact evaluation (SEC (2006)1165)

[2] Source: ISPRA and Regional Soil Services (SIAS Project)

Soil contamination may impact on limited areas (contaminated sites) or it can affect extensive areas (diffuse contamination).

In Italy there are 57 contaminated Sites of National Interest. The Ministry for the Environment, Land and Sea coordinates restoration directly.

related to the Thematic Strategy for Soil Protection (COM (2006) 231), performed by the European Commission, estimated that the annual cost of soil contamination ranges between 2.4-17.3 billion Euro.
Soil contamination may impact on limited and well defined areas, corresponding to known point sources (contaminated sites), or it can affect extensive areas by release into the environment of large quantities of polluting substances from multiple sources dispersed throughout the territory (diffuse contamination).
At present, in Italian national territory, 57 contaminated Sites of National Interest have been located (SIN, Figure 8.2). These sites were identified by issue of specific decrees a on the basis of the site characteristics, quantity and level of danger of the polluting substances, plus the magnitude of health and ecological risks and the detrimental effects on cultural and environmental resources. The restoration efforts of these sites are directly coordinated by the Ministry of the Environment, Land and Sea, which draws on the services of the ISPRA for the assessment of site characterization and remediation projects, as well as Regional and Provincial Environmental Agencies and the National Institute of Health (ISS).

Sites of National Interest are concentrated in areas subject to high authropogenic impact (active or abandoned industrial areas, port areas, dumps, extraction areas, etc.).

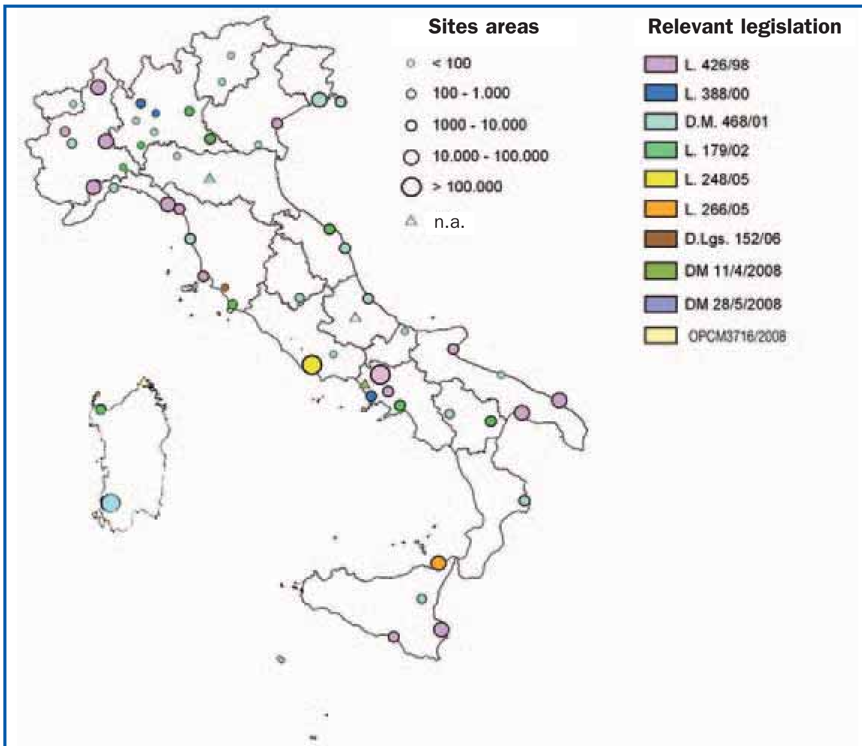

Figure 8.2: Localisation, dimensions and relevant legislation on Sites of National Interest (2008)[3]

Some Sites of National Interest are particularly extensive (e.g. the Domizio-Flegreo Littoral, Agro Aversano area and the Sulcis-Iglesiente-Guspinese site) and/or characterised by historical contamination levels of soil and groundwater (e.g. Porto Marghera). In these cases, implementation of actions for full site recovery over the medium-short term (25 years) is a difficult objective in technical, economic and environmental terms. For this reason, some of them are called "megasites". In addition to Sites of National Interest, there are several other thousands of contaminated or potentially contaminated sites falling under regional responsibility, and which, based on the legislation currently in force, should be included in special "Regional Registries of Sites to be Restored". A separate topic is that of *brownfield*. These are abandoned, inactive or underused sites which have hosted productive facilities,

There are about 15,000 potentially contaminated sites, of which more than 4,000 need to be reclaimed. These fall under the responsibility of regional authorities.

[3] Source: ISPRA

generally industrial or commercial. Their utilization is hindered by a real or potential condition of historical pollution. These sites are often located inside urban land and therefore have a high economic potential. In Italy, the regions with the highest number of brownfields are in the North, particularly in the regions of Lombardy, Piedmont and Veneto which experienced the highest industrial development in the past decades. The Centre and South of Italy is characterised, instead, by few but extensive industrial areas. These have witnessed concentrated development in a limited number of areas.

Cases of diffuse contamination are found in almost every region but Italy still lacks a uniform national scale framework.

A national homogeneous overview of diffuse soil contamination is not yet available, even though the related problems are present in almost all Italian regions. Accumulations of heavy metals in soil have been reported near road infrastructures (Pb), in wine-producing districts (Cu) and intensive farming areas. Soils contaminated by organic compounds are found near industrial areas, particularly in the Campania region where pollution by PCBs, furans and toxins is a very serious problem. As regards pollution by nitrates, available data show a surplus of nitrogen and of phosphorous in almost all Italian regions. However, these have a progressively reducing trend. The highest levels are found in intensive farming areas, particularly in some regions of the Po River Plain.

Erosion by water produces loss of soil, fertility and biodiversity.

Another issue of great environmental and economic relevance is the phenomenon of soil erosion by water (i.e. the removal of topsoil, rich in organic matter, by surface waters). Damages caused by erosion are distinguished as on-site and off-site damages. On-site damages are generally classified as damages that occur in the same place where the phenomenon takes place, which lead to loss of soil, fertility, biodiversity, etc. Off-site damages occur far from where the erosion phenomenon takes place, causing floods, damages to infrastructures, contamination of surface waters (due to transport of pollutants by surface water runoff), etc. Limiting these damages in many cases requires corrective operations especially in highly prestigious farmlands, economically relevant ones or, in any case, in areas where the erosion tolerance rate (factor T) exceeds the provided standards. The erosion tolerance rate (expressed in tons/hectare/year) enables a controlled productive and protective use of the soil. It

should therefore be generally lower with respect to the soil formation speed (pedogenesis). Assessment of soil loss is carried out by using empirical models (e.g. USLE – Universal Soil Loss Equation) and physically-based ones (e.g. PESERA – Pan European Soil Erosion Risk Assessment). The models show that in about 30% of Italian soils the erosion risk is higher than the allowed values. These national-scale estimates, realised by means of models, are only based on approximate data. There are still few experimental stations that directly measure this process and would be able to validate the results obtained. However, a national framework of reference showing the actual situation, based on data collected at local level, is currently being finalised under the above mentioned SIAS project. Regional information is being harmonized in accordance with criteria provided under the INSPIRE Directive. The project is coordinated by ISPRA in collaboration with the CRA, JRC-IES and Italian regions.

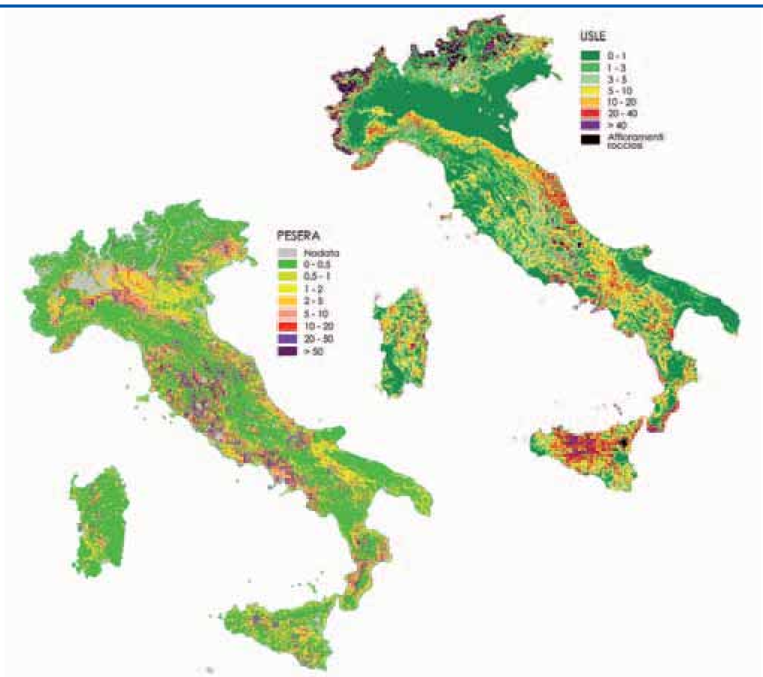

Figure 8.3: Actual erosion risk assessment (t $*$ ha^{-1} $*$ year^{-1}) according to USLE (1999) and PESERA (2004) models[4]

Loss of soil by water erosion is usually assessed by means of models. Although these estimates offer interesting information at national scale, they are affected by simplifications carried out when defining environmental parameters. Therefore, in some cases, their results can be substantially different from regional ones.

[4] Source: JRC - IES

Salinization is the accumulation of salts in soil in quantities that can compromise its vital functions.

A particularly common phenomenon, especially in the coastal areas, is soil salinization. This refers to an excess of salts in soil, due to natural and human causes. It can reach levels that can compromise vegetation and farming activities causing negative effects on the soil's biodiversity and on its resistance to erosion. The phenomenon is considered one of the main factors that lead to desertification. The JRC-IES (Joint Research Centre-Institute for Environment and Sustainability) estimates that in Europe (EU27) between 1 and 3 million hectares of land are affected by this threats (Figure 8.4).

A national map indicating the extent and characteristics of salt-affected soils is still not available but a lot of information has been collected by Universities and regional soil services. A first survey at national scale was recently carried out by the University of Palermo. It highlighted that salt-affected soils are mainly

Soil salinization is considered one of the main factors that lead to desertification. It is estimated that in Europe (EU27) between 1 and 3 million hectares of land are affected by this phenomenon.

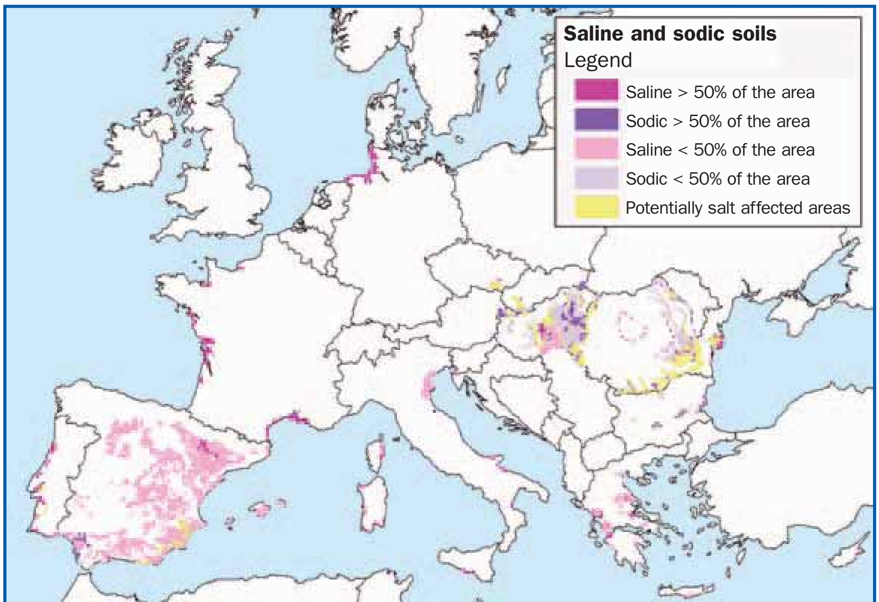

Figure 8.4: Distribution of salt affected soils in the European Union (2008)[5]

[5] Source: Tóth *et al*. (2008) *Updated Map of Salt Affected Soils in the European Union*. In: Tóth G., Montanarella L. and Rusco E.(Eds.), *Threats to Soil Quality in Europe EUR 23438* – Scientific and Technical Research series Luxembourg: Office for Official Publications of the European Communities p.61-74

located in the lower Po River Plain, along extensive Tyrrhenian and Adriatic coastal strips and on the coasts of Apulia, Basilicata and Sardinia. Sicily is worth mentioning on its own, since the problem of salinization involves 10% of its regional land (Figure 8.5).

Soil salinization affects a large portion of Italian coastal areas and is particularly developed in Sicily due to the concomitant presence of natural and human causes.

Figure 8.5: Distribution of salt-affected soils in Italy (red areas)[6]

Areas characterized by intensive farming can be prone to soil compaction process. Compaction, which is mainly due to the use of agricultural machinery, occurs when soil particles are pressed together, reducing the pore space between them. This induces important changes in the soil's structural properties and behaviour, such as the temperature and moisture regimes, the balance and the liquid and gas phases that form the soil. Apart from the topsoil, layer, compaction is also frequently formed at the depth of cultivation (plough sole). The result is not only the reduction of soil functions but also a drastic reduction of water infiltration with subsequent runoff increase.

Soil compaction is considered an important factor in the great floods that have affected different European countries.

[6] Source: C. Dazzi, (2007), *La salinizzazione*. In: Il suolo, la radice della vita. APAT

During intense and concentrated rainfall, there is frequent submersion of plain lands and superficial landslides near compacted layers of soil. This highlights that the problem is common in Italian farming areas, both plain and hilly. Quantitative data are very few and limited to some analysed areas. The only national map that is available regards the natural susceptibility of soils to compaction. It was edit by JRC-IES but does not provide information on the actual extent of the problem (Figure 8.6). At european level, compaction is considered an important factor of the great floods that have affected Northern Europe in the recent past. At national level, there is

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.

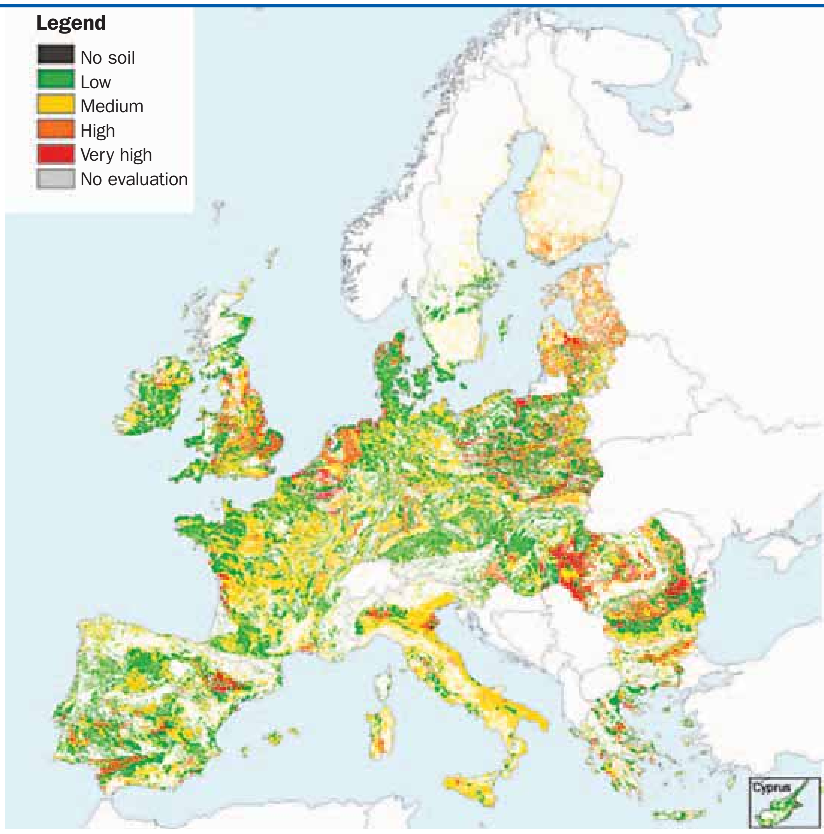

Figure 8.6: European soil compaction susceptibility (2007)[7]

[7] Source: JRC -IES

a lack of studies on the actual effect of compaction on the flooding of Italy's main river floods.

The problem of soil loss due to urbanization is a particularly serious one and a matter of concern since it strongly compromises large areas of land, which are often characterised by soils with a high agricultural value. Soil that has been sealed for urban areas and infrastructures looses many of its ecological functions, some of which become practically irreversible. Comparing between CORINE Land Cover data sets (1990 and 2000) has led to the identification of a trend in land use , even though the minimum mapping unit limit of 25 ha does not clearly show the development of scattered urban centres and of the minor road network. This highlighted that in Italy there is a progressive reduction of areas destined for agricultural use (-1.6 %), a recovery of forest or semi-natural soils (+1.0 %) and an increase of urbanized areas (+0.6 %). On the coast, urban areas have increased, especially in Sardinia and Calabria. Italy, like the rest of Europe, is reducing agricultural land due to the effects of contrasting cultural abandonment and urbanization processes, with a progressive trend towards reduced and more specialised farming areas cultivated following the mixed traditional regime. Forest and especially urban areas, instead, have an expanding trend with an increased variety of use.

Between 1990 and 2000, agricultural areas reduced by 1.6%, in favour of forest or semi-natural areas (1%) and urbanized ones (0.6%).

Soil sealing, is the result of covering the soil with impervious materials, which partially or totally prevent it from performing its vital functions. The issue primarily concerns built-up areas, where the largest surfaces covered by buildings may be found, and areas covered by industrial plants, commercial buildings and transport infrastructures, but similar effects may also be observed in intensive farmland areas, due to the formation of compacted layers of soil, or in areas predominantly used for greenhouse farming or covered with plastic mulch films. These impervious layers form a vertical barrier between the pedosphere, the atmosphere and the hydrosphere. Soil sealing limits/prevents water infiltration and the soil/subsoil's function of retaining the same, thus increasing the event of flash floods.

Soil sealing prevents infiltration of meteoric water and is a factor of floods.

The highest percentages of sealed areas are located near urban areas, near the main road axes and along the coast.

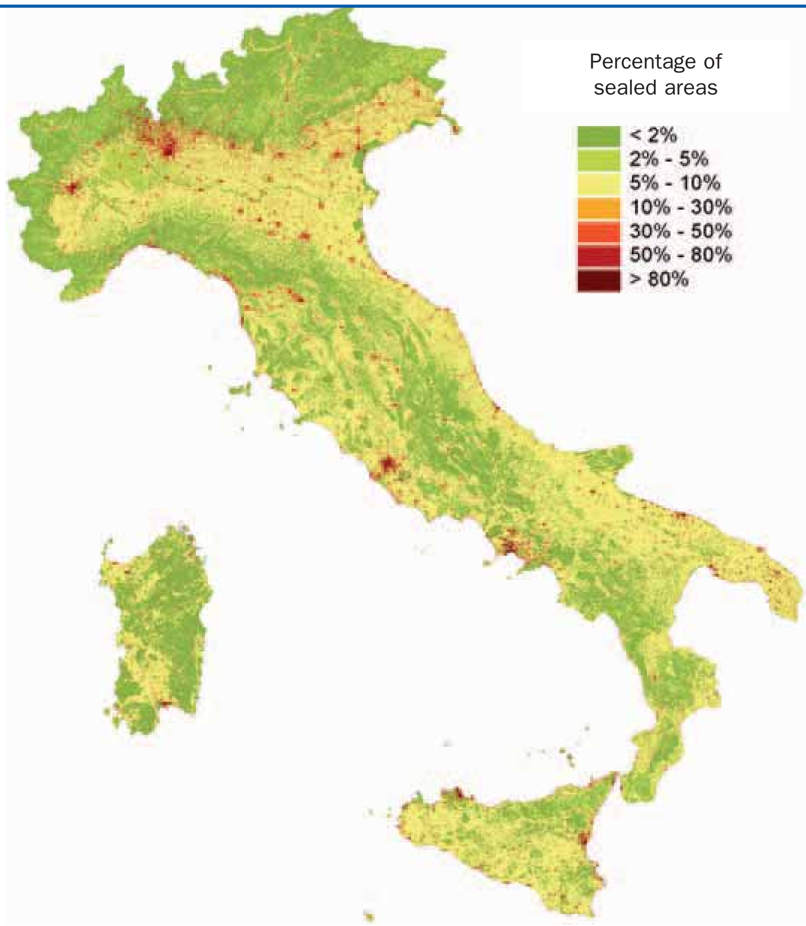

Figure 8.7: National soil sealing map (2006)[8]

The national map of sealed areas due to urbanization (Figure 8.7) is based on data from CORINE Land Cover 2000, and shows that the highest values of this problem are found in Lombardy, Apulia, Veneto and Campania with higher concentrations near urban areas and along the main road axes. In particular, the problem is assuming worrying proportions in the large plain areas, where urbanization is coupled with intensive farming.

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[8] Source: ISPRA

Progressive loss of soil biodiversity is due to all the above mentioned factors.
Soil is a very complicated environmental matrix, providing *habitat* for a huge number of organisms. In the intricate three-dimensional matrix of soil, these organisms interact with each other within a very dense food web, giving life to a very complicated system of biological activities.

Soil dwelling organism play an essential environmental role, yet only a very small percentage of species is known.

These organisms actively contribute to providing various services that are critical to the ecosystem, such as: soil formation and water and nutrients retention capacity; decomposition of organic matter and therefore availability of elements contained therein; nitrogen fixation and carbon sink; suppression or induction of parasites and plant diseases and reclamation of soil through biological processes (bioremediation) of contaminated and degraded soil (by means of contaminant detoxication and recovery of physical, chemical and biological properties and processes). Despite their importance, only a very small percentage of organisms living in soil has been identified and classified so far.
A census highlights that, compared to all other European countries, Italy hosts the highest number of soil invertebrates. This is summarised in the table below which shows the number of Italian arthropod families and species. Currently, due to the absence of a specific monitoring network, their exact distribution and the intensity of their populations has still not been identified. Areas subject to soil biodiversity loss in Italy mainly correspond to areas that are affected by previously described threats. Recent surveys have shown that inside protected areas there is a very high quantity of edaphic organisms.

Compared to all other European countries, Italy hosts the highest number of soil invertebrates.

Compared to all other European countries, Italy hosts the highest number of soil invertebrates.

Table 8.1: Number of Italian arthropod families and species, highlighting classes more related to soil[9]

Classes	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

Desertification is a global process, but it has specific characteristics according to the different ecosystems. In its most extreme forms, it concerns over 100 countries threatening the survival of more than 1 billion people. Overexploitation, unsustainable management of soil resources and climate conditions contribute to increasing the environment's vulnerability to desertification. This phenomenon does not only occur in arid, semi-arid and dry sub-humid areas of the earth but also in other parts which are prone to chemical pollution, salinization and exhaustion of water availability as well as in areas where soil management is inefficiency. The Mediterranean basin is a transition area where desertified areas alternate with areas at risk of desertification.
The EEA and the ETC-LUSI (European Topic Centre Land Use and Spatial Information) consortium have realised a map of European sensitivity desertification index (Figure 8.8).

In Italy, desertification process is becoming always more evident especially in Sardinia, Sicily, Basilicata, Apulia and Calabria.

In Italy, although the situation is not as dramatic as other parts of the world, this process is becoming always more severe in at least five regions (Sardinia, Sicily, Basilicata, Apulia and Calabria) and negative warnings are showing in other areas of Central and Northern regions. Assessing the intensity and extension of desertification is a difficult task due to the absence of a univocal and integrated methodology that can be adopted both at global and regional level.

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[9] Source: MATTM, 2006. *Check-list* della Fauna d'Italia, by F. Stoch

The Mediterranean basin is a transition area where desertified areas alternate with areas at risk of desertification.

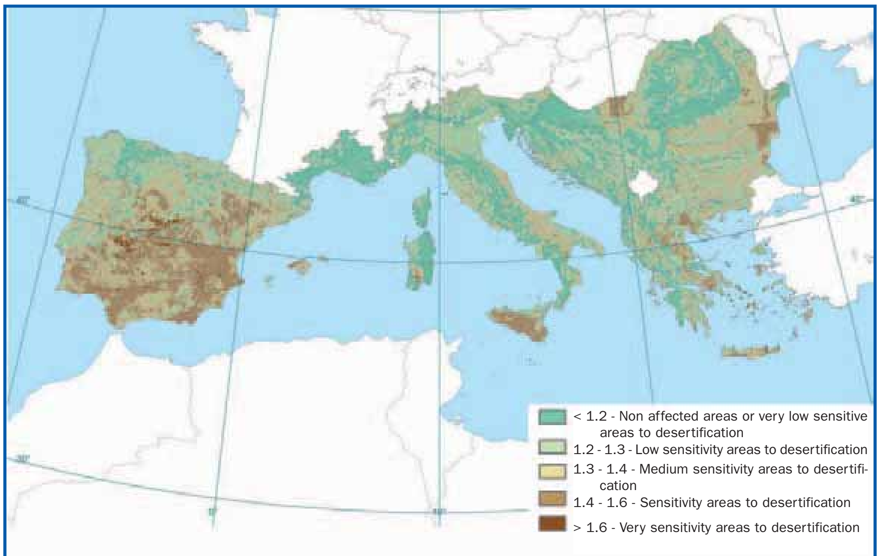


Figure 8.8: European sensitivity to desertification index map (2008)[10]

The Research Unit for Climatology and Meteorology applied to Agriculture (CRA-CMA) has recently published a national map assessing land degradation and desertification processes. In particular, the national map of the ESAI (Environmentally Sensitive Areas Index - Figure 8.9), obtained by applying the MEDALUS method, shows a medium-high degree of environmental vulnerability in Sicily (about 70% of the regional area), followed by Molise (58%), Apulia (57%) and Basilicata (55%). Six regions (Sardinia, Marche, Emilia Romagna, Umbria, Abruzzo and Campania) have a vulnerability percentage between 30% and 50%. Other seven regions (Calabria, Tuscany, Friuli Venezia Giulia, Lazio, Lombardy, Veneto and Piedmont) show a land vulnerability assessment between 10% and 25%, and three regions (Liguria, Aosta Valley and Trentino Alto Adige) show very low values (between 2% and 6%).

[10] Source: Fondazione di Metereologia Applicata, AEA, ETC-LUSI

In Italy, about 33% of the country (equivalent to about 10 million hectares) is vulnerable to land degradation processes, even if at different levels.

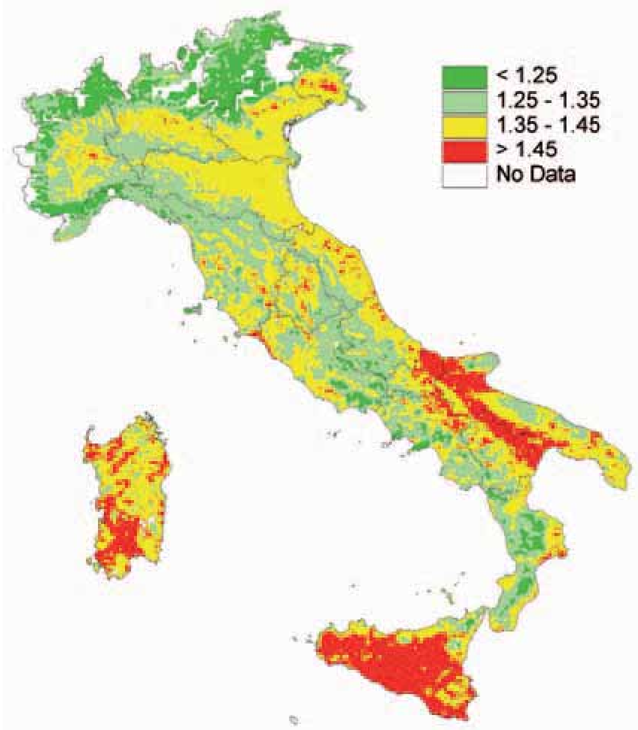


Figure 8.9: National environmental vulnerability index (2000)[11]

The difference between the Italian situation (represented in Figure 8.9) and the one realised on a European scale is due to the utilization of different databases and historical trends that make it difficult to compare results and final vulnerability indexes, even if the same methodology was used.

Extraction activities have temporary impacts and produce permanent changes on land.

Primary and secondary mineral extraction activities (mines and quarries, respectively) represent an important sector of the national economy, which, however, also features a high environmental and landscape impact. Besides the temporary impacts (noise, dust, pollution, etc.), these activities produce deep and irreversible amendments to the landscape as well as a permanent soil loss, possible pollution of underground water and a series of problems related to the use of abandoned areas.

[11] Source: CRA-CMA, CNLSD, MATTM

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 active mineral sites. Only 194 are now operating.

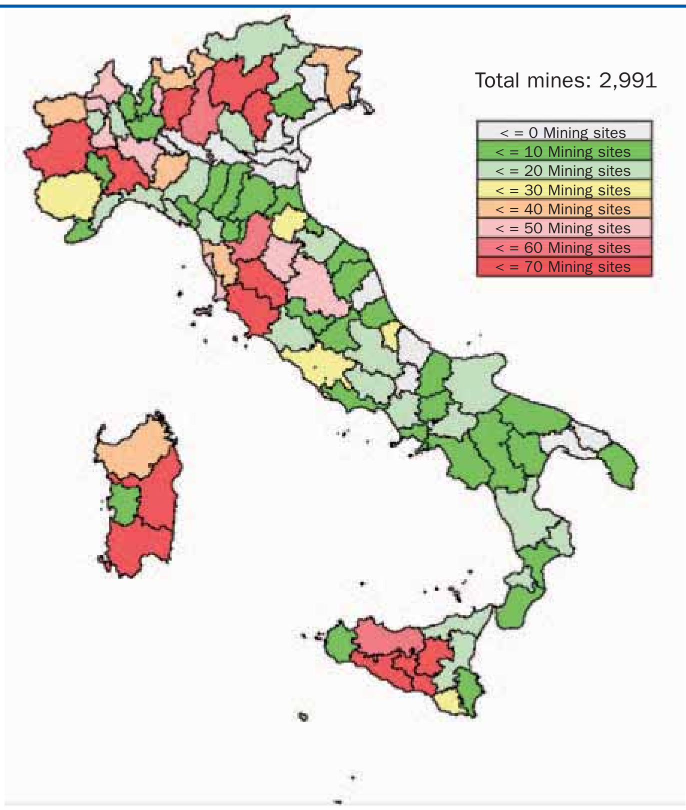


Figure 8.10: Registered mining sites in Italy (2006)[12]

In the period between 1870 and 2006 a total of 2,991 mines were active in 88 provinces out of 103. Mining activities spread nationwide according to a growing trend up to the middle of the last century. Currently, mining is residual and mainly related to the extraction of marlstone for cement, ceramic minerals and minerals for industrial use. The progressive downscaling of mining activities, particularly those related to the extraction of metal ores which produce discards with a high concentration of pollutants, has certainly mitigated the pressure of mines on the environment. However, the serious ecological, health, static and structural problems relating to the hundreds of abandoned mines have not yet been solved.

Mining activities have been scaled down with respect to the last century but problems related to abandoned sites are still unsolved.

[12] Source: ISPRA – Census of abandoned mining sites

Active quarries are distributed throughout the national territory. It is still not possible to make an outline of abandoned or illegal sites.

As regards quarries, data collected from relevant regional offices show that there are currently about 5,400 quarries operating in the country, of which more than 60% extract flood materials and carbonatic rocks. The regions with the highest number of quarries are Veneto, (where the extraction of flood materials is particularly developed), Apulia (with an absolute predominance of limestone extraction), Sicily, Sardinia and Tuscany (which has the highest number of metamorphic rock quarries due to marble extraction sites on the Apuan Alps) as well as the autonomous provinces of Trento and Bolzano. As at today, it is still not possible to make an outline of the thousands of unused or illegal quarries, which can be a source of serious environmental problems related to their intended use.

The regions with the highest number of active quarries are Veneto, Sardinia, Sicily and Apulia. The provinces of Vicenza, Verona, Trento, Bolzano and Bari have more than 140 active quarries in their territories.

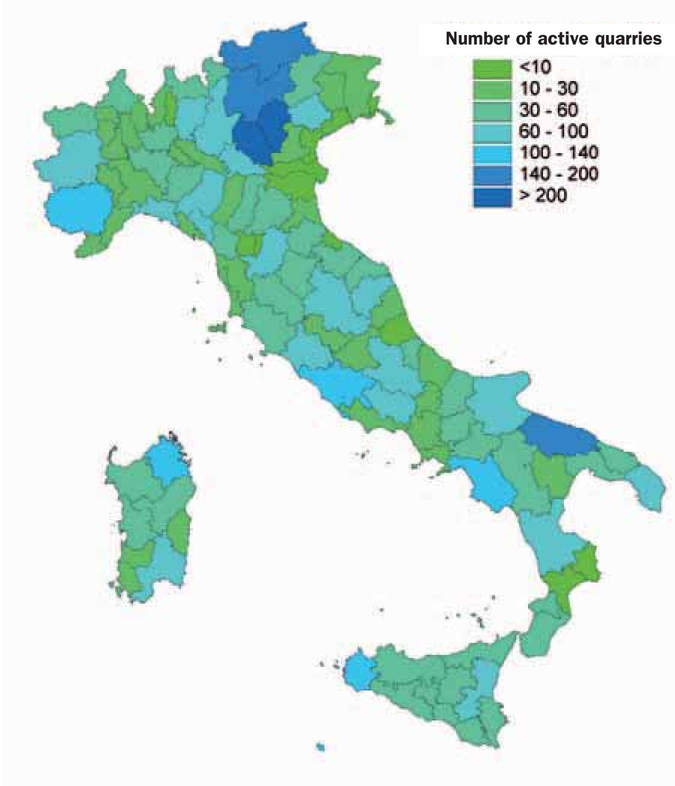


Figure 8.11: Active quarries in Italy (2009)[13]

[13] Source: ISPRA

The most important energy resource deposits are located in: Basilicata (which produces 75% of oil and 12% of natural gas in Italy); Sicily (which produces 10% of oil and 4% of gas); the Adriatic offshore (where there is the highest production of natural gas - 52% in zone A, 14% in zone B and 10% in zone D, respectively in the higher, medium and lower part of the Adriatic coast).
Recoverable reserves are estimated to be about $130*10^6$t of oil and $100*10^6$ Sm^3 of natural gas, but the production is constantly decreasing (Figure 8.12).
Despite the great geothermal potential of the Italian territory only two areas are being exploited, both located in Southern Tuscany (Larderello-Travale/Radicondoli and Monte Amiata). The production of energy from geothermal sources is in any case constantly increasing. The geothermalelectric station installed in Northern Lazio (Latera) was abandoned due to technical and environmental problems.

Most of the country's oil is produced in Basilicata, while natural gas is mainly produced in the higher part of the Adriatic coast. Production of geothermal vapour is developed only in Tuscany.

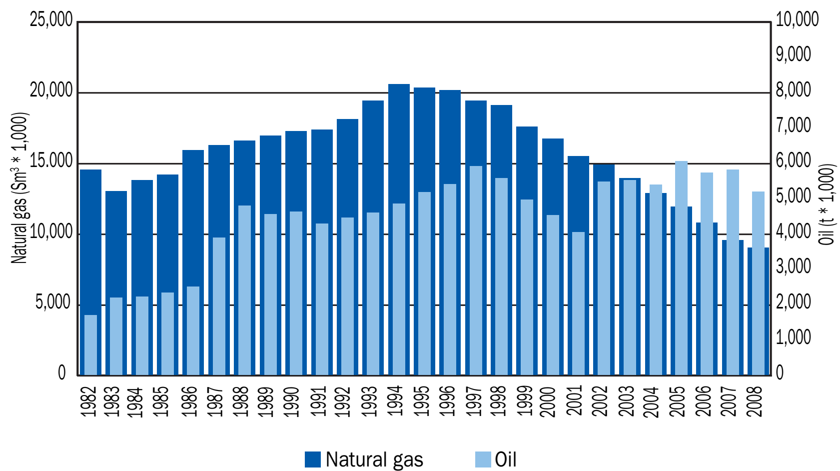


Figure 8.12: National production of oil and natural gas (2008)[14]

Since 1994, the production of natural gas is decreasing due to the decline of old fields that are insufficiently replaced by new findings. Even the production of oil has reduced with respect to 2008 (-11%).

Geosites are geological and geomorphological areas having rare and unique characteristics; they are an important component of our geological heritage and give essential information for our knowledge of the Earth. They also provide an essential contribu-

In Italy are actually counted, about 4,000 geosites.

[14] Source: Ministry for Economic Development data processed by ISPRA

Italy is rich of geosites and geodiversity and therefore of biodiversity (which is produced by geodiversity).

tion to the scientific understanding of the geological history of a region and have an exceptional value for the landscape and for the cultural, educational and recreational life of the land. Geosites are non renewable natural resources that need to be studied and counted as a landscape component that needs to be protected and conserved. Italy, with its particular geological and geomorphological characteristics, is rich of geosites and geodiversity and therefore of biodiversity (which is produced by geodiversity).
Geosites are an expression of the geological, geomorphological, hydrological and pedological variety in a given area. They are important for the life of the different species existing in that area. Conserving the geodiversity and protecting the geological heritage therefore contribute to combating biodiversity loss and maintaining the integrity of ecosystems. Since 2002 ISPRA is updating a database of Italian geosites, which have today reached almost 4,000 (Figure 8.13). Keeping a database of geosites is necessary since this knowledge is at the basis of any protection and sustainable development activity to be carried out in the territory.

The number of geosites differ from region to region according to the progress of census operations.

Figure 8.13: Distribution of geosites in Italy (2009)[15]

The main causes of soil degradation

The various problems related to physical and biological degradation of soil in most anthropized areas (e.g. erosion, compaction, organic substance loss, etc.) are mainly caused by the great transformation suffered by the Italian territory during the last century, when economic development came into contrast with the soil's ecological functions.

The irregular expansion of urban centres, industrial development, springing up of infrastructures, extraction of raw materials and modernization of agriculture (focused on research and maximum productivity) exercised considerable and, at times, inevitable pressure on soil. A large part of the territory was therefore sacrificed

[15] Source: ISPRA

to the society's development needs, often in an inconsiderate way. We have now reached a stage in which we can no longer postpone the protection of this resource and need to adopt policies for the sustainable management of land and soil.

Activities involved with punctual contamination are: oil refining industries, chemical and metallurgical industries, manufacturing of asbestos products and some waste management activities.

The presence of contaminated sites is a problem common to all industrialized countries, as it is often linked to human activities such as industries, mines, waste deposits and other structures that because of spilling, plant/tank leakage, incorrect waste management, etc., may have an impact on local soil contamination. In Italy, the activities mostly involved with punctual contamination phenomena are mainly related to oil refining industries, chemical and metallurgical industries, manufacturing of asbestos products and some waste management activities.

However, diffuse contamination can even be caused by atmospheric fall-out, intensive farming or widespread and/or prolonged human activity. This makes it difficult to identify the exact source of contamination (Figure 8.14).

Diffuse contamination is caused by industrial, civil or agricultural sources. When soil looses its protective functions, polluting substances contaminate water flows and layers entering the food chain.

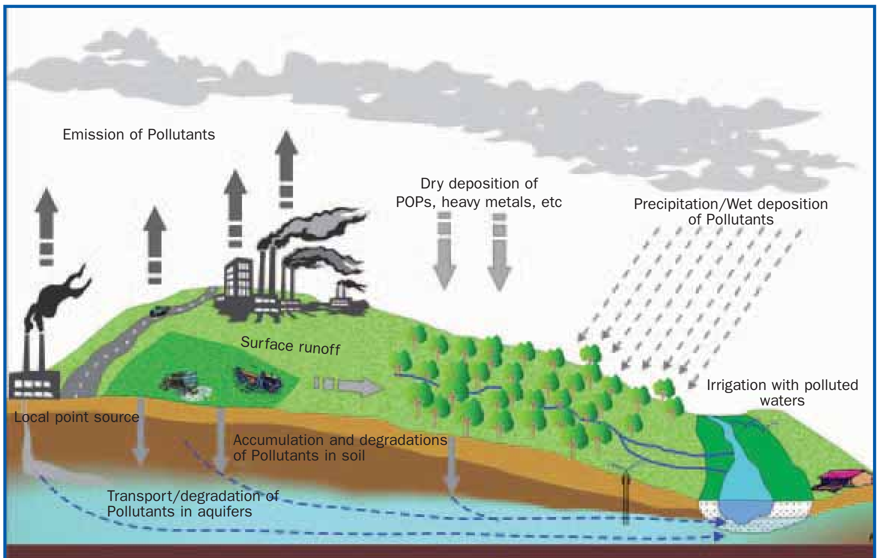


Figure 8.14: Diffuse contamination diagram[16]

[16] Source: ISPRA

Industrial and vehicle emissions that are in the atmosphere cause the release into soils of acidifying contaminants (SO_x, NO_x and NH_3), heavy metals (Pb, Hg, Cd, As, Cr, Cu, Ni, Se and Zn) and organic compounds (straight-chain hydrocarbons, IPA, dioxins, furans, etc.). Intensive farming practices, making abundant use of pesticides, chemical fertilisers and manure, can result in an excess of nutritional elements (N, P and K), in accumulation of heavy metals and in the spread of biocide substances. In particular, an excess of nutritional elements can result in serious groundwater pollution and eutrophization of water ecosystems, since nitrates are highly soluble in water and not easily retained by soil.

Industrial and urban activities release acidifying substances, heavy metals and organic compounds in the atmosphere. Farming practices result in excess of nutritional elements, accumulation of heavy metals and the spread of biocide substances.

The observed trend of excess nitrates has gradually decreased in almost all Italian regions in the last decades, thanks to the measures taken to comply with the current legislation. In some cases, the use of sewage sludge in farming (that can produce significant quantities of hazardous substances if combined with nutrients and organic carbon) has raised concern when it is not correctly managed and controlled.

The nitrate surplus trend is gradually decreasing in almost all Italian regions, mainly as a result of measures taken to comply with the current legislation.

Finally, in specific geological contexts, the high levels of some contaminants can have a natural origin[17]. Infact, an elevated concentration of heavy metals in the soil can be determined by the chemical characteristics of the rock/parent material. Therefore, in order to identify eventual human contamination, action needs to be taken to correctly define the soil's natural content.

Some soils can have naturally high contents of contaminants.

Data collected by APAT/CTN_TES (2005) from a limited number of samples, but covering most Italian regions, highlight an accumulation of Zn, Cu, Pb and Cd in the first 30 cm of soil. This witnesses a human contamination, both industrial/civil (Pb and Cd) and agricultural (Cu and Zn). Other elements (Ni, Cr and As) present higher concentrations below the topsoil, which could confirm a natural content for the areas of reference due to the geological composition of parent material.

When assessing the amount of heavy metals in soil, it is extremely important to distinguish the natural content (background value) from that originated by human activities.

Excessive concentrations or mixtures of pollutants have negative

[17] APAT-ISS: *Protocollo operativo per la determinazione dei valori di fondo di metalli e/metalloidi nei suoli dei siti di interesse nazionale*. June, 2006

Pollution, intensive farming, erosion, compaction, salinization, organic matter decline and sealing are also responsible for soil biodiversity loss and therefore reduce its vital functions.

effects also on soil organisms both directly (emigration or death of the most sensitive individuals or species) and indirectly (development of resistant and generalist organisms). For this reason, soil biodiversity is more and more utilised in soil and contaminated site monitoring programmes. It can be used as a useful biological indicator to integrate chemical and physical data collected during conventional soil analyses.

However, the causes of soil biodiversity loss are not limited only to the presence and persistence of pollutants. Intensive farming also may have a very negative impact. Heavy and frequent farming and the formation of compact layers often reduce the availability of a favourable habitat for soil biota. Reducing the porosity of the so-called "plough sole" also reduces the diffusion of oxygen, water retention and nutrient migration, therefore producing changes in food chains and particularly modifying the type and distribution of soil organisms.

A serious biodiversity loss can also be caused by changes in land use particularly involving soil sealing. Other threats come from decreases in organic matter supply or to its loss due to erosion or following fires. The availability of organic carbon is one of the main factors that determines the growth of soil organisms. Its reduction can inhibit biological activities.

Increase in salt or pH variations in soil are other factors that limit the presence of soil biota and change the structure of microorganism communities.

Finally, the casual or deliberate introduction of allochthonous species often causes invasive demographic explosions that damage autochthonous species, which are in harmony with the environment.

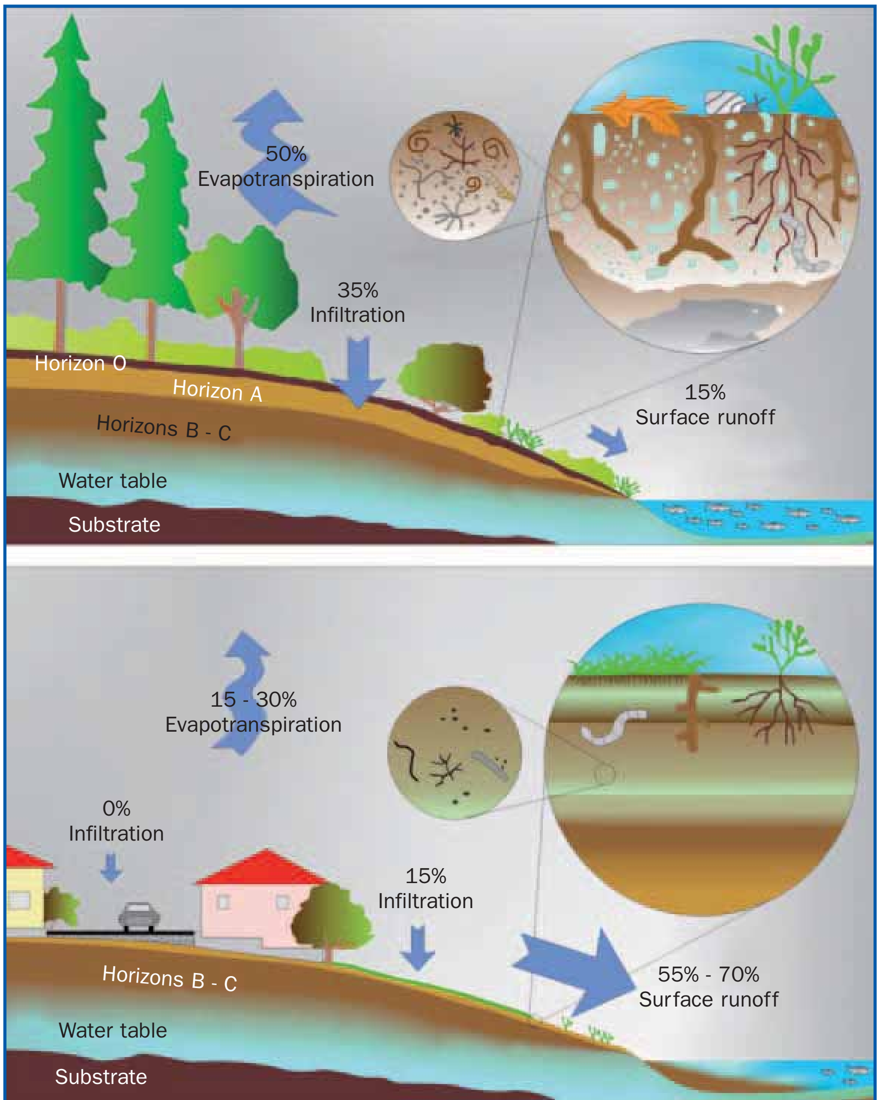


Figure 8.15: Indicative sketch of water movement on natural and anthropised soil[18]

Soil in its natural conditions is able thanks to its porosity, permeability and humidity, to retain a large quantity of water from rainfall contributing to regulate the surface runoff. In an anthropized environment, on the other hand, the presence of impervious surfaces, the reduction of vegetation, the, removal of the surface layer (rich in organic matter) and the onset of compaction processes result in an increase in surface runoff and in the transport of large quantities of sediment in natural collectors. The values shown in the figure are only indicative and can change significantly depending on a variety of parameters (the physical and chemical characteristics of soil, the topography and geology, as well as the duration and intensity of rainfall, etc.).

Biodiversity loss, which implies a progressive loss of the soil's functional capacities, is also related to the reduction of organic substances.

Organic matter (OM) loss is one of the most serious process of

Organic matter decline is related to transformation of soil's intended use and to intensive farming practices.

[18] Source: USDA-NRCS, 2005. Urban Soil Primer. Redraw by ISPRA

soil degradation. This phenomenon is, on one side, related to land use and land cover changes at different times (impressive deforestation, conversion of forests or of permanent pastures to arable lands, etc.) and on the other side caused by the development of intensive farming practices. Indeed, a great anomaly in agricultural systems adopted during the last century is the breaking of the organic matter cycle, of which agricultural biomass is an important stage. In addition, traditional reintegration practices (especially with manure) were abandoned for a long time. Therefore the input of organic carbon for soils used in these systems mainly relies on a more or less cautious management of crop residues and various other forms of exogenous organic substance supply. Organic matter mineralization processes also depend on the climate and the type of soil. In the Mediterranean, the concentration of OM in soil is generally low. Therefore, in Italy, the speed with which soil problems related to OM reduction arise is clearly higher.

Agricultural practices focused only on productivity have triggered off serious erosion and soil compaction phenomena.

Agricultural practices aimed at supporting specialized and intensive farming have greatly transformed the agricultural landscape and have not been able to keep a balance between production needs and the environment. The abandonment of hydraulic and agricultural facilities and of terracing plots, the levelling of lands, cultivation along steep slopes, excessive crushing of soil clods and the use of always heavier machinery have triggered off dangerous soil erosion phenomena which have caused a loss of surface horizons, rich in organic matter.
Heavy machinery also causes the most serious cases of soil compaction, particularly when used on wet soils. Excessive grazing also has a similar effect while prolonged ploughing at the same depth causes the formation of a compact layer in the soil (plough sole).
The impacts of farming on soil can be mitigated by using innovative farming practices that enable the soil to keep its productive capacity and fertility. The results of a recent project conducted by the European Commission[19] on specific farming systems

[19] Sustainable agriculture and soil conservation – SoCo project - http://soco.jrc.ec.europa.eu/

(conservative and organic farming) have highlighted the important positive effects of applying these alternative farming practices from an economic, social and especially environmental point of view. Farming systems such as no-tillage or reduced tillage adequately combined with cover crop or appropriate crop rotation can reduce soil degradation processes and help to achieve good results (see Table 8.2), such as:

- The reduction of the water erosion risk and subsequent increase in the soil's capacity to absorb water;
- The increase in organic matter and carbon dioxide in topsoil due to the reduced use of pesticides and weed killers, protecting the underlying water table from possible pollution and reducing the storage of greenhouse gases;
- The organic carbon stock, biological activity, above- and below-ground biodiversity and soil structure are all improved. An higher biological activity results in the formation of well-connected, mostly vertical soil macro-biopores that increase water infiltration and resistance to severe packing.

However, the implementation of similar farming systems must inevitably keep into account the initial investments that farmers need to make in specialised machinery, the extensive training and the transition period of five to seven years before a conservation agriculture system reaches equilibrium.

A conservative farming system generally needs between 5 and 7 years before reaching its equilibrium.

Table 8.2: Effects (positive/negative) of farming practices on soil degradation processes and relative environmental issue[20]

Conservation agriculture	Soil degradation processes				Related environmental issue			
	Water erosion	Organic matter decline	Compaction	Salinizatione/ Sodification	Contamination	Biodiversity	Landslides and floods	Greenhouse gas emissions
No- or reduced tillage	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							
Buffers	1	3	3		1	1		
Terraces	1	3					2	

Legend:
1 = Positive effect (observed)
2 = Positive/negative effect (observed)
3 = Positive effect (expected)
4 = Positive effect (limited or indirect)

Results of the SoCo (Sustainable Agriculture and Soil Conservation) project highlighted that there are no specific solutions to reduce the effects of soil degradation process caused by the application of inadequate farming practices. Conservative agriculture, which some people still call “Blue Agriculture”, can be a solution. But even in this case it is necessary to assess whether it can apply to the soil’s specific nature, the type of farm and the production that is planned. Modern agriculture, also aimed at preserving natural resources, cannot avoid having a deeper knowledge of the same resources and studying the “territorialization” of farming management systems.

[20] Source: http://soco.jrc.ec.europa.eu/

The project also highlighted the positive effect of the Common Agriculture Policy reform, which introduced "environmental conditions". The implementation of measures on the "environmental condition", "Mandatory Management Criteria" (MMC) and "Good Agricultural and Environmental Practices" (GAEP) are tools that can have a strong impact on the reduction of soil degradation phenomena.

Italy, like other countries of Mediterranean Europe, is particularly affected by salinization problems related both to factors that cause the formation and natural evolution of soil on particular *parent material* (primary salinization), factors induced by man (secondary) or the concurrence of both effects. In particular, secondary salinization of soils due to irrigation is a problem that is bound to worsen not only because of the strong competition in the use of water between cities, industries and countryside but also due to the overexploitation of water layers, the use of always less adequate water in agriculture (salty waters, civil and industrial refluent water) and the effects of climate change that increases aridity, reduce leaching and therefore increase salinization. Areas that tend to have a hot and arid climate are therefore particularly exposed, such as the coastal areas, where excessive drainage (for agricultural, civil or industrial use) reduces water layers and increases the possibility of saline water intrusion.

Italian coastal areas are particularly exposed to salinization phenomena due to the drainage and use of water, which is becoming always more salty.

The process of soil degradation is therefore related to different factors caused by natural or human pressure. Desertification is the result of this complex system of interaction and takes place when degradation compromises the sustainable productive capacity of agricultural and forest ecosystems in an irreversible way. Climate factors that mostly characterise this process are aridity, drought and rain erosiveness.
The main anthropic causes of desertification are, instead, related to socio-economic activities and their impacts: agriculture, breeding, management of water resources, woodland fires, industry, urbanization, tourism, dumps and extractive activities.

Desertification is the final stage of soil degradation.

All these activities produce a competitive use of natural resources (soil, water and vegetation/biodiversity) and their subsequent overexploitation with respect to their actual availability.

Soil degradation is related to factors caused by natural or human pressure.

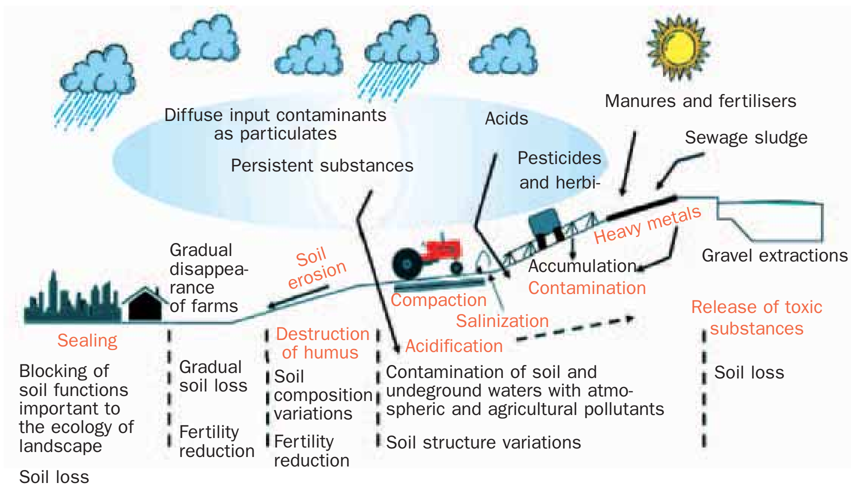


Figure 8.16: Diagram of threats that compromise soil functions. Desertification is the final degradation stage[21]

Action aimed at soil conservation

At European level, the growing awareness of the environmental importance of soil and the need to: contrast its progressive degradation and function loss; limit the development of desertification processes; mitigate hydrogeological instability and reduce human pressure on land has led to a substantial review of the legal framework. The 6th Environment Action Programme, the new Common Agricultural Policy (CAP; Reg. EU 1782/03 and 1783/03) and the directive proposal for soil conservation (COM (2006) 232) acknowledge the environmental function of soil and lay the foundations for the protection and conservation of this resource.

The new Common Agricultural Policy lays the foundations for sustainable agriculture.

Due to problems caused by the application of the old CAP with respect to surplus production, excessive increase in community investments, the emergence of considerable environmental

[21] Source: JRC - IES

damages and progressive reduction of performance, the new agricultural policy is focused on environmental sustainability.
Based on the principles of Agenda 2000, the subsequent medium-term reform of the CAP (Fischler Reform) was a decisive turning point towards an agriculture that could be balanced as much as possible with the environment in order to guarantee productivity even in the future.
The Fischler Reform is based on four main points: *decoupling, modulation, conditionality* and *rural development.*
The principle of "conditionality" is of particular interest to soil conservation. According to this principle, farmers benefit from direct payments only if they observe a series of requirements related to the correct management of land (even in absence of farming). Among these requirements are food safety, respect of the environment, personnel safety, animal health and livelihood.
Farms are therefore supported if they respect the Mandatory Management Criteria (MMC) and they keep the land in Good Agronomic and Environmental Conditions (GAEC). Every year, the Ministry of Food, Agricultural and Forest Policies issues a decree with the full list of MMC and GAEC that need to be respected during the course of the subsequent year, giving single regional authorities time to issue implementation provisions that are more adequate to each specific territory.
In particular, the MMC are legal provisions ("Acts") already in force deriving from the national and regional implementation of the corresponding community laws (e.g. Directive 86/278/EEC "Mud Directive" and Directive 91/676/EEC "Nitrates Directive"). GAEC ("Regulations") are established at national and regional level to guarantee the four priority objectives established by the European Union, namely:

- Protecting soil with adequate measures;
- Maintaining soil's organic substance levels by means of appropriate practices;
- Protecting the soil's structure by means of adequate measures;
- Maintaining minimum ecosystem levels and preserving habitats.

Regulations for keeping land in good agronomic and environmental conditions include: control of surface waters in sloping land;

"Conditionality" obliges European farmers receiving subsidies to guarantee correct soil management. Every year, the Ministry of Food, Agricultural and Forest Policies issues a Ministerial Decree containing the list of regulations that need to be respected.

management of stubble and residue; efficiency of drainage networks for surface water flows; protection of permanent pastures; management of areas withdrawn from production; maintenance of olive groves and protection of the landscape's characteristic elements.

The Strategic National Plan for Rural Development provides addresses for the Regional Rural Development Plans.

The Fischler Reform further strengthens rural development with the introduction of new regulations and the allocation of new resources. The Strategic National Plan for Rural Development prepared by the Ministry of Food, Agricultural and Forest Policies provides addresses for the corresponding Regional Plans and provides four priority objectives for Axis 2 *"Improvement of the Environment and the Rural Area*". These objectives, which intend to strengthen "conditionality" provisions, are:

- Conservation of biodiversity, protection and diffusion of agro-forest systems with a high natural value;
- Qualitative and quantitative protection of surface and deep water resources;
- Reduction of greenhouse gases;
- Land conservation.

The fourth objective must be obtained by means of a series of interventions aimed at mitigating: water erosion phenomena; salinization; compaction; contamination; reduction of organic substance and biodiversity; soil consumption and waterproofing. All regions and autonomous provinces have prepared their own Strategic Regional Plan, making necessary adjustments to the National Plan according to their local needs.

The European Commission prepared a Thematic Strategy that led to the issuance of a "Proposal for a Soil Framework Directive" (COM (2006) 232).

The Common Agricultural Policy reform was influenced by soil conservation addresses contained in the COM EC 179/2002 "Towards a Thematic Strategy on Soil Protection", which underlined the great impact that agriculture has on the environment. In the EU 77% of land is used for agriculture. In particular, in 2000 intensive farming covered 37% of the territory.

In September 2006, the European Commission adopted the 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 of protecting European land. These documents confirm the environmental role of soil and identify the threats that can compromise its functions until its final

degradation stage of desertification. They distinguish threats mainly caused by agriculture (erosion, compaction, salinization, organic substance loss and landslides) from local and diffuse contamination and waterproofing. They acknowledge the strong interaction between soils and their environmental matrices and the need to include a strong local component in protection policies due to their extreme variability. The Strategy also requires the verification on the inclusion of soil protection and impact measures in Regional Action Plans. This is necessary to protect soil and comply with the minimum requirements to keep soils in Good Agronomic and Environmental Conditions, as provided by the CAP. Member states must identify "agricultural threats" and areas at risk according to common elements, establish objectives to reduce the risk in the relevant areas and prepare programmes with measures required to achieve these objectives. Programmes can refer to national measures that have already been taken (such as "conditionality"), measures on rural development of the CAP, action plans provided by the Nitrates Directive, etc.
Member states can even freely decide to combine various other strategies to resolve concomitant problems.
Contamination is acknowledged as one of the "priority threats" against the soil's functions. The main elements contained in the strategy are: definition of a common risk-based assessment of "contaminated" and "reclamation" sites; implementation of a systematic procedure for identifying contaminated sites; realization of national registers of contaminated sites and introduction of "reports on soil conditions" as a useful tool during sale transactions of sites hosting potentially polluting activities. The Strategy also highlights the need for member states to define a "National Strategy for Land Reclamation". This should include objectives (number of sites that need to be reclaimed), priorities and an implementation schedule.
This proposal is currently being discussed and reviewed.

Legislative Decree 152/06 regulates the reclamation process of contaminated sites and introduces the risk analysis concept.

At national level, there are many regulations in force to protect soil from pollution. These also involve other institutional departments.
The recovery of contaminated sites can be obtained by means

of more or less complicated reclamation processes. In Italy, these are regulated firstly by Ministerial Decree 471/99, and then by Legislative Decree 152/06 (Part IV, Chapter V) and the relative Corrective Decree 4/08.
Legislative Decree 152/06, “Environmental Regulations” under Part IV, Chapter V “Reclamation of Contaminated Sites” contains new and important elements. Among these is the definition of a potentially contaminated site as: “*a site in which one or more concentration values of polluting substances found in environmental matrices are higher than the Threshold Value of Contamination (TVC), while waiting to carry out characterization operations and site-specific risk analyses that would determine the actual contamination conditions on the basis of Risk Threshold Concentrations (RTCs).* Instead, a “contaminated site” is defined as: *a site in which Risk Threshold Concentration (RTCs) values are exceeded. RTC values are determined by applying the risk analysis procedure as per Annex 1, Part 4 of the said decree based on the characterization plan’s results”.*
In the decision-making process of identifying and managing contaminated sites, the difference between the Threshold Value of Contamination (TVC) and the Risk Threshold Concentration (RTC) is therefore relevant. If the former is exceeded there is an obligation to carry out characterization and risk analyses. If the latter is exceeded then the site is considered “contaminated” and it is therefore submitted to safety or reclamation operations.
This recent provision introduced clear criteria for the definition of a contaminated site’s reclamation objectives, based on a site-specific risk analysis. It therefore updated the definition of “contaminated site” contained in Ministerial Decree 471/99.
Currently, characterization and reclamation projects that were already started and/or approved follow the procedure established by Ministerial Decree 471/99. However, in view of the new decree, the promoter can request to re-examine the documents presented. Projects presented after the issuance of Legislative Decree 152/06 follow the procedure established by the latter. As regards Sites of National Interest (SNIs), ten years have passed since the issuance of the first regulation. As at today, the percentage of recovered and/or reclaimed areas is still low and

the progress of reclamation activities appears rather scattered over the whole country.
In general, most reclaimed and/or recovered areas are found in the less complicated SNIs. In particular, it is noticed that procedures are faster in areas where highly profitable settlements are planned (e.g. redevelopment of areas for urban or residential use, new production plants, etc.).
Introducing public funding systems and other initiatives aimed at streamlining procedures for the reutilization of polluted areas by the private sector could lead to increased development of reclamation activities and to the productive recovery of contaminated sites for industrial use. This could be done through Legislative Decree 04/08 Art. 252-b) (*Sites of Prominent Public Interest for Industrial Reorganization)* which provides for the involvement of the Ministry of Economic Development.
Programme Agreements are another efficient tool to ensure concerted action between the various actors involved in reclamation activities and in the streamlining of administrative procedures. These have already been signed for SNIs in Brindisi and Eastern Naples.

As regards SNIs the percentage of recovered and/or reclaimed areas is still low.

As mentioned above, Ministerial Decree 471/99 provided that regions should endow themselves with a system of collection and updating of data on polluted sites. This must be done by creating "regional registers of sites to be reclaimed" and adopting the relative reclamation plans. The realization of registers is definitely delayed with respect to the schedule provided by the decree. Those that have been prepared also show very strong differences due to the different criteria used to identify contaminated sites. Indeed, some regions require a preliminary verification for changes in the intended use of sites used for productive activities while others only register the more complex sites.
The establishment of registers was confirmed by Legislative Decree 152/06. The decree introduced substantial amendments on site identification modalities which caused difficulties when comparing information collected in different periods. More generally, when identifying potentially contaminated sites (i.e. areas that host or have hosted potentially polluting activities and which need

Contaminated sites are managed by regions and must be inserted in specific "regional registers of sites to be reclaimed".

to be examined) the criteria for inserting contaminated sites in regional registers often suffer from the lack of a systematic and homogeneous procedure that can be valid for the whole the country.
As regards brownfields, action is being taken in order to revitalize abandoned areas making them an active part of the urban territory. Many areas have already been recovered and generally assigned for residential use, public gardens, shops and public areas while activities for the reorganization of "megasites", especially those located in the Southern regions of Italy, are still very low with respect to the actual potential.
In case of diffuse contamination, the most efficient action is to undertake preventive activities aimed at mitigating the pressure. This can be done by: improving controls of emissions to air and water; limiting the use and distribution of potentially contaminating substances; defining quality criteria for products used in agriculture and limiting the quantities of fertilizers used (according to their composition). The quality of sewage sludge used in agriculture is defined by Directive 86/278/EEC. This was implemented with Legislative Decree 99/92 while Ministerial Decree MiPAF 19/04/99 "*Code of Good Agricultural Practices*" focuses on the correct use of fertilizers in order to avoid a surplus of nutritional elements. Legislative Decree 152/06, Part 3 "*Regulations for protecting soil, combating desertification, protecting waters from pollution and managing water resources*" provides indications on interventions for mitigating water pollution from nitrates and establishes (Annex 7) the regional identification of Nitrate Vulnerable Zones (NVZ) as well as zones vulnerable to plant protection products. The definition of NVZs is a complicated process that derives from the intersection of soil's protective capacities and hydrogeological characteristics with respect to agricultural loads and water quality data (Figures 8.17 and 8.18). These zones were identified at different times throughout the country. Aosta Valley, Trento and Bolzano were excluded since they do not have this problem. An estimate, at basin scale, of contamination of water bodies including local and diffuse contamination phenomena is also provided by Directive 2000/60/EC (Water Directive).

In case of diffuse contamination, the most efficient action is to undertake activities aimed at mitigating the pressure.

The map shows the potential capacity of soil to retain pesticides within the root zone and for a sufficient amount of time to allow their degradation.

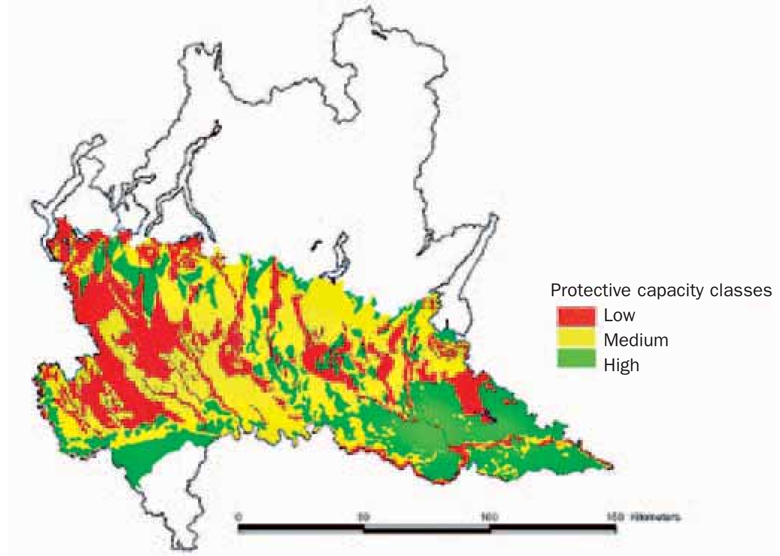


Figure 8.17: Map of soil protection capacity in the Lombard plain with respect to underground waters (2005)[22]

In areas identified as "vulnerable", a series of provisions need to be applied. These regard the management of fertilizers and other agricultural practices as well as measures described in the Code of Good Agricultural Practices.

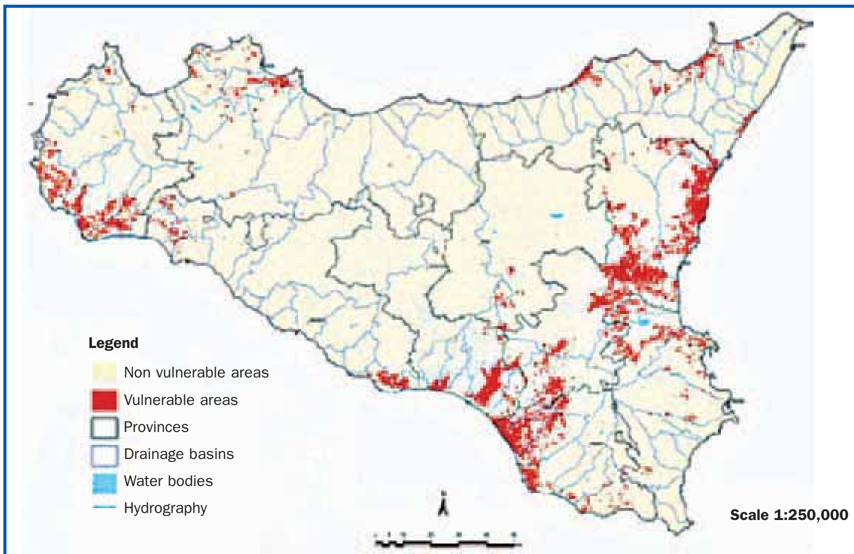


Figure 8.18: Regional map of Nitrate Vulnerable Zones of agricultural origin (2005)[23]

[22] Source: ERSAF (Ente Regionale per i Servizi all'Agricoltura e alle Foreste – Regional Body for Agricultural and Forest Services) - Lombardy Region
[23] Source: Sicily Region

The United Nations Convention to Combat Drought and/or Desertification is an international legal tool that engages all signatory countries to cooperate in the fight against desertification.

With Law no. 170 dated 4 June 1997, Italy ratified the United Nations Convention to Combat Drought and/or Desertification (UNCCD) signed in Paris in 1994. The Convention is an international legal tool that engages all signatory countries to cooperate in the fight against desertification, with the aim of mitigating the effects of drought in seriously affected countries by means of an approach that improves the conditions of life of the local communities.

The Convention provides for "*the preparation of National Action Programmes aimed at ensuring sustainable development in order to reduce loss of soil productivity caused by climate change and human activities*". To comply with its obligations, with Deliberation CIPE no. 299/99, the Italian Government adopted the National Action Programme (NAP) for the Fight against Drought and Desertification. This highlights that the problem is a matter of concern for the Italian territory particularly with reference to the role played by human activities associated to extreme climatic events, which are always more frequent.

However, since no specific legislative measures aimed at the problem of desertification have been issued so far, Legislative Decree 152/06, Part 3 indirectly refers to this problem as well as the planning and implementation of contrast action in charge of regions and authorities of the Basin. In the last few years, the Ministry for the Environment, Land and Sea has allocated financial resources to the regions that were particularly affected. This is an institutional organism composed of representatives of ministries, public institutions, research bodies and organizations that are institutionally involved in activities aimed at combating desertification.

No specific laws have been issued to fight the problem of desertification. Legislative Decree 152/06, Part 3 indirectly refers to this phenomenon and to the planning and implementation of contrast action in charge of regions and Basin authorities. In the last few years, the Ministry for the Environment, Land and Sea has also allocated financial resources to some of the most affected regions. Even if limited, these resources have started off the definition of local action plans.

With regard to mines, national regulations are based on the

following legal references: Royal Decree no. 1443 of 29/07/1927 (on mine research and cultivation); Decree of the President of the Republic no. 128/59 (on controlling mines and quarries); Law no. 388 of 23/12/2000 (which provides an extraordinary plan for reclamation and environmental recovery also of former mineral extraction areas, on the basis of a subsequent Ministerial Decree); Law no. 179 of 31/07/2002 (which establishes a census of abandoned mineral sites) and Legislative Decree 117/2008 implementing Directive 2006/21/EC (on the management of waste from extractive industries).

Discards from extraction activities (mines and quarries) are regulated by Legislative Decree 117/2008, implementing Directive 2006/21/EC.

Legislative Decree 117/08 establishes measures, procedures and necessary action to prevent or reduce as much as possible, any eventual negative effects on the environment and human health risks caused by the management of waste from extractive industries. The Decree obliges the person in charge of extractive activities to prepare a management plan of extraction waste. This is submitted for approval by the relevant authority. It also provides for the realization of a national inventory of abandoned mineral sites, which needs to be annually updated through the Institute for Environmental Protection and Research (ISPRA).

The decree also considers the management of waste from quarries. This is regulated by regional laws as established by the Decree of the President of the Republic no. 616 of 24/7/1977, which transferred these responsibilities to the regions.

Planning of extractive quarry activities takes place by means of Regional (or Provincial) Plans of extractive activities. These plans contain: a register of active or abandoned quarries, notes on identification and limiting of extraction areas (territorial areas subject to constraints); needs; extraction modalities; excavation times and recovery plans to be followed when planning single interventions (according to the different situations and morphological characteristics).

Planning responsibilities are transferred to regions by means of Regional and/or Provincial Plans of extractive activities.

However, the situation is not harmonized at national level. Regions have different approval times and some regions have still not adopted these plans.

With regard to geosites, following their introduction in landscape planning activities under the "*Cultural Heritage and Landscape Code*" with Law 42/2004, many regions and provinces have

Many regions have started projects for the identification of geosites.

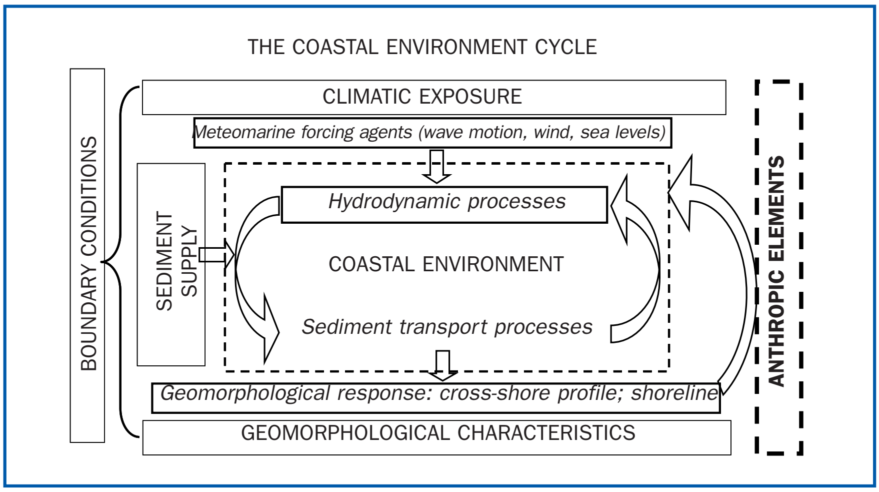
started projects for the identification of geosites in their territory and their introduction in Landscape Plans, which is the first step towards their protection. From a legislative point of view, Emilia Romagna and Liguria are the only regions which have a law for the enhancement and conservation of geodiversity.

CHAPTER 9

COASTAL AREAS

Introduction

The coast is a continually evolving area. Its changes are more clearly visible near low and sandy shores, where there are new adjustments of the seashore and land surfaces that emerge and are submerged by the sea. Coastline dynamics mainly depend on the sea's action (wave action, tides, currents and storms), but they are also influenced by all those direct and indirect natural and human activities that intervene on the coastal balance changing its morphological characteristics. The extraction of inert material from riverbeds and the remediation of banks and mountain slopes reduce the flow of sediments at the river mouths when they should be naturally distributed along the coast. Urban and productive settlements in coastal areas as well as land and sea transport infrastructures and protection works invade the sea and the coastal areas interacting with their natural evolution.



In the previous edition the phenomenon of coastal erosion and the impacts on the coastline were discussed in detail, even in view of the expected climate change and the relative adjustment policies. Other issues were also mentioned, such as: knowledge of marine forcing and the territorial structure; response with regard to territorial planning and national and regional action plans.
These elements that describe the coastal environment are not subject to short term change and the updating of information

Adoption of the ICZM Protocol within the framework of the Barcelona Convention.

requires a time span of several years. Therefore, this year we thought of giving more attention to other marine and land components that characterize our coastal habitats. This approach was also suggested by the recent adoption of the ICZM (Integrated Coastal Zone Management) Protocol within the framework of the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean. It was signed during the diplomatic Conference that took place on January 20-21th 2008 in Madrid. The Protocol was signed by the European Union and by 14 States, including Italy. It was subsequently published on the Official Gazette of the European Union of 4/2/2009.

The ICZM Protocol promotes the definition a national integrated management strategy for all environmental, socioeconomic and cultural issues. The Protocol aims at the protection and sustainable development of coastal regions of the Mediterranean. It intends to create a new and more efficient approach to the many protection needs of the coastal and island habitats and landscapes in order to preserve the cultural heritage while developing economic activities.

Therefore, apart from providing more details on the coastal sedimentary dynamics and its balance, this edition will also talk about other natural phenomena and the qualification of habitats (such as dunes and *Posidonia* banquettes). We will also illustrate some elements of change in the marine and coastal environment (water quality and marine algae) which are often induced by human action but perceived as a problem only in the summer season, due to the utilization of the beaches for tourism and bathing.

The situation

The Italian coast has a length of 8,353 km, of which 4,863 km are low sandy or delta coastlines (Tables 9.1 and 9.2). From a physical point of view, the latter are more vulnerable to sea action and subject to intense geomorphological dynamics. Indeed, in Italy coastal zone risks are mainly related to erosion phenomena and to storms or floods, which are mostly relevant for low and sandy coasts and for coastal alluvial plains.

On the Italian coast, 4,863 km of sandy or delta coastlines are more vulnerable to sea action.

Table 9.1: Distribution of Italian coast by type[1]

Type of coast	km	%
Natural	7,687	92.0
Artificial	314	3.8
Fictitious	352	4.2
TOTAL	**8,353**	**100**

Table 9.2: Distribution of natural coast by type[2]

Type of coast	km	%
High	2,824	36.7
Low	4,863	63.3
TOTAL	**7,687**	**100**

The coastal system suffered a very strong anthropic process.

In Italy, over 300 km of coasts host commercial or leisure port facilities.

In the last century, the coastal system suffered a very strong anthropic process that, in many areas, has considerably changed and altered the natural and environmental features of the territory. Due to their accessibility, low coastal areas are more densely occupied by residential settlements and intense business activities (even for tourism) as well as by roads and sea transport infrastructures. Indeed, in Italy more than 300 km of coasts host commercial and leisure port facilities.

About 30% of the total population lives in the 642 coastal municipalities.

According to surveys carried out by the National Statistics Institute (ISTAT) 16.8 million inhabitants permanently live in the 642 coastal municipalities, which represent about 30% of the total population. This gives an idea of how populated coastal areas actually are in Italy, given that both seasonal and tourism flows are not included.

Coastal urbanization has transformed the evolution of coastline and has turned the natural phenomenon of coastal erosion into a serious problem, particularly near urban centres where homes, infrastructures and economic activities are at risk.

There are many human activities in coastal zones (industries, tourism, fishing, aquaculture, etc.). Problems arise when these activities tend to develop together on the narrow coastal area and

[1] Source: ISPRA
[2] Source: ISPRA

come into conflict both with each other and with the protection of natural environments and landscape.

Data on land use collected by the Corine Land Cover 2000, covering an area of 10 km from the coast towards the hinterland, shows that 58.7% of land is used for agriculture and 6.6% is occupied by urban centres, industries and road, air and sea transport infrastructures. In other words, in Italy two thirds (over 65%) of land within the 10km strip from the shore, is used for human activities and is moulded even by invasive and irreversible human action on the environment (Figure 9.1).

58.7% of land within the 10 km strip from the shore is used for agriculture while 6.6% is occupied by urban centres, industries and various infrastructures.

Over 65% of land is included within the 10 km strip from the shore, which is used for human activities and moulded by invasive and irreversible action on the environment.

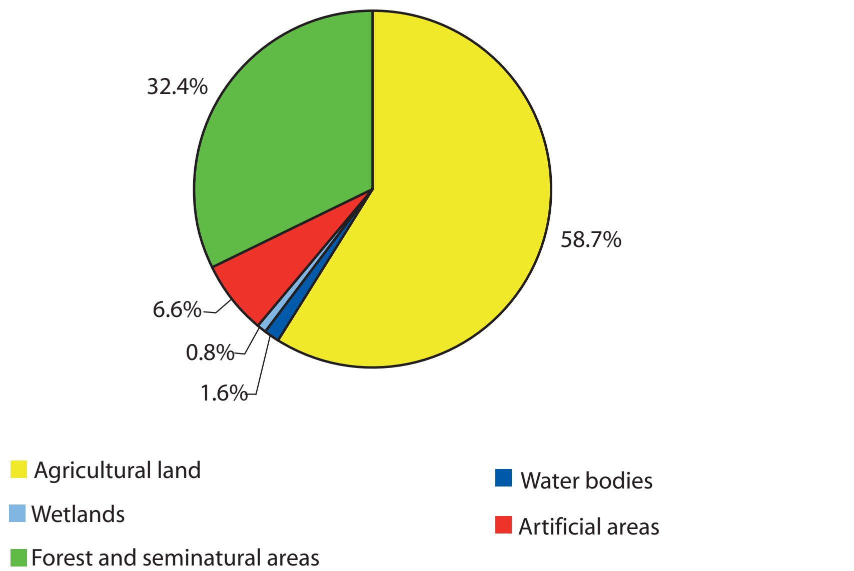


Figure 9.1: Land use in Italy within the 10 km strip from the shore[3]

As a result, Italy is among the countries having the highest risk of coastal erosion in Europe.

Table 9.3 summarizes the analysis of variations in the coasts over the last 50 years extended to all Italian coasts. It shows that 30% of the shoreline is subject to an intense geomorphological evolution.

Italy is among the countries having the highest risk of coastal erosion.

[3] Source: ISPRA

30% of the coast is subject to an intense geomorphological evolution. Furthermore, over the last 50 years, 24% of sandy coast has eroded by an average of over 25m.

The regions that are mostly affected by coast erosion are: Sicily (313 km), Calabria (208 km), Apulia (127 km) and Sardinia (107 km).

The area subject to potential flood risk (RICE), in coastal areas, is equivalent to 3.17% of the national surface and involves 9.12% of the population.

Moreover, the study showed that only in the low coasts (Table 9.4) out of the 4,863 km of low and delta coasts in Italy 1,170 km are definitely eroding. In other words, over the last 50 years 24% of sandy coasts suffered an average erosion of over 25m.

Table 9.3: Stable and changed coast, both erosion and accretion[4]

COAST	km	%
TOTAL	**8,353**	**100.0**
Stable	5,385	64.5
Changed	2,448	29.3
Unclassified	520	6.2
Changed	**2,448**	**29.3**
Erosion	1,285	15.4
Accretion	1,163	13.9

Table 9.4: Stable and changed low coast, both erosion and accretion[5]

COAST	km	%
TOTAL	**4,863**	**100.0**
Stable	2,387	49.1
Changed	2,227	45.8
Unclassified	248	5.1
Changed	**2,227**	**45.8**
Erosion	1,170	24.1
Accretion	1,058	21.7

The most affected regions are: Sicily (with as many as 313 km of eroding coast); Calabria (208 km), Apulia (127 km), Sardinia (107 km), Lazio (63 km) and Tuscany (60 km). With regard to coast length, most decreasing beaches are found in Marche (38.6%), followed by Basilicata (38.1%), Molise (34.7%) and Calabria (32%).
Considering the evolutionary trend of Italian shoreline and the concentration of activities and urban settlements along the coast, it can be assessed that the area subject to potential flood risk (RICE - Radium of Influence of Coastal Erosion[6]) in coastal areas covers 954,379 ha. This is equivalent to 3.17% of the national surface and involves 5,276,535 people (9.12% of the whole population). It is also estimated that 336,746 ha of land

[4] Source: ISPRA
[5] Source: ISPRA
[6] The area of RICE is defined as the locus of points that satisfy at least one of the following two conditions: distance from the coast up to 500 meters altitude not exceeding * 5 meters above sea level. (*) To take account of the errors associated with the definition of DTM (Digital Terrain Model) and to avoid underestimation of areas with altitude of more than 5 m, was considered as the level curve corresponding to the limit value of 10 m.

(1.12% of the national surface) and 2,133,041 people (3.69% of the total population) are exposed to a medium-high and high risk.
Interventions have taken place over the years to protect eroding shoreline. Hard structures, such as beams and barriers, have been realized on long sections of coastline which have not resolved the erosion problem especially in the medium and long term. In many cases they even contributed to increasing the process of artificialization and marine/coastal habitat degradation.
Figure 9.2 shows the distribution of protection works and harbours over the whole national territory.

Coastal defence works with hard structures have not resolved the erosion problem.

Distribution of protection and harbour works over the whole national territory.

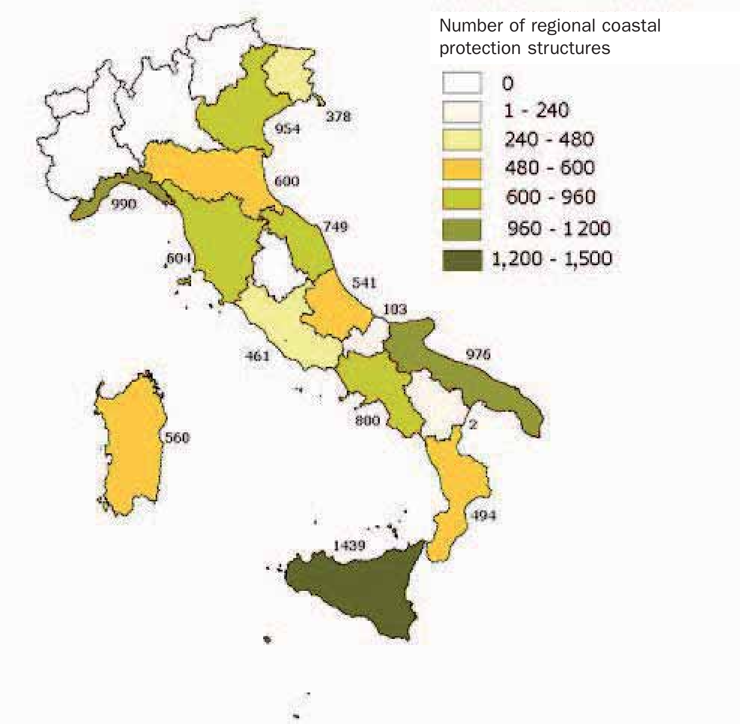


Figure 9.2: Distribution of harbour and protection works by region[7]

An alternative technique to recover eroding coastlines is beach nourishment, which consists in reconstructing the eroded beach by replacing the sand lost by erosion with nourishment material

Beach nourishment is an alternative technique for the recovery of eroding coastlines.

[7] Source: ISPRA

(usually sand). The material is normally taken from land, river or marine quarries.

The search for new beach nourishment material has focused on sea beds.

In the last few years, the search for new sources of material to be used for the nourishment of eroding coastlines has focused on the study of sea bottoms. Indeed, deposits of relict sand (generally referable to paleo-beaches) that can be used for beach nourishment are found on the continental shelf. These deposits may be covered by pelitic sediments of recent deposition, or, alternatively, by outcropping sediments) and are located at different depths between 30-130 m.
Using relict sand deposits has some advantages with respect to using land quarries, such as: availability of large quantities of sediments (millions of m^3); potentially similar composition to the sand on our coastlines; limited effects on the environment and lower costs (for beach nourishments requiring large volumes of sediment).

The utilization of marine sand deposits for beach nourishment has been a widely used practice for various years both in Europe and in the rest of the world (nourishment of the Coney Island Beach, NY, USA, 1922-23).

The first nourishment activities in Italy were carried out on the beaches of Cavallino and Pellestrina (Venice).

In Italy, the first documented activities of beach nourishment using relict sands were carried out on the beaches of Cavallino and Pellestrina (Venice). The operation involved the dumping of about 6,000,000 m^3 of sand dredged from a marine sand deposit located between the mouths of the Rivers Tagliamento and Adige at a depth of 20 m.

In the Tyrrhenian Sea, the first nourishment was carried out on the coastline of Ostia (Rome) in 1999.

In the Tyrrhenian Sea the first experiences regarded the nourishment of the Ostia coastline in 1999, conducted by the Lazio Region local authority using sands from a marine deposit off Anzio (Rome). The Lazio Region has started the first programme of relict sand dredging for beach nourishment on a regional scale in 1999. Activities are still going on today sediment from the above mentioned deposit of Anzio and from other two relict sand deposits located respectively off Montalto di Castro (VT) and Torvaianica (Rome) (Figures 9.3 and 9.4).
Other dredging operations for beach nourishment were conducted offshore Ravenna and Civitanova Marche (AP).

Figure 9.3: Overflow plume caused by dredging operations[8]

Figure 9.4: Some phases of relict sand dredging off Montalto di Castro (Lazio)[9]

Table 9.5 summarizes all relict sand dredging operations for beach nourishment carried out in Italy until 2007.

[8] Source: ISPRA
[9] Source: ISPRA

Dredging and nourishment operations carried out in Italy.

Table 9.5: Relict sand dredging interventions for beach nourishment carried out in Italy until 2007[10]

Relict sand deposits (Location/name/ executive authority)	Dredge execution year	Dredged volumes m³	Sand destination	Overflow volumes m³
Adriatic Sea/ Deposit in the open sea between the mouths of the Rivers Tagliamento and Adige / Magistrato alle Acque di Venezia	1995 - 1999	7,231,570	Pallestrina coastline (VE)	4,097,119
	1994 - 1999		Cavallino (VE)	1,921,604
	1999 - 2000		Jesolo (VE)	565,362
	1999 - 2003		Jesolo - Cortellazzo (VE)	351,000
	2003 - 2004		Eraclea (VE)	296,485
Tyrrhenian Sea/ Marine sand deposit off Anzio (Site AN) / Lazio Region	1999	950,000	Ostia (RM)	950,000
Adriatic Sea / Marine sand deposit off Ravenna (Area C1) /Emilia Romagna Region	2002	799,850	Misano Adriatico (RN)	165,300
			Riccione sud (RN)	253,750
			Igea Marina (RN)	65,200
			S. Mauro Pascoli - Savignano (FC)	27,000
			Gatteo a Mare (FC)	28,000
			Zadina (FC)	43,500
			Milano Marittima nord (RA)	176,100
			Lido di Classe - Foce Bevano (RA)	41,000
Tyrrhenian Sea / Marine sand deposit off the Gulf of Cagliari / Cagliari Province	2002	370,000	Poetto (CA)	370,000
Tyrrhenian Sea / Marine sand deposit off Anzio (Site AZ) / Lazio Region	2003	2,039,265	Ostia centro (RM)	409,895
			Ostia levante (RM)	554,773
			Anzio (RM)	191,192
			Focene nord (RM)	407,942
			Ladispoli (RM)	475,463
Tyrrhenian Sea / Marine sand deposit off Montalto di Castro (Site A2) / Lazio Region	2004	480,000	Tarquinia (VT)	480,000
Tyrrhenian Sea / Marine sand deposit off Montalto di Castro (Site A2) / Lazio Region	2005	330,000	Ostia (RM)	330,000

continues

[10] Source: Prepared by ISPRA based on data provided by: Consorzio Venezia Nuova for the marine sand deposit located between the mouths of the Rivers Tagliamento and Adige; by the University of Cagliari for the sand deposit off Poetto; by the ARPA Emilia Romagna for the sand deposit off Ravenna and by the ICRAM (today's ISPRA) for the remaining data

follows

Table 9.5: Relict sand dredging interventions for beach nourishment carried out in Italy until 2007[10]

Relict sand deposits (Location/name/ executive authority)	Dredge execution year	Dredged volumes	Sand destination	Overflow volumes
		m^3		m^3
Tyrrhenian Sea / Marine sand deposit off Torvaianica (Ardea Site C2) / Lazio Region	2006	1,429,000	Terracina Porto Badino - Centro (LT)	375,000
			Terracina Porto Badino - F. Sisto (LT)	420,000
			Fondi (LT)	634,000
Adriatic Sea / Marine sand deposit off Civitanova Marche (Area B1) / Arenaria s.r.l. for Abruzzo Region	2006	1,106,039	Pineto Silvi (TE)	64,245
			Martinsicuro (TE)	184,850
			Montesilvano (PE)	93,106
			Francavilla (CH)	159,325
			Casalbordino (CH)	85,612
			Sand storage in Marina Palmense (AP)	518,901
Adriatic Sea / Marine sand deposit off Ravenna (Area C1) and (Area A) / Emilia-Romagna Region	2007	825,349	Misano Adriatico (RN)	149,000
			Riccione sud (RN)	105,065
			Igea Marina - Rimini nord (RN)	105,788
			Cesenatico nord (FC)	78,391
			Milano Marittima nord (RA)	90,108
			Lido di Dante (RA)	107,128
			Punta Marina (RA)	189,869
Tyrrhenian Sea / Marine sand deposit off Anzio (Site AS) / Lazio Region	2007	1,658,000	Terracina Porto Badino-Centro (LT)	283,000
			Minturno (LT)	563,000
			San Felice Circeo (LT)	432,000
			Fondi nord (LT)	150,000
			Formia (LT)	230,000

Although beach nourishment contributes to resolving coastal erosion on a local scale in the short term, it would be appropriate to plan a series of activities aimed at the preservation of the coastal system's resilience capacity, particularly with reference to natural elements that ensure the stability of coastal dynamics such as dunal environments.

Coastal dunes develop behind the beaches due to the effect of several factors. Three of these are essential: the availability of sediment in proportion to the width of the beach; the energy of

It would be appropriate to plan a series of activities aimed at the preservation of the coastal system's resilience capacity, particularly with reference to dunal environments that ensure the stability of coastal dynamics.

dominating winds; the presence of specialized vegetation that stabilizes sands moved and deposited by the wind. These factors must reach a dynamic balance to allow the sediment to accumulate and consolidate until a more or less stable permanent deposit is formed. Dunes can be made of incoherent sand (mobile dunes) or by sediments fixed by specialized vegetation (fixed dunes).

Once the vegetation has colonized the Aeolian deposit (Figure 9.5) it not only stabilized the sand but even fertilizes it increasing the humidity rate. Pioneer plant species are actually able to survive due to their high tolerance to salinity and high sedimentation rates. Vegetation therefore has a deep influence on the morphology of foredunes that evolves accordingly.

Coastal dunes not only have a high landscape value but they also play an essential role to protect the coastal zone increasing its resilience. In particular, they are able to annul the erosion risk since they act as a sediment reservoir that is able to reduce the beach. Depending on their characteristics, dunes can also contrast the inland flooding risk. Due to their height with respect to the surrounding areas and good filtration capacity, coastal dunes can also prevent saline intrusions in freshwater aquifers (groundwater table). Finally, coastal dunes host specific and characteristic ecological niches and are therefore extremely important both for the plant communities and for the animal species associated to them. For some species they are actually essential ecological corridors for the coastal environment.

It should not be forgotten that the preservation of dunes and beaches natural conditions are closely related to those of other equally important ecosystems, such as humid retrodunal environments, coastal lagoons and lakes, *Posidonia oceanica* meadows and other marine phanerogams[11].

[11] http://www.apat.gov.it/site/_contentfiles/00140500/140589_R54_2005.pdf

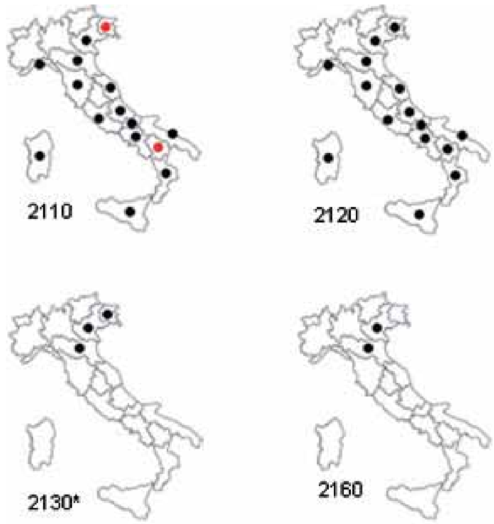
Figure 9.5: Dunal habitat[12]

In Central and Northern Europe in the 1990s only 45% of coastal dunes were in integral conditions.

Data provided by the EUCC (1994) show that in the 1990s in Central and Northern Europe coastal dunes covered areas of about 5,300 km^2 (about 75% of dunal areas in the last century) of which only about 3,200 km^2 (45%) were in integral conditions[13]. As regards Italy, a study[14] was conducted to compare the current presence and distribution of protected habitats listed under Attachment I of Directive 92/43/EC with data reported in the *Natura 2000* Data Bank of the Ministry for the Environment, Land and Sea (updated in 2007) in order to find possible variations, lacks and/or inconsistencies and prepare the "Manuale italiano di interpretazione degli habitat della direttiva 92/43/CEE" (Italian Interpretation Manual of habitats described by Directive 92/43/EEC). The study identified 10 habitats with a clear presence of coastal dunes. Three of them were included in the list of priority habitats, always according to the same Directive, falling under two different macrocategories of reference:

[12] Source: ISPRA
[13] http://www.apat.gov.it/site/_contentfiles/00140500/140589_R54_2005.pdf
[14] Biondi E., Blasi C., Burrascano S., Casavecchia S., Copiz R., Del Vico E., Galdenzi D., Gigante D., Lasen C., Spampinato G., Venanzoni R., Zivkovic L.: *Manuale italiano di interpretazione degli habitat della direttiva 92/43/CEE*, 2009 http://vnr.unipg.it/habitat/index.jsp

"Sea dunes of the Atlantic, North Sea and Baltic coasts" and "Sea dunes of the Mediterranean Coast". Figures 9.6 and 9.7 show the distribution of these habitats in the different Italian regions. It can be noted that most of them exist all along the national coastline, with some exceptions.



NATURA 2000 code	Habitat
2110	Shifting embryonic dunes
2120	Mobile dunes of the sand bar with presence of *Ammophila arenaria* (white dunes)
2130*	Fixed coastal dunes with herbage (grey dunes)
2160	Dunes with presence of *Hippophae rhamnoides*

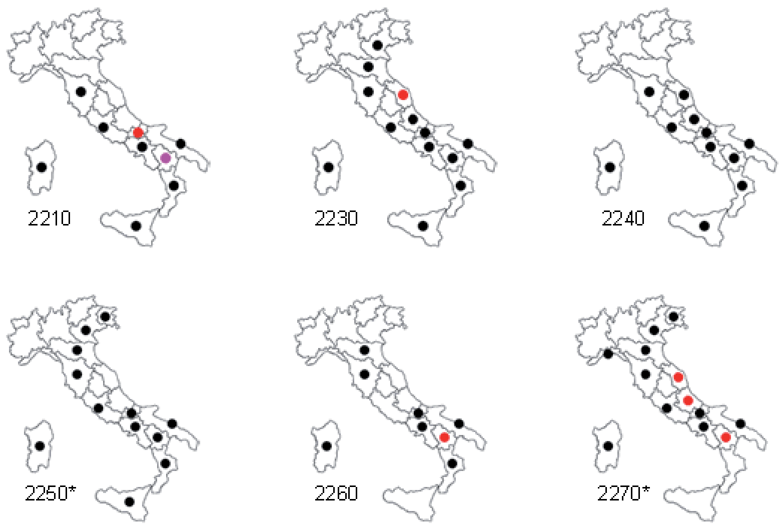
● Datum taken from the *Natura 2000* Data Bank of the Ministry for the Environment, Land and Sea (2007), confirmed in Biondi et al. (2009)

● New identifications (Biondi et al., 2009)

* Priority habitats (amended by Biondi et al., 2009)

Figure 9.6: Distribution of habitats falling under the macro-category: "Sea dunes of the Atlantic, North Sea and Baltic coasts" in Italy[15]

[15] Source: Ibidem



NATURA 2000 code	Habitat
2210	Fixed dunes of the littoral *(Crucianellion maritimae)*
2230	Dunes with *Malcolmietalia* meadows
2240	Dunes with *Brachypodietalia* meadows and annual vegetation
2250*	Coastal dunes with *Juniperus* spp.
2260	Dunes with *Cisto-Lavenduletalia* sclerophyllous scrubs
2270*	Dunes with *Pinus pinea* and/or *Pinus pinaster* forests

● Datum taken from the *Natura 2000* Data Bank of the Ministry for the Environment, Land and Sea (2007), confirmed in Biondi *et al.* (2009)
● Datum taken from the *Natura 2000* Data Bank of the Ministry for the Environment, Land and Sea (2007), not confirmed in Biondi *et al. (2009)*
● New identifications (Biondi *et al., 2009*)
* Priority habitats (amended by Biondi et al., 2009)

Figure 9.7: Distribution of habitats falling under the macro-category: "Sea dunes of the Mediterranean Coast" in Italy[16]

The only currently available reference that provides a national framework of the presence and features of coastal dune systems is the "Geographical Data Bank of Coastal Dunes in Italy" that was realized within the framework of the project on "Aeolic deposits of Italian coasts and the flow of sediments between

In Italy, a national framework of coastal dunes was produced within the framework of a project funded by the Ministry of Education, University and Research.

[16] Source: Ibidem

beaches and dunes” funded by the Ministry of Education, University and Research. This data bank contains vectorial data on the distribution and conservation conditions of coastal dunes in all the Italian regions with respect to their evolutionary trend and the utilization of the littoral in front. In accordance with the EU’s INSPIRE Directive, data are reported on a scale of 1:10.000 and are updated as at 1998-99[17]. For example, according to results produced by the research, in Lazio none of the regional dune systems (occupying an area larger than 20 km^2 and about 200 km of coast) are sufficiently natural. This is due to the high human impact and the general withdrawal of the coastline. In Emilia Romagna, instead, just over 28% of the 130 km of coast is bordered by dune ridges. Of this area, only 0.6 km^2 (3%) is occupied by active dunes, whose evolution is largely compromised by human activities (about 59%). 60% of this area also develops along eroding coastlines. According to a study conducted by the WWF (2007) along the Peninsula’s coasts, preserved dune systems are found in:

- Tuscany (dunes of the Migliarino San Rossore Park and of the Tuscan Maremma);
- Lazio (dunes of the Circeo National Park);
- Veneto (fossil dunes of the Po Delta);
- Emilia Romagna (fossil dunes of the Po Delta);
- Basilicata (dunes along the Ionic coast);
- Apulia (dunes of the Torre Guaceto Natural Reserve);
- Sicily (dunes of the Torre Salsa, Vendicari and Capo Passero Natural Reserves);
- Sardinia, which hosts some of the largest dunes in Europe (dunes of Piscinas-Pistis, important for the endemic vegetation of *Juniperus macrocarpa*, and dunes of Porto Pino, characterized by the presence of a spontaneous pine forest of *Pinus halepensis*).

A widespread and very current phenomenon that involves large sections of the Italian coast is the stranding of seabed vegetation and its compatible management. This is what occurs with the marine phanerogam *Posidonia oceanica*, an endemic species of

[17] AA.VV., Studi Costieri – *Dinamica e difesa dei litorali – gestione integrata della fascia costiera*, n. 11, GNRAC, 166 pp (2006)

Figure 9.8: *Posidonia oceanica* meadow[18]

Figure 9.9: Lamellar structure of a *banquette*[19]

the Mediterranean (Figure 9.8) that colonizes large areas of the seabeds forming actual underwater meadows. The meadows are one of the fundamental components of the coastal environment's balance and richness and are acknowledged as a priority habitat and thus protected by the Habitat Directive (92/43/EC).

The stranding of remains of *P. oceanica* (dead leaves, rhizomes and fibrous remains) is a natural phenomenon that is annually observed on the coasts, especially after autumn and winter seastorms. The accumulation of stranded remains, combined with sand, form structures known as "*banquettes*" (borrowing the French term). These can reach heights of even 2 metres and develop for hundreds of metres along the coastline, according to its geomorphological structure. In general, *banquettes* are mainly made of *Posidonia oceanica* leaves since their string-like shape and way of accumulating contribute to the formation of a very compact and elastic lamellar structure (Figure 9.9). In any case, these are temporary deposit structures that can easily be deformed by the swell they are submitted to.

Autumn and winter seastorms annually accumulate remains of Posidonia oceanica on our beaches.

Banquettes and their sediment fractions carry out an important role providing a mechanical protection against erosive phenomena by preventing the swell's energy and action thus contributing to ensure beach stability. They also both directly and indirectly contribute to the activity of animal and plant biocoenosis on the

[18] Source: M. Magri
[19] Source: G. Bovina

beach, since leaf degradation products provide great quantities of fundamental nutrients for the life cycle of flora and fauna of the coastal area. For the above reasons, the SPAMI Protocol of the Barcelona Convention has included them in the list of priority habitats that should be protected.

Pollution produced by the discharge of chemical and organic substances often generates irreversible environmental changes in marine habitats.

The sea is a large ecological system in which plant and animal organisms establish a series of complex relationships and balances both between each other and with the environment. But the effects of human activities are threatening these balances and the survival of marine species.

The utilization of marine and coastal waters has an important role especially in industrialized societies. However, it is generally known that pollution produced by the discharge of chemical and organic substances (deriving from human activities) often generates irreversible environmental changes that can destroy marine habitats. Currently, microbiological pollution and eutrophication are the main critical factors for coastal areas but we do not have homogeneous and continuous data on chemical, physical and biological parameters of marine waters. With the exception of marine areas submitted to special protection regimes, the effects of pollution, are monitored and faced only for the protection of citizens' health and for purposes of tourism activities carried out on the coasts. We still lack of a holistic vision for the protection of marine and coastal ecosystems.

Italy is among the European countries with the highest number of marine bathing waters.

Along the Italian coast there are 4,615 sites where recreational and bathing activities can be practiced. This places Italy at the top of the list of European countries with the highest number of marine waters used for this purpose. In order to protect bathers' health the quality of beach waters is controlled by a very strict monitoring programme that provides for the establishment of chemical and microbiological parameters. At the beginning of each bathing season, the Ministry of Labour, Health and Social Policies publishes a report that summarizes the results of the monitoring programme on the quality of Italian bathing waters carried out in the previous bathing season. According to the "Bathing Waters 2009" Report, in Italy 5,175 km of coastline was checked of which 4,969 km was suitable for bathing. This value represents 33.8% of bathing coast in Europe and 55.2% of bathing coast in the Mediterranean area.

5,175 km of coastline was checked, of which 4,969 km was suitable for bathing.

According to microbiological parameters, 91.43% of Italian sites fall within the European guide values, with respect to the average of 88.6% in other member States. If we consider imperative values fixed by European regulations, the suitability percentage of Italian sites is of 92.8%, against a European average of 96.3%. The above percentages show the high quality of Italian bathing waters. It should also be taken into account that, for microbiological parameters, Italy adopted the European Directive imposing limit values that in some cases were even more restrictive. Furthermore, the Presidential Decree no. 470/82 imposes the closing of a site if for two consecutive seasons it should not be suitable for bathing. Most other member States, instead, only advise against bathing. A site can only be reopened after an improvement programme has been implemented.

Results of monitoring activities carried out in 2008 show that at national level 62 sites do not fall within the given parameters and need to be submitted to improvement programmes. These sites will be included among the closed ones and suspended from monitoring activities until an improvement programme establishes that they are suitable for bathing again. Since the implementation of beach recovery programmes requires availability of financial resources and long realization periods, over the years the number of prohibited sites has by far exceeded that of recovered ones. Indeed, while 301 marine water sites were closed in 2008 (281 in 2007), only 6 sites were recovered in the 2009 season. As at today, only 23 improvement projects have been presented. For this reason, according to the EEA's "Annual Report on the quality of bathing waters", Italy has the highest number of closed sites. However, with the application of Directive 2006/7/EC this value will probably improve since all permanently prohibited sites (such as river mouths and inaccessible areas for monitoring activities) will not be counted as bathing areas. Table 9.6 and Figure 9.10 show bathing suitability percentages of the Italian coast calculated with respect to the total coast length.

Out of the 7,375.3 km of coastline, 5,175 km is checked and 67.4% is suitable for bathing.

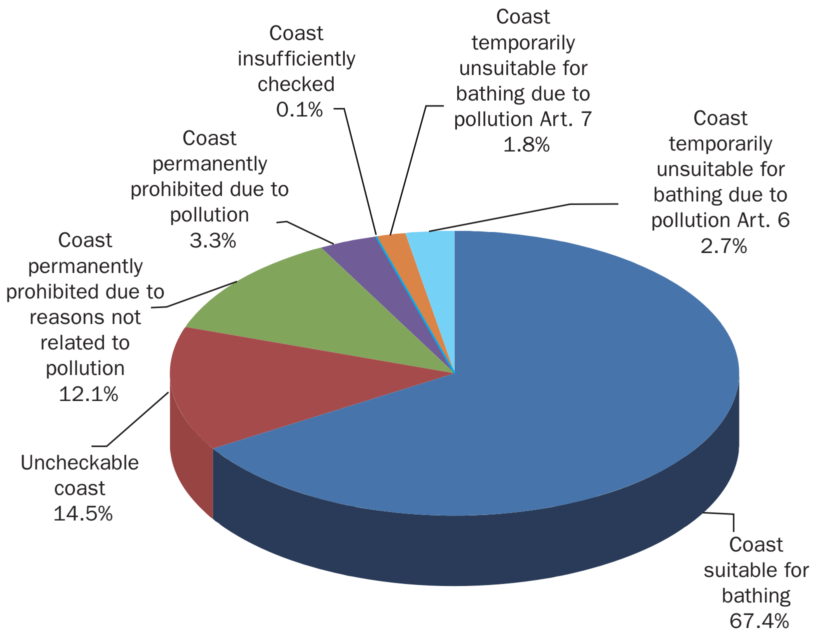


Figure 9.10: Bathing suitability percentages with respect to the coast length (2009)[20]

4,969.1 km of coast is suitable for bathing, which represents 67.4% of the total length.

Table 9.6: Bathing suitability of the coast (2009)[21]

			km	%
Coast length[22]			**7,375.3**	**100**
Unchecked coast	Uncheckable coast		1,067.6	14.5
Unchecked coast	Coast permanently prohibited due to reasons not related to pollution		892.3	12.1
Unchecked coast	Coast permanently prohibited due to pollution		240.2	3.3
Coast insufficiently checked			8.1	0.1
Coast temporarily prohibited due to pollution		Art. 7	135.9	1.8
		Art. 6	62.1	0.8
		TOTAL	198	2.7
Coast suitable for bathing			**4,969.1**	**67.4**

[20] Source: Ministry of Labour, Health and Social Policies data processed by ISPRA
[21] Source: Ministry of Labour, Health and Social Policies data processed by ISPRA
[22] Length of Italian coast considered by the Ministry of Labour, Health and Social Policies to asses the quality of bathing waters

Table 9.6 shows that about 2,200 km of coast has not been checked for different reasons. This can be due to the inaccessibility of sites to monitoring activities (1,067 km) or reasons related to permanent prohibition from bathing either for pollution (240 km) or for other causes such as port areas, marine reserves or military areas (892 km). The remaining 5,175 km of coast has been checked and 4,969 km of the total length (67.4%) is considered suitable for bathing, while 198 km is polluted.
Where there is major algal proliferation, especially of potentially toxic species such as *Ostreopsis ovata,* the local authorities issue temporary closure provisions for the sections of coast involved by the phenomenon. However, being exceptional cases that are not easily predictable, these provisions are not considered when judging the suitability of beaches for the next season.

4,969.1 km of coast is suitable for bathing, which represents 67.4% of the total length.

Microalgae belonging to the *Ostreopsis* genus and the *ovata* species have received growing scientific attention over the last ten years both due to their implication in toxic events and the apparent extension of their geographical distribution from the tropical and sub-tropical areas where they originate to temperate areas. They are benthonic epyphitic oval-shaped dinoflagellate organisms that can produce toxins, with a width of 27-35 μm and a length of 47-55 μm (Figures 9.11 and 9.12). They are found at low depths and are associated to substrata such as rocks and macroalgae. In particular, in the Mediterranean area, molecules responsible for toxicity, such as palytoxins, have been identified both in their cells and in their water matrix. This is a risk for both human beings and the marine environment.

The bentonic microalga Ostreopsis ovata, which has been existing in the Mediterranean for several years, can cause toxicity events that can harm human beings and the marine environment.

Ostreopsis ovata.

Figure 9.11: *Ostreopsis ovata* under electron microscope[23]

Figure 9.12: Ostreopsis ovata under optical microscope[24]

The blooming of algae of the Ostreopsis genus occurs annually in different areas and periods and can cause serious damages to the existing bentonic communities.

As regards damages to human health, the first recorded cases of intoxication started in 1998 in Tuscany on the Apuan littoral section. In July 2005, many cases of intoxication occurred to people who bathed in some beaches of Genoa. These cases were referred to the verified presence of the above dinoflagellate in water samples and microalgae. The case raised the attention towards the issue of both citizens and institutions.

In the following years, other coastal areas were affected by the same phenomenon.

It has been observed that episodes of blooming or finding of microalgae of the *Ostreopsis* genus do not always appear in the same areas and in the same period. Surveys realized during the blooming period show that the latter is characterized by: a uniform layer of reddish gelly covering the seabed; the presence of beige, brown or reddish mucillaginous and foamy aggregates on the water surface; a diffuse opalescence with a reduction of clearness and flakes of suspended material in the water column; traces of anaerobiosis and sufferance of the existing bentonic communities.

On the basis of results obtained from monitoring activities carried out to check the quality of bathing waters and within the framework of a three-year programme implemented by the Ministry for the Environment, Land and Sea (Law 979/82), the presence of

[23] Source: *Florida Marine Reaserch Institute*

[24] Source: ARPA Liguria

the toxic microalga (with or without signs of blooming) was found in most coastal regions except for Basilicata, Emilia Romagna and Veneto (Figure 9.13).
Despite the scientific consistency of monitored parameters, the controls carried out to check the suitability of waters and the proliferation of algae are still focused only on the protection of citizens' health, for a better utilization of coastal areas especially during the summer season.
Facing problems related to the pollution of the marine ecosystem requires the continuous monitoring of marine waters and river runoff in order to identify the causes and therefore implement concrete initiatives to mitigate the negative effects both on people's health and on the survival of marine habitats and their animal and plant species.

The presence of the toxic microalga was found in most coastal regions except for Basilicata, Emilia Romagna and Veneto.

Figure 9.13: Blooming and/or presence of O. ovata along the Italian coast[25]

The presence of the toxic microalga was found in most coastal regions except for Basilicata, Emilia Romagna and Veneto.

[25] Source: ARPA Tuscany data processed by ISPRA

Causes

The evolution of Italian coastlines is mainly influenced by sediments coming from river flows.

In ancient times, the amplitude of the Italian coast was due to deforestation caused by the intensification of trading and agricultural activities, first by the Italic and then by the Roman people. This activity increased the speed of land erosion processes in the countryside and in the hilly area, favouring the flow of large quantities of sediment through rivers to the sea. Many river mouths therefore benefited, receiving a great availability of sediment. This enabled the development of wide and branched deltas and favoured the structuring of coastal plains as well as the accretion of beaches. In recent times, this availability of sediment has lacked due to: control of water flows, urbanization of coasts (with the dismantling and hardening of dunal structures), cautious use of soil (to reduce loss of fertile soil) and stabilization of slopes. This has favoured beach regression and triggered off erosion phenomena in the whole peninsula. The blockage of sediment and the drainage of water for irrigation and reclamation works (which have created healthy soils in many coastal areas) have contributed to creating vast depressed areas subject to floods, which today are below sea level.

Sea storms, relative increase in sea level and subsidence phenomena contribute to the erosion of Italian coasts.

In brief, the phenomenon of erosion on Italian coasts is constantly increasing due to:

- The reduction in the contribution of solid river sediments flowing towards beaches, either collected from riverbeds or caught up by slope stabilization, river control and dam works (mainly human and not natural);
- Sea storms occurring in concomitance with floods causing paroxysmal erosion phenomena at river mouths;
- The relative increase in sea level and concomitant lowering of land level due to natural and human-induced subsidence processes.

Coastal erosion phenomena can have a serious impact on the loss of biodiversity, of landscape and environmental heritage (coastal pine woods, dunes, beaches, etc.) and of areas where very valuable economic activities can be developed.
In the Mediterranean and in Italy, coastal areas are among the most vulnerable and seriously threatened natural ecosystems of

today, even though they are largely protected by specific tools both at national and community level. To confirm this, the European Environmental Agency[26] even newly acknowledged that the European coastal area is affected by a diffuse and progressive degradation in terms of habitat loss, eutrophication, contamination, erosion and invasion of alien species.

The destruction of dune habitats can be due to both natural and human causes, which often act jointly.

As regards dune habitats, their destruction can be due to both natural and human causes. They can act independently or more often jointly, triggering off feedback mechanisms that are difficult to control. For example, the formation of blowouts (areas subject to intense wind deflation) occurs where there is a reduced plant coverage. This can be related to natural factors (e.g. grazing by herbivorous communities) and human ones (e.g. excessive treading due to tourism pressure).
According to studies carried out by the European Union for Coastal Conservation[27], in the last decades there have been daily losses of about 30 hectares of dune surface mainly due to uncontrolled tourism exploitation and human activities. These are the main threat for these coastal areas which translates into a compromised integrity and stability of dune systems[28]. In this regard, it should be underlined that when dunes are demolished (especially those covered by vegetation) they need extremely long periods to regenerate and the phenomenon can be considered practically irreversible.

If on one side it can be useful to keep accumulated banquettes of *Posidonia oceanica* on the beaches (to prevent their erosion and favour the productivity of coastal waters), on the other their presence in touristic and bathing areas can discourage swimmers both because of floating residues and for the smell produced by bacterial degradation processes. These aspects reduce the touristic value of beaches. Local administrations are therefore asked to remove these deposits in order to make the beaches more appealing.

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[26] EEA, 2006
[27] EUCC, 2002
[28] http://www.apat.gov.it/site/_contentfiles/00140500/140589_R54_2005.pdf

The main cause of marine water pollution is the release of chemical and microbiological pollutants originating from human activities.

The good quality of the coastal environment is in any case closely related to the quality of marine waters. The potential causes of marine pollution can be many, but the main ones are related to the release of chemical and especially microbiological pollutants in the environment. In 2009, these caused a bathing prohibition in 84% of beaches.
The sources of sea pollution are mainly from insufficiently purified liquids, industrial discharges and agricultural soil runoff. Therefore urban effluent water purifiers, industrial activities, farming activities (fertilizers, pesticides, etc.), animal breeding and solid waste treatment are all potential sources of bathing water pollution. The risk for bathers caused by a contamination source can vary according to the hydrological features of the drainage basin. Generally, the presence of a large river mouth near a bathing area can represent a potential risk according to the substances that are carried by that specific water flow. In this regard, meteorological phenomena are also particularly important. Indeed, it is generally known that the quality of bathing waters can worsen after strong rains because both chemical and microbiological pollutants are washed out of soils and directed towards bathing areas through rivers.

The fundamental mechanisms that determine toxic blooming phenomena are still not well known today but a few probable causes can be assumed, although their interactions have still not been defined.
Blooming of *Ostreopsis ovata* and *Ostreopsis* spp. along the Italian coasts have occurred almost only in the summer season and recently even in autumn during conditions that favour their development. These are: presence of rocky substrata; low water depth; poor hydrodynamism (due to the natural morphology of the coast or the presence of artificial brushes and barriers to control beach erosion); reduced swell; very stable meteomarine conditions and prolonged high atmospheric pressure; high sun ray exposure; water overheating >25°C; absence of thermocline; presence of macroalgae. During the blooming period, environmental stress situations were highlighted with fish-kill or pathologies affecting marine organisms and effects on

human health. These were reported by bathers, fishermen and residents.

Response

Regulations and planning

There is a greater awareness of improving coastal management.

In the last decades, there is a growing awareness on the need to improve the management of coastal areas, both at national and international level. Over the years, this has generated specific regulations at European level as well as national strategies, regional plans, studies, inventories and researches. Indeed, today many regulations and tools are applied, which contribute to protecting the coastal environment. In Italy the main regulations on coastal areas are indicated below:

The main regulations.

- The Marine Navigation Code regulates action on state maritime property.
- Law 431/85 (Galasso law) establishes landscape obligations in the coastal area within 300 m from the water's edge. However, these obligations are very general, passive and insufficient in contrasting the growing coast transformation initiatives.
- Law 183/89 on land protection gives the State the function of defining geneal approaches, criteria and administrative functions on the protection of coast in basins and areas of national relevance for the security of the State and maritime navigation. In other areas, administrative functions are carried out by the regional authorities.
- Legislative Decree 112/98 gives the state the function of defining general approaches and criteria for protecting coasts. Administrative functions related to planning and integrated management of coastal areas are given to regional authorities. The subsequent Legislative Decree 96/99 also involves provincial authorities in the administrative part. Land protection and specifically coast erosion problems have contributed to increasing the awareness on the need to allocate resources and plan interventions aimed at preventing risks rather than taking emergency action.

- Reform of Chapter V of the Constitution (Constitutional Law 3/2001).
- Law no. 179 dated 31 July, 2002 on «Environmental provisions» and in particular Art. 21 on authorizations for action aimed at the protection of the coastal area.
- Legislative Decree 152/2006 that rearranges and integrates the regulations of all environmental sectors.
- Legislative Decree 116/2008 for the implementation of Directive 2006/7/EC on the management of bathing water quality.
- Decree of the Ministry for the Environment, Land and Sea no. 56 dated 14 April, 2009, containing the «Technical criteria for monitoring water bodies and identifying conditions to amend technical regulations of Legislative Decree no. 152 dated 3 April 2006, indicating environmental provisions in accordance with Article 75, paragraph 3 of the same Legislative Decree».

Adoption of the ICZM Recommendation (2002/413/EC) by the European Council and Parliament.

At European Community level, between 1996 and 1999 the Commission realized a demonstrative programme on Integrated Coastal Zone Management (ICZM). Then, in 2002, on the basis of the Programme's experience and results the European Council and Parliament adopted the ICZM Recommendation (2002/413/EC).
"*The integrated management of coastal zones is a dynamic, interdisciplinary and interactive process aimed at promoting the sustainable structure of coastal zones*" (Communication no. 547 of the European Council of September 27th 2000). The ICZM principles are very dynamic and all-embracing: they include the possibility of any activity being carried out on the coastal area as long as it is done in a sustainable way. The management of a system consists in overlapping a physical context with the many human activities that are carried out. These can include economic activities and development of the housing and infrastructural system with their relative impacts on the environment and the territory.

At international level, Italy is one of the signatory countries of the Barcelona Convention for the Protection of the Marine Envi-

ronment and the Coastal Region of the Mediterranean and its relative protocols. 21 States of the Mediterranean basin and the European Community have adhered to the Convention. According to Article 4 of the Convention, Protocol VII on Integrated Coastal Zone Management (ICZM) of the Mediterranean was adopted during the conference of plenipotentiaries that was held in Madrid on January 20-21th 2008. It was signed by the European Union and by 14 States, including Italy, and was then published on the European Union's Official Gazette of 4/2/2009.

Adoption of Protocol VII on Integrated Coastal Zone Management (ICZM) of the Mediterranean signed by the EU and by 14 States, including Italy.

Protocol VII is the first binding legal tool in the definition of a national strategy for the integrated management of coastal zones and governance of marine and coastal zones. Both the Protocol and the European Recommendation request the parties involved to first of all prepare a national strategy indicating the fundamental decisions for the future of coastal areas, privileging their conservation and protection or trying to give real sustainability to existing or future economic activities. The ICZM Protocol provides measures aimed at the protection and sustainable development of coastal areas in the Mediterranean introducing a series of principles, objectives and forecasts for the regular analysis of the environmental impact, the protection of marine ecosystems, the safeguarding of coastal and island landscapes, the conservation of the cultural heritage and development of economic activities.
It implies the integration of all the different sector policies involved, the administration at all levels and the integration of the land and sea components in the territory involved.

Regional coastal management planning.

Currently, the coastal territory in Italy is managed in very different ways. Planning tools are often in contrast and at times indications are not binding. Table 9.7 shows the situation in Italy and summarizes the regional planning tools on the management of coasts in the 15 coastal regions.

Table 9.7: Regional coastal plans[29]

Region	Regional plan		Coastal protection plan			ICZM Plan			Coast protection plans RAP
		Type		period	status		period	status	
Liguria	Yes	Coastal Coordination Territorial Plan	yes	2000	approved				
Tuscany	Yes	ICZM Plan for Hydrogeological Readjustment	yes	2004	published				Yes
Lazio						yes		experimental	Yes
Campania	Yes	Erosion Transitional Plans							
Basilicata									
Calabria	Yes	Hydrogeological Settlement Transitional Plan – Integrated Management Plan (=Protection Plan)	yes	2005	approved	yes	2006	in process	Yes
Apulia			yes	2006	editing				Yes
Molise									Yes
Abruzzo	Yes	Organic Plan for vulnerable areas at risk	yes	2003	approved				Yes
Marche	Yes	ICZM Plan	yes	2005	approved	yes	2004	approved	Yes
Emilia Romagna	Yes	ICZM Plan	yes	1983	approved	yes	2005	approved	Yes
Veneto									Yes
Friuli Venezia Giulia									Yes
Sardinia	Yes	Lanscape Regional Plan				yes		experimental	Yes
Sicily	Yes	Hydrogeological Settlement Transitional Plan	yes	2004	editing				Yes
Plans Total	**9**		**8**			**3**			**12**

11 regions have tools that are extended to the whole regional territory.

Out of 15 coastal regions, 11 of them are endowed with planning tools extended to the entire regional territory. Among these, 6 regions have a specific coastal protection plan and only Emilia Romagna and Marche have an approved integrated management plan of the coastal area.

In Calabria, after having dealt with the coastal erosion problem within the scope of the Hydrogeological Settlement Transitional Plan (adopting an initial risk analysis methodology), the region is now preparing to draw up an integrated management plan. The plan considers previous action as one of the elements functional to the construction of a broader conceptual plan. The remaining

[29] Source: Prepared by ISPRA on the basis of data from coastal regions.

regions mainly have coast protection and Regional Action Plans (RAPs) that merely define a list of protection works to be realized in short sections of the coast.
Indeed, the current coastal planning framework in Italy does not yet reflect the wider scope introduced by the Integrated Coastal Zone Management.

Action is being taken for the preparation of a National Strategy.

However, it should be underlined that since the ratification of Protocol VII on ICZM, the Ministry of the Environment, Land and Sea started a series of studies and projects to prepare Italy's National Strategy. The attention is focused on two indicative elements of the natural, social and economic life of coastal areas, namely:

- The parties that need to be involved at various levels (institutions, productive sector, independent bodies, etc.);
- The area of application (which requires the delimitation of the coastal area).

Institutional, economic and cultural parties operating in the coastal area need to be involved.

The ICZM imposes an agreement on the environment and its resources between all the parties involved in the coastal area. This means that the need to find a harmonized management of the environment (integrating environmental planning policies with economic, cultural and territorial ones) is the primary need. The ICZM promotes and requires the preparation and development of a coordination mechanism between the economic, administrative and cultural sectors. This mechanism must be able to define the strategic elements of a National Policy of integrated management taking into account the interests on the environment and on the territory in order to protect and use it limiting the redundancy and the overlapping of planning tools that are put in place by the administrations and all the parties involved.

Characterization of the environmental and socio-economic scenarios on the coastal area.

Since the environment is the primary value promoted by Protocol VII to achieve a coherent application of integrated management principles, a characterization of the socio-economic scenario (urban centres, infrastructures, economic activities, etc.) needs to be carried out. This should describe the natural environment's

quality as well as the territory in order to confirm eventual decisions aimed at the protection and conservation of the existing ecosystems.

Continuous assessment of the National Strategy implementation progress.

Another primary element is monitoring action, which ensures the continuous assessment of the National Strategy and the efficacy of implemented plans and programs. It also enables to make amendments and integrations to the same programs, if necessary, and to draw up reports on the implementation progress as provided by the European Community.

Action aimed at protecting, studying and monitoring the marine and coastal environment

There is an inevitable need to find ways of protecting the coastal areas.

Erosion, loss of coastal resilience, pollution, biological phenomena and human pressure. All these indicators lead to the inevitable need to protect coastal areas and take action keeping in mind the great complexity and vulnerability of this environment. In order to control the phenomenon of beach erosion and the expansion of flood-risk areas, protection measures have been taken mainly by realizing barriers. However, these have not resolved the erosion problem, especially in the medium and long term. In many cases, the barriers even contributed to the process of artificialization and degradation of the marine and coastal habitats. Interventions aimed at the nourishment of beaches using sand from marine quarries started only in the least few decades.

Effects on the marine environment caused by the relict sand dredging for beach nourishment.

The dredging of relict sands for beach nourishment (even with good quality sediments) can, however, induce significant effects on the marine environment. The main ones can be the variation and nature of seabottom features with possible localized effects on fishing activities (e.g. damaging of fishing nets) and the immission of fine-grained sediment in the water column. The latter mainly occurs during dredge-loading operations when the excess water that was sucked in with the sediment is released (overflow). This overflow can damage sensitive habitats (such as *Posidonia oceanica* meadows, Coralligenous biocoenosis, etc.) that can be present in proximity of the dredged areas.

In view of the above, it is therefore important to have a detailed and updated knowledge of the environment where marine sand deposits are located in order to forecast and assess the eventual effects of dredging operations and the choice of eventual impact mitigation measures that need be adopted.
Since 1999, ISPRA started working with the Regione Lazio local authority and the Environmental Agency (ARPA) of Emilia Romagna to carry out a series of environmental studies. These studies have led to the definition of a specific environmental monitoring Protocol for these activities that can be applied also to other geographical areas.

ISPRA then extended the experimentation of this Protocol to other Italian regions (Marche region) and presented the Protocol to the European community[30].
The proposed Protocol[31] involves the realization of a specific environmental monitoring study in 3 areas: the dredging area, the transport area and the nourishment area. The study is divided into three phases: before (*ante operam*), during and after (*post operam*) operations. During each of the three phases surveys are carried out on: benthic assemblages; fish assemblages; chemical and granulometric characteristics of the seabottom sediment; physical-chemical characteristics and dynamics of the water column and suspended particulate matter. The environmental monitoring study does not only define the area's environmental compatibility to dredging (in other words the environmental feasibility of such operations).
It also enables to assess the recovery times and modalities of the marine environment. In particular, surveys carried out *ante operam* in the dredging site (characterization of dredging site) not only provide general environmental data for the monitoring but also supply important information to obtain the dredging authorization.

The Protocol proposed by ISPRA involves the realization of a specific environmental monitoring study, divided into three phases: before, during and after the operations.

[30] www.beachmed.eu
[31] Quaderno ICRAM no. 5 "Aspetti ambientali del dragaggio di sabbie relitte a fini di ripascimento: proposta di un protocollo di monitoraggio" ("Environmental aspects in the dredging of relict sands for beach nourishment: proposal for a Monitoring Protocol")

Some European projects [32] considered the different aspects (such as the planning, environmental and economic point of view) of relict sand and/or offshore sand dredging for beach nourishment.

Protection and recovery of dune ridges.

As regards coastal dunes, data recently published in the EEA Report (2006) (Figure 9.14), show that dune environments protected by Directive 92/43/EEC represent 6% of coastal sites included in the *Natura 2000* network, covering a total area of about 250 km^2.

Dune environments protected by Directive 92/43/EEC represent 6% of coastal sites included in the Natura 2000 network.

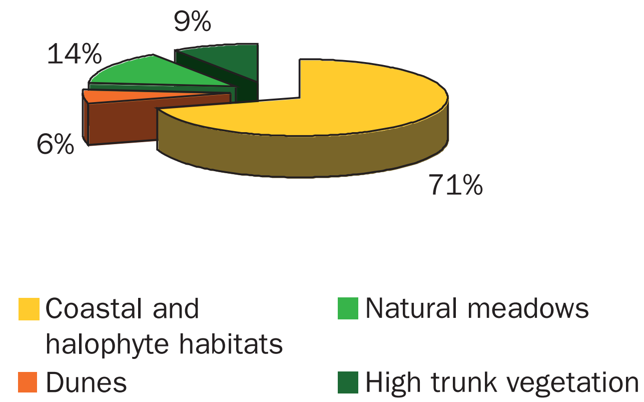


Figure 9.14: Types of coastal sites in Europe[33]

Many studies and interventions for the protection and recovery of coastal dunes scattered over the national territory have been conducted, funded by both local and national administrations and the European Community. Many are also the European projects that have the primary or secondary aim of managing and studying coastal dunes. A recent example is the POSIDuNE project, funded within the framework of the INTERREG IIIC Beachmed-e[34], that promoted activities in the Tuscany region.

[32] www.beachmed.it
[33] Source: EEA, The *changing faces of Europe's coastal areas,* 2006
[34] http://www.beachmed.it/Beachmede/SousProjets/POSIDUNE/tabid/99/Default.aspx

Management of stranded biomass (marine phanerogams and algae).

In the management of beaches, local administrations dealing with the problem of stranded *Posidonia* deposits adopted temporary emergency solutions. This involved expensive operations with clearing and disposal of the deposits in the dumps. In general, the removal of biomass takes place before the summer season and is carried out with mechanical vehicles which also carry away great quantities of sand. The nature of the coastal area where beach clearing operations take place is not taken into account. This triggers off and speeds up the process of beach erosion and compromises the integrity of the coastal habitat obliging the local administrations to intervene with expensive protection measures and beach nourishment operations.
In the absence of shared rules and models, the management of stranded matter is not an easy process. Indeed, the current laws in force are not always easy to interpret. There is no specific reference on this matter being considered waste and only recently are marine phanerogams (such as stranded *Posidonia*) used for the production of compost (Decree dated January 22th 2009 issued by the Ministry of Agriculture, Food and Forests). In view of the above, the Ministry for the Environment, Land and Sea (also in response to clarification requests advanced by coastal municipalities) issued Circular no. 8123/2006 that provides for three possible types of management related to the specific features of the coastal area and the social and economic situation: 1) local maintenance of the *banquettes*; 2) relocation of the deposits; 3) permanent removal and disposal in dumps.
The theme of *banquette management* was also tackled by the European project POSIDuNE, which produced specific technical documentation on the issue.

At national level, ISPRA is collaborating with technical staff of the regional environmental agencies (ARPA) on the coasts and with the Province of Livorno. A programme of activities was started in 2006 as a first step towards the study and management of *banquettes*. The programme also provides background knowledge for the definition of rules or guidelines in order to respond to these problems that local administrations have to deal with on a yearly basis.

New measures for the management of bathing water quality.

The suitability of beaches to bathing is established every year on the basis of data obtained from monitoring operations carried out by the regional environmental agencies (ARPA) during the previous year's bathing season. The management of bathing waters currently follows provisions established by Presidential Decree 470/82. This establishes the monitoring of water quality every 15 days from 1 April to 30 September, checking the microbiological parameters (fecal contamination indicators) and chemical-physical ones (transparency, colour, pH, dissolved oxygen, etc.).
This control system will soon be substantially changed due to the entrance into force of Legislative Decree 116/2008 in June 2008 to implement European Directive 2006/7/EC (which annuls Directive 76/160/EEC). The main objective of the new law is to protect human health from risks related to the poor quality of waters through a prevention and environmental improvement strategy.
The quality of bathing waters will be classified according to four quality levels (excellent, good, sufficient and poor) based on 90th and 95th percentile values of the two microbiological indicators (intestinal *Enterococci* and *Escherichia coli*) calculated from monitoring data of the last four years.
Although the trend has been to assess the marine environment's conditions only with reference to human health risks, the new law acknowledges the important role played by environmental factors in influencing the quality of bathing waters. Indeed, apart from checking fecal contamination indicators, a series of assessments will also be made on potential pollution sources taking into account the different factors, such as the morphology and hydrogeological features of the territory and the specific meteo-marine conditions in the area. For this reason, each area must have a profile with data on the water itself, a description of the territory and information on the impacts that can influence its quality. These profiles will be prepared for the first time by March 24th 2011.
Directive 76/160/EEC will be definitely annulled with effect from 31 December 2014. In this transitory period, technical regulations are being defined to implement the contents of the new Directive. In the meantime, monitoring activities continue to be carried

out according to indications contained in the Presidential Decree 470/82.
For example, for the surveillance of *O. ovata* the Ministry of Health prepared guidelines to identify operational procedures for the management of risks related to the blooming of *Ostreopsis ovata* on the Italian coast ("Gestione del rischio associato alle fioriture di *Ostreopsis ovata* nelle coste italiane" – May 2007). These guidelines are currently being revised.
Following repeated communication received from the authorities, in 2006 the Ministry for the Environment, Land and Sea appointed ISPRA to activate a working programme on "toxic algae" in agreement with the regional environmental agencies (ARPA). The programme was aimed at sharing knowledge and information on the ecology, monitoring methods and any other aspects that could help understand the phenomenon.
The result of this activity was the identification of elements for a common national strategy aimed at the sampling, analysis, monitoring, surveillance, information, communication and management of the "toxic algae" phenomenon.
Operational protocols for the national management of the phenomenon were produced by ISPRA/ARPA and these were recently adopted by the Ministry for the Environment, Land and Sea during marine and coastal monitoring activities. A brochure was also prepared and distributed to inform the local population on the phenomenon.
In addition to the above activities, ISPRA works closely with the ARPA agencies in coastal regions to prepare an annual report on the "toxic algae" situation, especially in the summer season. Regular seminars are also organized to keep constantly updated.

Scientific studies on the toxicity of microalgae.

Scientific studies were also conducted and some of them are still in course (Research programme on *Ostreopsis ovata* and *Ostreopsis spp.*: new microalgal toxicity risks in the Italian seas). The studies are aimed at acquiring more information on toxic algae to understand the environmental conditions that favour their proliferation and the mechanism with which the toxins are transferred in the marine aerosol.

CHAPTER 10

WASTE CYCLE

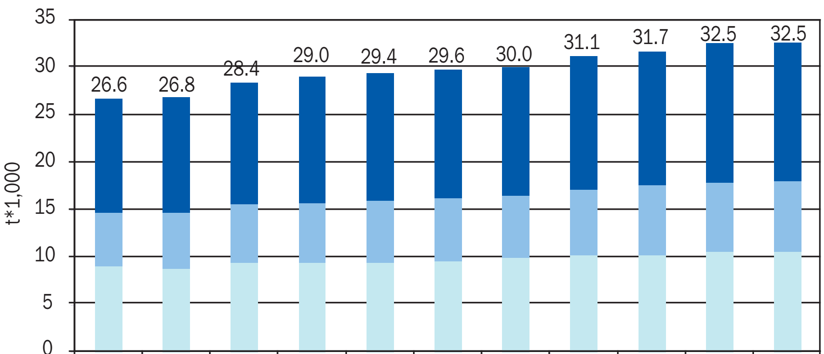
Total municipal waste generation between 2006 and 2007 marked a substantial stability with a growth of about 0.1%.

Generation and separate collection of municipal waste

In 2007 the national generation of municipal waste reached 32.5 million tons, a value similar to the one recorded in 2006 (Figure 10.1). The growth in these two years is actually just above 30,000 tons, marking an increase of about 0.1%.

Despite the relative stability of the last two years, in the period between 2003-2007 the total generation of municipal waste increased by about 8.4% with more substantial increases between 2003 and 2004 (+3.7%) and between 2005 and 2006 (+2.7%). A more controlled growth was recorded between 2004 and 2005 and in the last year (+1.6%).

Despite the stability recorded in the last two years, the generation of municipal waste between 1997 and 2007 increased from 26.6 million tons to about 32.5 million tons.



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
North	11.9	12.2	12.9	13.3	13.4	13.6	13.6	14.0	14.2	14.6	14.6
Centre	5.6	5.8	6.1	6.2	6.5	6.6	6.6	6.9	7.2	7.4	7.4
South	9.1	8.8	9.4	9.5	9.5	9.6	9.9	10.2	10.3	10.6	10.6

Figure 10.1: Generation of municipal waste[1]

With reference to single geographical macroareas, it can be observed that in general data on the North of Italy reflect the national trend with a growth, even in this case, of 0.1% between 2006 and 2007. A slightly higher increase, but still very slight, can be seen in the South, with a growth of about 0.2% while a substantial stability is recorded in the Centre of Italy (about -0.02%).

In 2007 per capita generation of municipal waste at national level was of about 546 kg/inhabitant per year.

The analysis of per capita data is necessary to extract the individual production level from that of the resident population. In this regard, in 2007 a decrease was observed with respect to the

[1] Source: ISPRA

previous year: the national per capita production recorded about 546 kg/inhabitant per year, compared to the 550 kg/ inhabitant per year of 2006.
In particular, it should be noted that the per capita production is substantially influenced by the increase in the official resident population, which grew by 488,003 units (+0,8%) between the 31st December 2006 and the 31st December 2007, and therefore it is larger with respect to the recorded municipal waste data.
In the three geographical macroareas the highest production values in 2007 are similar to the ones reported above and therefore are found in the Centre, with about 630 kg/inhabitant per year. The lowest values are recorded in the South with about 508 kg/ inhabitant per year. In particular, the Centre recorded a 1.1% drop in the per capita municipal waste production percentage with respect to the previous year (which is about -7 kg/ inhabitant per year) and a contraction of about 0.2% in the South (-1 kg/ inhabitant per year).

The highest per capita production values in 2007 are found in the Centre of Italy (630 kg/ inhabitant per year) and the lowest are found in the South (508 kg/ inhabitant per year). The North produces 539 kg/ inhabitant per year.

The North produces about 539 kg/ inhabitant per year, which is -0.9% with respect to 2006 (-5 kg/ inhabitant per year).
Despite the substantial stability of the total production of municipal waste it can be observed that between 2006 and 2007, separate collection at national level increased by almost 590,000 tons (+5.8%). This growth brings the amount of separately collected waste to about 9 million tons, representing 27.5% of the total municipal waste generation (Figure 10.2).

In 2007, the percentage of separate collection at national level was of 27.5%.

However, the collection is still below the 35% target by Article 205 of Legislative Decree no. 152/2006 to be reached by 31st December 2006 the 40% target introduced by Law no. 296 of 27 December 2006, to be reached by 31st December 2007.
In any case, the analysis of geographical macroareas highlights an extremely diversified scenario: while the North (with a collection rate of 42.4%) is clearly beyond the 2007 target, which was actually almost reached in 2006 (39.9%), the Centre and South (with respectively 20.8% and 11.6%) are still very far from achieving the target.

There is a diversified scenario in the three macroareas: the North (with a separate collection rate of 42.4%) is clearly beyond the target of 40% set by the Law of 2007) while the Centre and South (with respectively of 20.8% and 11.6%) are still very far from achieving the target.

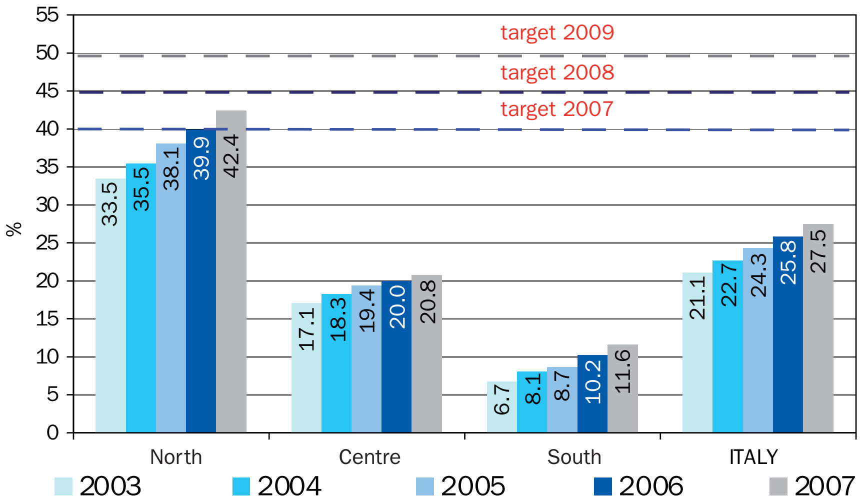


Figure 10.2: Percentage of separate collection of municipal waste[2]

In the North (where the separate collection system is already well developed) between 2006 and 2007 the total growth of waste from separate collection amounted at 380,000 tons (+6.5%). A minor increase can be observed in the South (almost 150,000 tons more, between 2006 and 2007). However, this increase corresponds to a particularly relevant rise in percentage terms (about +13.8%), considering the low collection levels that had been recorded so far in this specific macroarea. In Central regions of Italy the increase in separate collection reached about 58,000 tons (+3.9%). This is a lower value with respect to the growth recorded the previous year, which reached about 84,000 tons (+6.1%).

In 2007, the regions with the highest percentages of separate collection are Trentino Alto Adige (53.4%) and Veneto (51.4%). Piedmont and Lombardy almost reach 45%.

In 2007, the regions with the highest percentages of separate collection are Trentino Alto Adige and Veneto with over 50% (53.4% and 51.4%, respectively). More than a half of municipal waste generated in these two regions is therefore collected separately. Regions that almost reach the 45% (the target established by the law, to be reached by December 31st

[2] Source: ISPRA

2008) are Piedmont (44.8%) and Lombardy (44.5%). In general, all the regions in North of Italy, are well above a separate collection performance of 35%, with the exception of Liguria (19%),

In the Centre, during 2007, the only region with a separate collection rate over the 30% threshold was Toscana (about 31.3%), followed by Umbria (25%) and Marche (21%). Lazio, instead, reached a rate of 12.1%. Among the Southern regions of Italy, Sardinia reached a separate collection rate of 27.8%. The region increased its separate collection of almost 18% (in 2005 the rate of separate collection was below the 10%). Abruzzo follows with a rate of 19% (18.6%) in 2007 and Campania with 13.5%. Other regions of the South (Molise, Basilicata, Apulia, Calabria and Sicily) still have separate collection rates below the 10%.

Among the Southern regions of Italy, Sardinia has a separate collection rate of 27.8%. In 2005 the percentage of separate waste collection was lower than 10%.

At provincial level it can be noticed that in 2007, 29 provinces out of 107 (5 more than in 2006) went over a 40% rate of separate collection (15 of these collect more than 50%), while 39 provinces collect a quantity lower than 20% (6 less than in 2006). The provinces with the highest collection rates are Treviso and Novara, with percentages respectively of 69.1% and 61.1%, confirming the data recorded in 2006.

A relevant growth was recorded in the last year in the province of Medio Campidano (Sardinia). The percentage of separate collection increased from 43.8% in 2006 to 59.1% in 2007.

Rates higher than 55% are recorded in different provinces of the North and particularly in Trento (56.1%), Padova (55.6%), Varese (55.5%), Verbania (55.5%) and Cremona (55%), while separate collection rates between 50 and 55% are found in Rovigo (53.9%), Bergamo (52.8%), Gorizia (52.2%), Lecco (52.1%), Asti (50.7%) and Bolzano (50.2%).

Various provinces in the North have separate waste collection percentages above the 50%.

It is worth noting that, apart from the province of Medio Campidano, even the province of Ogliastra (also located in Sardinia) has a separate collection value higher than 40% (42.3%).

Several provinces in Toscana, and one province in Sardinia (Oristano) are among the provinces with a separate collection rate above the 30%. The lower percentages are found in the provinces of Caltanissetta, Siracusa and Messina (all below 4%) as well as

in Frosinone, Rieti, Isernia and Campobasso, with rates between 4 and 5%.

Separate waste collection at municipal level

Data on the generation and separate collection of municipal waste are collected and processed by ISPRA for each single city, except for cases in which only joint information is available for mountain communities, basin consortiums or unions of municipalities. These, however, include a very limited number of municipalities which, in 2007, reached 191 (2.4% of the total number of Italian municipalities and 1.2% of the national population).

Of the above 191 municipalities, 83 are located in the North of Italy, mainly in the region of Aosta Valley (73), 33 in the Centre (27 in the province of Rieti and 6 in the province of Frosinone) and 75 in the South (of which 30 in the province of Palermo and 35 in the province of Agrigento).

A first analysis based on data collected in 2007 is shown in Figure 10.3. The 7,910 municipalities for which separate collection data are available are divided into different classes.

More than one half of the analyzed municipalities (about 52.5% which is equivalent to 4,156 municipalities) in 2007 has separate collection percentages lower than 30%, while only about 4.1% of the cases(although with an increasing trend with respect to 2006) showed collection rates higher than 70%. The percentage of municipalities that in 2007 had a collection rate between 50% and 70% is of 21.8% (also in this case with an increasing trend with respect to 2006) while the percentage of those having collection rates between 40% and 50% and between 30% and 40% is respectively of 9.4% and 12.2%.

In order to have a more in-depth analysis of the separate waste collection performances, the different municipalities can be divided into various classes of resident population. In this way, the impact that municipalities with the highest collection percentages have in their specific classes can be analysed.

An analysis of data at municipal level conducted in 2007 shows that 4.1% of municipalities have separate collection rates higher than 70%, while over half (about 52.5%) have collection rates below 30%.

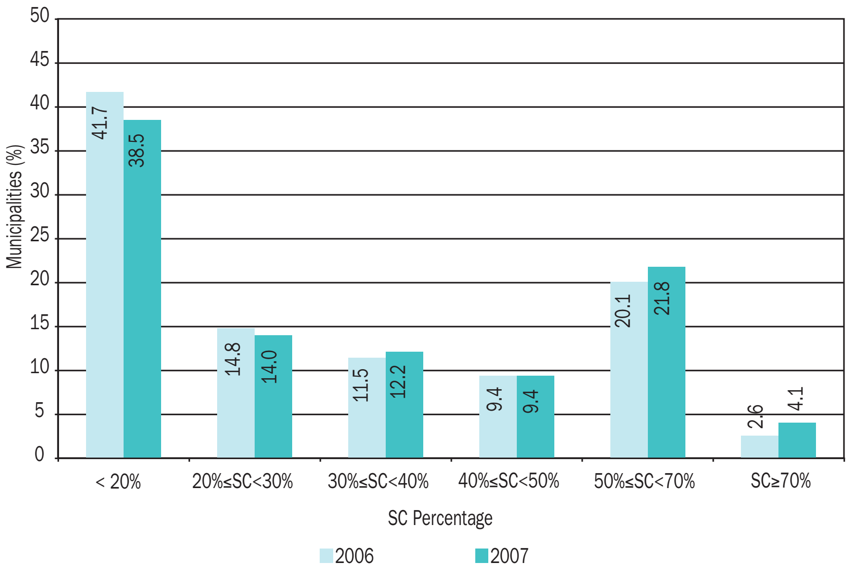


Figure 10.3: Separate collection percentages in Italian municipalities[3]

In particular, municipalities can be divided into the following population classes:

- 1 – 5,000 inhabitants
- 5,001 – 15,000 inhabitants
- 15,001 – 30,000 inhabitants
- 30,001 – 50,000 inhabitants
- 50,001 – 150,000 inhabitants
- >150,000 inhabitants

The division of municipalities into the above classes is shown in Table 10.1. It should be noted that the analysis below only takes into account the municipalities that were able to provide single data on their specific separate collection in 2007 (this was possible for 7,910 municipalities, which represent about 97.6% of total Italian municipalities and 98.8% of the national population).

[3] Source: ISPRA

By dividing municipalities into classes, according to the resident population, it can be noted that 70% of the same have less than 5,000 inhabitants while 27 cities have more than 150,000 inhabitants.

Table 10.1: Division of municipalities into classes of resident population[4]

Population classes	Municipalities	Population	Municipality percentage	Population percentage
	number		%	
0 – 5,000	5,557	10,120,254	70.3	17.2
5,001 – 15,000	1,650	14,067,572	20.9	23.9
15,001 – 30,000	401	8,236,216	5.1	14.0
30,001 – 50,000	157	5,935,743	2.0	10.1
50,001 – 150,000	118	8,758,193	1.5	14.9
>150,000	27	11,791,131	0.3	20.0
TOTAL	**7,910**	**58,909,109**	**100.0**	**100.0**

With reference to the analysed samples, it can be noted that over 70% of municipalities have less than 5,000 residents while only 17.2% of the population lives there. If we include even the municipalities having between 5,001 and 15,000 inhabitants, the percentage (out of total municipalities) reaches about 91.2%. In terms of population, about 41% of the 58.9 million inhabitants (which is the total population of analysed municipalities) live in cities having a resident population lower than 15,000 inhabitants. The cities with more than 150,000 inhabitants are 27, representing 0.3% of analysed municipalities but 20% of the national population. Once having divided the population into classes, we can proceed by grouping up the municipalities belonging to each class according to their separate collection of waste (SC) levels. To this purpose, the following ranges have been identified:

- SC<20%
- 20%≤SC<30%
- 30%≤SC<40%
- 40%≤SC<50%
- 50%≤SC<60%
- 60%≤SC<70%
- SC≥70%

The results of the analyses that were conducted are reported in Table 10.2. The fifth column of the table shows the percentage of municipalities (belonging to a given population class) that fall within the

[4] Fonte: ISPRA

range of separate collection indicated in column 2, with respect to the total number of municipalities of the same class. The sixth column, instead, refers to the relationship between the resident population in the municipalities falling within a given range of separate collection and the total population in the municipalities of that class.

By dividing municipalities belonging to different population classes into ranges of separate collection of waste, it can be noted that municipalities with a higher separate collection rate are less as the population grows in dimension.

Table 10.2: Summary of separate waste collection percentages in Italian municipalities, according to classes of resident population[5] (2007)

Resident population class	SC level	Municipalities	Population	Number of municipalities/ Total number of municipalities in the same class	Municipality population/ Total population in the same class
		number		%	
0-5,000	SC<20%	2, 181	3,803,030	39.2	37.6
	20%≤SC<30%	851	1,297,307	15.3	12.8
	30%≤SC<40%	636	1,154,490	11.4	11.4
	40%≤SC<50%	494	967,538	8.9	9.6
	50%≤SC<60%	630	1,252,719	11.3	12.4
	60%≤SC<70%	549	1,187,249	9.9	11.7
	SC≥70%	216	457,921	3.9	4.5
	total	**5,557**	**10,120,254**	**100.0**	**100.0**
5,001 – 15,000	SC<20%	554	4,747,212	33.6	33.7
	20%≤SC<30%	185	1,549,194	11.2	11.0
	30%≤SC<40%	218	1,896,463	13.2	13.5
	40%≤SC<50%	173	1,481,709	10.5	10.5
	50%≤SC<60%	202	1,756,350	12.2	12.5
	60%≤SC<70%	225	1,849,869	13.6	13.1
	SC≥70%	93	786,775	5.6	5.6
	total	**1,650**	**14,067,572**	**100.0**	**100.0**
15,001 – 30,000	SC<20%	159	3,339,987	39.7	40.6
	20%≤SC<30%	37	710,126	9.2	8.6
	30%≤SC<40%	60	1,257,823	15.0	15.3
	40%≤SC<50%	46	937,694	11.5	11.4
	50%vSC<60%	50	1,022,779	12.5	12.4
	60%≤SC<70%	39	782,125	9.7	9.5
	SC≥70%	10	185,682	2.5	2.3
	total	**401**	**8,236,216**	**100.0**	**100.0**

continues

[5] Source: ISPRA

follows

Table 10.2: Summary of separate waste collection percentages in Italian municipalities, according to classes of resident population[5] (2007)

Resident population class	SC level	Municipalities	Population	Number of municipalities/ Total number of municipalities in the same class	Municipality population/ Total population in the same class
		number		%	
30,001 – 50,000	SC<20%	83	3,162,491	52.9	51.9
	20%≤SC<30%	15	535,119	9.6	8.8
	30%≤SC<40%	18	681,082	11.5	11.2
	40%≤SC<50%	15	591,691	9.6	9.7
	50%≤SC<60%	16	777,556	10.2	12.8
	60%≤SC<70%	8	284,728	5.1	4.7
	SC≥70%	2	61,297	1.3	1.0
	total	**157**	**6,093,964**	**100.0**	**100.0**
50,001 – 150,000	SC<20%	60	4,154,265	50.8	47.4
	20%≤SC<30%	16	1,220,463	13.6	13.9
	30%≤SC<40%	19	1,521,716	16.1	17.4
	40%≤SC<50%	15	1,275,403	12.7	14.6
	50%≤SC<60%	6	426,542	5.1	4.9
	60%≤SC<70%	2	159,804	1.7	1.8
	SC≥70%	0	0	0.0	0.0
	total	**118**	**8,758,193**	**100.0**	**100.0**
>150,000	SC<20%	12	6,728,998	44.4	56.2
	20%≤SC<30%	3	804,536	11.1	6.7
	30%≤SC<40%	11	4,095,307	40.7	34.2
	40%≤SC<50%	1	341,263	3.7	2.9
	50%≤SC<60%	0	0	0.0	0.0
	60%≤SC<70%	0	0	0.0	0.0
	SC≥70%	0	0	0.0	0.0
	total	**27**	**11,970,104**	**100.0**	**100.0**
TOTAL		**7,910**	**59,246,303**		

As forecasted, as the population grows in dimensions there is a lower number of municipalities with higher rates of separate collection. In larger centres, for example, there are no cases of separate collection higher than 50%.
As regards municipalities with less than 5,000 inhabitants, about 34% of analysed samples have percentages of separate collec-

tion higher than 40%. In terms of population, these municipalities represent 38.2% of the total.
As for the class above (i.e. municipalities with a resident population between 5,001 and 15,000 inhabitants), 42% of municipalities have the best performance of separate collection (>40%) both in terms of number and in terms of population. In the class between 15,001-30,000, the number of municipalities with the highest percentages of SC is again below 40% (about 36%), while for municipalities with a number of inhabitants between 30,001 and 50,000 the percentage of those having a SC rate higher than 40% is 26% (in terms of number of municipalities) and 28% (in terms of resident population).
As regards the class between 50,001-150,000 inhabitants, the percentage of municipalities with the highest percentages of separate collection is of 19% (in number) and about 21% (in terms of resident population).
Evidence that the number of municipalities with highest SC rates reduce as the dimension of the municipalities grow can be seen from the analysis reported in Figure 10.4. This shows the percentage of municipalities (population/total population in the same class) belonging to the various classes of population according to the different ranges of separate collection.

In the class of municipalities with less than 5,000 inhabitants about 34% of municipalities have a SC rate higher than 40%. In centres with a population between 5,001 and 15,000 inhabitants, the number of municipalities with the highest SC rate (>40%) is of about 42%.

The larger municipalities never have separate collection rates higher than 50% and only one of them has a collection rate higher than 40%. However, 11 cities have collection rates between 30% and 40% of the total municipal waste production.

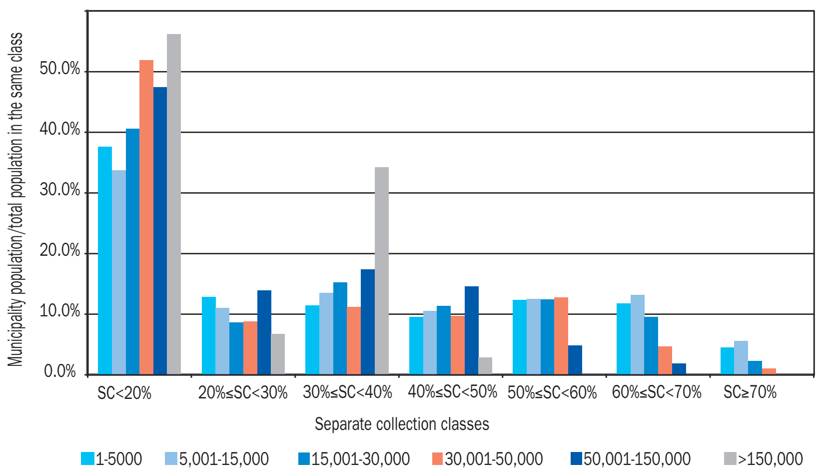


Figure 10.4: Percentage of municipalities by population classes according to the different separate collection ranges[6]

[6] Source: ISPRA

To this purpose, it should be highlighted that even if larger municipalities never have separate collection rates higher than 50% and only one of them has a collection rate higher above 40%, 11 cities still have separate collection rates between 30% and 40% of the total municipal waste production (34.2% of the total population in the large municipalities).
The following figures show the percentages of separate collection in the single municipalities according to the resident population of the same. The figures refer to all Italian municipalities (Figure 10.5) and to municipalities in the respective geographical macroareas (Figures 10.6-10.7-10.8). For a better interpretation of the figures below, it should be noted that urban centres with a resident population higher than 500,000 (Turin, Milan, Genoa, Rome, Naples and Palermo) have been excluded from the analysis.

By analysing the percentages of separate waste collection of single municipalities according to the resident population it can be observed that in Italy most municipalities have collection rates lower than 40%.

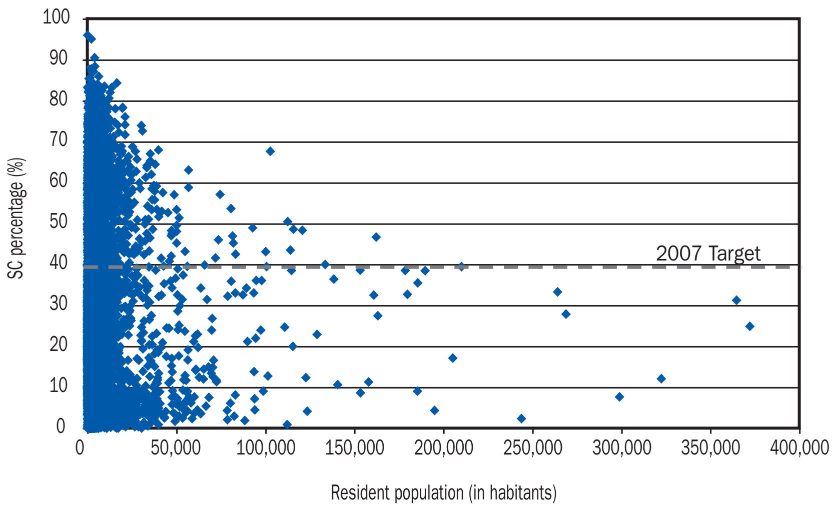


Figure 10.5: Percentages of SC according to the resident population in Italian municipalities (2007)[7]

[7] Source: ISPRA

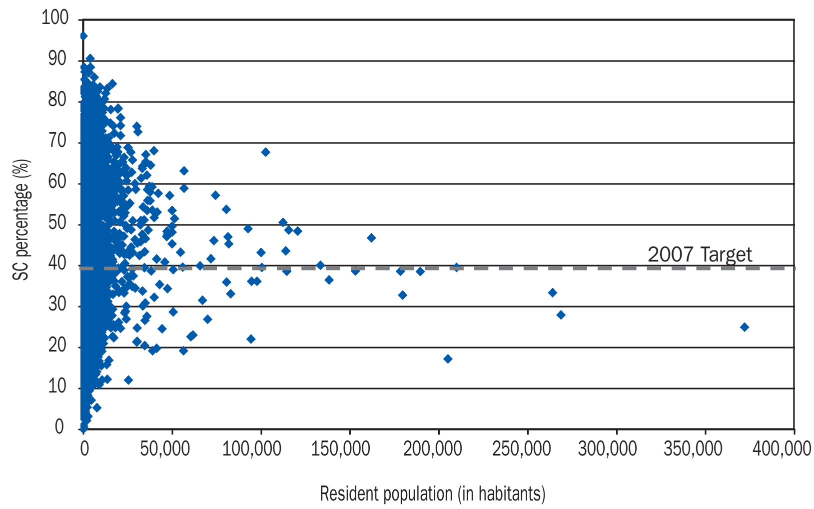


Figure 10.6: Percentages of SC according to the resident population in municipalities of Northern Italy (2007)[8]

In the North, there is an almost symmetrical distribution of municipalities reaching the 40% target of separate collection, both for smaller and medium-large municipalities in terms of resident population.

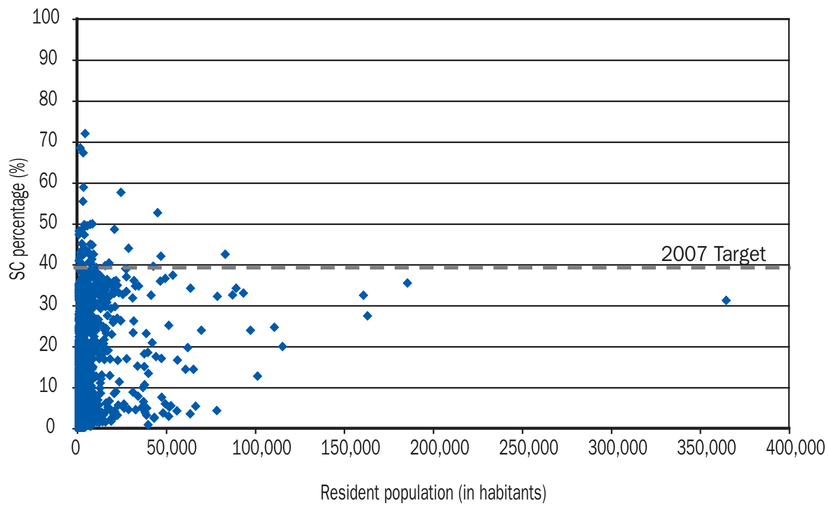


Figure 10.7: Percentages of SC according to the resident population in municipalities of Central Italy (2007)[9]

In the Centre, there is a more asymmetrical distribution with a higher concentration of lower separate collection percentages.

[8] Source: ISPRA
[9] Source: ISPRA

In the South, there is an asymmetrical distribution with a more pronounced concentration of low separate collection percentages.

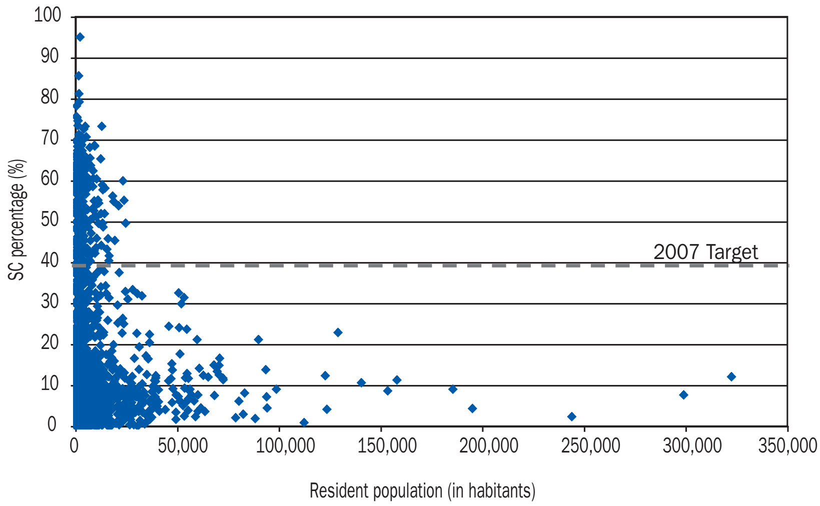


Figure 10.8: Percentages of SC according to the resident population in municipalities of Southern Italy (2007)[10]

An analysis of the above figures shows that there is a higher presence of municipalities with high SC rates in Northern Italy and a higher concentration of low collection rates in Central and Southern Italy. The North has an almost symmetrical distribution with respect to the 40% target both for smaller municipalities and for medium and large ones in terms of resident population. The Centre and South, instead, have a more asymmetrical distribution with a higher concentration of municipalities having a low separate collection rate. In the Centre, this trend is more evident even in the smaller municipalities, while in the South there is a higher number of smaller municipalities with SC rates higher than the 40% target but most municipalities fall in any case below the SC threshold of 20%. Municipalities with a separate collection rate higher than 40% are almost all located in Abruzzo (6.9%), Campania (23.9%) and Sardinia (67.5%).

[10] Source: ISPRA

In the South, unlike the Centre, there is even a decreasing trend in the separate collection rate as the dimensions of the municipality increases. Indeed, in 2007 urban centres with a resident population from 25,000 upwards did not report separate collection rates higher than 35%.

INSTRUMENTS FOR ENVIRONMENTAL KNOWLEDGE AND AWARENESS AND INTERFACE WITH THE MARKET

Dissemination of environmental information
Environmental Education and Training Programmes
Instruments for improving environmental services

Introduction

This chapter presents an overview – concise and definitely not exhaustive – of the different cognitive instruments that can be used to ensure that all levels of society have access to in-depth knowledge of an ever-increasing number of environmental matrixes and factors, with a view to raising the level of awareness of environmental issues and facilitating the adoption of increasingly eco-friendly life-styles.

Instruments available to society for the definition of a response strategy the environmental issues facing it.

The cognitive instruments selected for presentation in this section include reporting activities and their products, telematic tools for access to environmental data/information, library services, environmental education and training in the strict sense of the term, in addition to initiatives which, through the enactment of the European EMAS and Ecolabel regulations, aim to reconcile environmental improvement with the demands of the competitive market. At both global and local level, the use of these instruments helps steer citizens towards sustainable development, in other words, towards a model of development compatible with the need to safeguard resources.

The concept of sustainable development rests on the three pillars of environment, economy and society.

During the period between *Our Common Future,* the report published in 1987 by the World Commission on Environment and Development, or Brundtland Commission, and the United Nations conference at Rio de Janeiro in 1992, sustainable development gradually became a concept supported by three pillars: environment, economy and society. This model is based on attaining a better quality of life through levels of environmental quality that do not harm either humans or other living species and allow fairer access to resources.

In Italy the first step towards the affirmation of this principle is the "Environmental action strategy for sustainable development in Italy" developed by the Ministry of the Environment Land and Sea and approved by means of CIPE (Inter-Ministerial Committee for Economic Planning) Resolution no. 57 of August 2nd 2002, inspired by the Sixth Action Programme "Environment 2010: our future, our choice" (2001) and the aims of full employment, social cohesion and environmental protection established at the Lisbon and Gothenburg European Councils.

The most recent reference legislation is Legislative Decree no.

4/2008[1], which introduces the principle of sustainable development to the overall environmental protection principles.
This decree clearly states that all human activities must comply with the principle of sustainable development in order to ensure that satisfying the needs of present generations does not compromise the quality of life and possibilities of future generations, and that the actions of public administrations are aimed at enabling the best possible implementation of this principle.
The diffusion of environmental information plays a key role in promoting the principle of sustainability as a shared tenet of environmental culture.
The key tasks of environmental authorities include reporting activities – the systematic collection and publication of data on the environment, also through the use of an information and monitoring system. The authorities responsible for such activities in Italy are the Ministry of the Environment, Land and Sea, the regional Governments, the ISPRA (Institute for Environmental Protection and Research) and local environmental protection agencies.
As well as recognising citizens' right to receive information, to participate in decision-making and to obtain justice on environmental question, a right based on the principles of the 1998 Aarhus Convention, Legislative Decree 195/05[2] establishes a series of obligations for public authorities. The main ones are: the creation and updating on at least a yearly basis of public environmental information catalogues containing a list of types of environmental information and the diffusion of the environmental information possessed and relevant for the purposes of institutional activities, making use of IT communication technologies and electronic technologies where available.
Moreover, public authorities must transfer the following documents to the databases created: texts of international treaties;

Legislative Decree no. 195/05 recognises citizens' right to access to information, to participation in decision-making and to justice in environmental matters.

Public authorities must create and update, on at least a yearly basis, public catalogues containing environmental information.

[1] Legislative Decree no. 4 of January 16th 2008 "Additional corrective and supplementary provisions of Legislative Decree of April 3th 2006, no. 152, on environmental regulations"
[2] Legislative Decree no. 195 of August 19th 2005 "Enactment of Directive 2003/4/EC on public access to environmental information ", articles 4 and 8

conventions and agreements; European Community, national, regional or local legislative acts concerning the environment; environmental policies, plans and programmes and relative reports on their state of progress, if drawn up or stored in electronic form by the authorities concerned; the state of the environment report at national level and those at local or regional level, if available; data or syntheses of data produced by monitoring of activities with an impact – even potential – upon the environment; authorisations and opinions issued by the competent authorities enacting regulations on environmental impact assessment and environmental agreements, environmental impact studies and assessments of risks relative to environmental elements, or references informing citizens where such information can be requested or obtained.

The web plays a vital role in ensuring that environmental information is widely diffused.

The web, a powerful information dissemination tool, plays a vital role in ensuring that environmental information is widely diffused. Its flexibility and dynamic nature make it particularly suited to the distribution, among both the general public and specialists, of various types of data and information. The ISPRA web portal supplies information and services to citizens, enterprises and public administration in compliance with both accessibility requirements laid down by Law no. 4 of January 9th 2004 (so-called "Legge Stanca"), as well as with its usability and effectiveness requirements.

The ISPRA web portal complies with the accessibility, usability and effectiveness requirements laid down by law.

Along with other instruments, the services offered by the library network and documentation centres specialised in environmental topics – sometimes the only means of consulting certain documents and data time-series – ensure the diffusion of environmental information via several channels.

Environmental libraries play a major role in the diffusion of knowledge in the field of environmental protection and earth sciences, offering numerous services to both internal and external users: access to public, on-site reading and consultation; bibliographic orientation and reference assistance; internal and inter-library loans (ILL); location of information resources in other library institutions present in Italy via the cooperation and shared cataloguing networks (SBN, ACNP, MAI); document delivery (DD); consultation of on-line resources (OPAC, or Online Public Access Catalogue;

electronic periodicals; environmental, legal and technical regulatory data banks).
The availability of new IT tools has dramatically changed the way that users interface with libraries and use their services: local access is declining in favour of remote Intra/Internet connections and authentication using credentials or IP address recognition. Users frequently use e-mail to make requests for information or loans or for bibliographical research.

Increasing use of remote Intranet/Internet connections to contact libraries and access their services.

As regards educational activities and environmental training in the strict sense of the term, significant efforts have been made by the Agencies System, which has grown constantly in recent years. However, at the same time, the definition and objectives of environmental education have gradually changed. Over the decades the focus of environmental education has widened from the initial protection and conservation of nature (Bangkok conference, 1965) to include anthropogenic activities, the causal relationship between environmental quality and health, and technological progress (Stockholm conference, 1972).

Environmental education plays a vital role in launching a process of cultural and social change supporting sustainability.

The environment is not merely the natural environment but also the constructed and social environment: the Rio de Janeiro Earth Summit (1992) included environmental education in the "sustainable development" process. The Thessaloniki Declaration (1997) stated that environmental education plays a vital role in launching a process of social and cultural change supporting sustainability.
The Johannesburg Summit (2002) reinforced the previous commitments at all levels, both local and global, and proposed the proclamation of the International Decade of Education for Sustainable Development.

The Johannesburg Summit proposed the proclamation of the Decade of Education for Sustainable Development.

In September 2005, UNESCO approved the Draft International Implementation Scheme for the International Decade of Education for Sustainable Development - DESS (2005-2014) which establishes priority and action strategies on the basis of the four major thrusts of education for sustainable development:
• improving access to quality basic education;
• reorienting existing education programmes;
• developing public understanding and awareness of sustainability;
• providing training.

In its widest sense, environmental education can now be defined as a tool for the empowerment of citizens, helping them change their behaviour. As is the case with other spheres of individual civic training, environmental education, together with its distinguishing characteristics and objectives, must be viewed within its specific context: it has evolved in response to changes in both global and local scenarios, as well as the uprooting of environmental givens, often characterised by full-fledged emergencies, occurring throughout the Planet, and especially in recent decades. A process of growth has therefore proven necessary in terms of heightened awareness and responsibility regarding the anthropogenic component influencing large-scale changes. In short, as established by various European Union acts and documents, the primary aim is not the mere transfer of know-how but the launch of a process of growth involving all citizens and causing them to acquire a new awareness translating into the capacity to change individual behaviour as well as to participate in decision-making, especially at local level, thus favouring shared democratic identification of suitable solutions for specific problems.

Environmental training based on increasing technical competences contributes to studies and research into environmental prevention and rehabilitation tools.

Moreover, environmental training also increases technical competences leading to an in-depth knowledge of environmental issues and contributing to studies and research into environmental prevention and rehabilitation. Europe recognises the importance of training on the major issues of sustainability and public health, of the promotion of natural and cultural resources and of life-long training to increase competences, in particular with regard to human resources in public administrations. High quality education and professional training play a key role in allowing Europe to stand out as a knowledge society and compete effectively within the global economy. Although the single EU countries decide their education policies on an individual basis, they jointly establish common aims and share best practices. In 2001, the Gothenburg European council[3] launched the first sustainable development strategy, which was later updated in 2006[4]. The new strategy,

[3] The Gothenburg European council of June 2001 added the environmental dimension to the Lisbon process

[4] Council Decision 2006/702/EC of October 6th 2006 on Community strategic guidelines on cohesion [Gazzetta Ufficiale Law no. 291 of November 21st 2006]

which is closely linked to the energy and climatic change policies, underlines the importance of education, research and public funding for the development of sustainable production and consumption models. ISPRA and the Agency System promote various environmental training initiatives, including courses and seminars, with the aim of increasing technical know-how in the environmental protection field and of disseminating operational methods and innovative approaches in this sector. Moreover, internships and training schemes promoted under agreements with universities and training providers lead to useful synergies between Environmental Agencies and the research sector.

DISSEMINATION OF ENVIRONMENTAL INFORMATION

Technological innovation has contributed to increasing the effectiveness of environmental information dissemination.

Recent years have seen a considerable improvement in the dissemination of environmental information, promoted on the base of both Community and Italian environmental protection legislation[5], thanks in part to the technological innovation that has increased its effectiveness. As well as helping improve understanding of environmental phenomena, the promotion of an environmental culture among a wide public – based on the systematic collection and processing of environmental data disseminated by means of standard procedures and harmonised by the environmental authorities holding such information – also generates a growing demand for information.

The said Legislative Decree 195/05 is intended to guarantee the right of citizens to access environmental information held by public authorities and lays down the terms, basic conditions and procedures allowing this right to be exercised, ensuring that, for the purpose of greater transparency, this information is systematically and progressively placed at the disposal of the public and disseminated, also by means of telecommunication services and IT tools, in easy- to-consult forms or formats, recommending that information and communication technologies are used for the purpose. On account of this, a number of Environmental Agencies have launched a review process of information offered, based on

Environmental awareness is also created by news and data diffused by press and other media.

[5] The main legislative references are presented and illustrated in the 2008 edition of the *Key Topics* (pp. 309-310)

shared forms and methods, to ensure that up-to-date information is constantly made available using innovative technological tools. This process will presumably lead to a redefinition of the environmental information system overall, which will not only affect the tools adopted but also the nature of the information itself and, consequently, its organisation.
Moreover, dissemination of environmental information also includes the production of “informal” information, by which we mean news and data communicated by the press and other media involved in creating environmental awareness.
ISPRA organised a study, based on text analysis[6], of the words used in headlines of newspaper articles published in Italy between January 1st and June 30th 2009.
Several arguments were taken into account and classified as “features”: ISPRA; ARPA/APPA; Ministry of the Environment, Land and Sea; waste; renewable energy; nuclear; pollution; emergency; environment: biodiversity, fauna, climate; environmental sustainability, others. The press clippings of articles examined published in the leading Italian daily newspapers and periodicals[7] (Table 11.1) includes a non-probability sampling of 3,401 articles, with a total of almost 25,800 graphic forms (words/occurrences) with a vocabulary of around 6,000 different words. The preliminary phase of the study, which involved the analysis of graphic form frequency, revealed that the key word[8] with the greatest number of occurrences is “waste” (around 270), followed by “energy” (200) and “nuclear” (170).

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[6] Cf. Benzecrì, 1981, *Pratique de l’Analyse des Données en Economie*, tome 3: Linquistique et Lexicologie, Dunod, Paris and Cf. Bolasco, 2002, Analisi Multidimensionale dei dati, Carocci editore

[7] Corriere della Sera, La Repubblica, La Stampa, Il Messaggero, Il Tempo, Il Giornale, Libero, Il Foglio, L’Unità, Avvenire, Il Mattino, La Gazzetta del Mezzogiorno, Il Secolo XIX, Il Giorno, Il Gazzettino, La Nazione, Il Resto del Carlino, Corriere Adriatico, Il Tirreno, Corriere del Mezzogiorno, L’unione Sarda; Il Sole 24 Ore, Finanza&mercati, Finanza & Mercati Sette, Milano Finanza; L’Espresso, Panorama, Italia Oggi, etc.

[8] The keywords are technically defined as “full” when they transmit the meanings being examined. Words that do not express meanings of intrinsic importance are defined as “empty” (for example, definite and indefinite articles, prepositions, etc) and are not taken into account for the purpose of the analysis

In particular, the topic of "waste" is the most frequent subject of analysis, regarding 18.6% of articles, especially during the first three months of the year during the Naples waste emergency, while only 8% of articles dealt with "nuclear". During the time period examined, there was a widespread press debate concerning those in favour of "nuclear" and those against, in response to the government's plan to present legislative measures concerning the location of new nuclear power stations as part of the policies intended to reduce Italy's dependence on non-renewable energy sources. In addition to nuclear energy, 14.5% of the articles in the sample concerned renewable energy, in particular solar and wind power.

In the first half of 2009 18.6% of articles published in the leading Italian newspapers and periodicals were dedicated to "waste".

Current events also influence the topics dealt with by the press: for example, April saw a rise in articles about seismic risk in response to the Abruzzo earthquake that took place that month.

Current events influence the environmental topics covered by the leading Italian newspapers and periodicals.

Table 11.1: Articles by month of publication (2009)[9]

Month	Articles		Key words
	no.	%	
January	575	16.9	Recycling, gas, Salento, regasification plants
February	671	19.7	Chiaiano, dioxins
March	631	18.6	Colleferro, waste
April	638	18.8	Earthquake, regulations, safety plan
May	516	15.2	Blue Flag
June[a]	370	10.9	Palermo, Pellets, Sea
TOTAL	**3,401**	**100**	

[a] The number of articles is less than the number in other months because the analysis did not take into account the entire month

Environmental information from reporting and mass communication media

For a number of years now ISPRA, through publication of its Environmental Data Yearbook, has made known the results of the monitoring products of the Agency System, meaning reports on the state

The Agency System's most widely used reporting products are: state of the environment reports, yearbooks, manuals, guidelines and thematic reports.

[9] Source: ISPRA

of the environment reports/yearbooks, manuals/guidelines, “thematic” reports and proceedings of technical-scientific events (conventions, seminars, study days, etc.).
The development of reporting methods and the ever-closer examination of environmental themes, together with the use of new technological tools for environmental data dissemination have lead to the increasing diversification of publications and the creation of catalogues including extracts and specific publications on indicators, maps, fact sheets etc.

Table 11.2: Presence/absence of environmental data yearbooks and state of the environment reports[10]

Agency system		2006	2007	2008
		Presence/Absence		
ARPA/APPA	Piedmont	• •	• •	• •
	Aosta Valley	•		•
	Lombardy	• •	• •	• •
	Bolzano	• •	• •	• •
	Trent		•	
	Veneto	• •	• •	• •
	Friuli Venezia Giulia	• •	•	•
	Liguria	• •	•	•
	Emilia Romagna	•	•	•
	Tuscany	•	•	•
	Umbria		•	•
	Marche			
	Lazio			
	Abruzzo	•		
	Molise			
	Campania			•
	Apulia		•	•
	Basilicata	• •	•	
	Calabria		•	
	Sicily	•	•	•
	Sardinia			
	ISPRA	•	•	•

Legend: • State of the environment report; • Environmental data yearbooks

[10] Source: ARPA/APPA data processed by ISPRA

The methods used to disseminate these publications and other documents about the environment of interest to citizens have also evolved. The Ambiente in Liguria[11] portal, for example, gives access to the main environmental topics as well as various on-line services (data bank catalogue, maps, legislation, plans and programmes, publications and videos), while other Environmental Agencies are also adopting similar approaches.

Mass media play a key role in defining how environmental issues are perceived by society.

The yearbook and report drawn up by Environmental Agencies provide an overview of the local environmental situation including emergencies and critical areas for which structural rehabilitation and prevention policies will be developed. In the light of the recent legislation described above on access to environmental information, it is likely that the products used to disseminate reliable up-to-date information during the last decade – namely, the yearbook and report – will also be reviewed in terms of data presentation and diffusion methods.

Table 11.2 contains a concise overview of environmental information disseminated by the Agency System, from 2006 to 2008, by means of the environmental data yearbooks and state of the environment reports. During the reference period, ARPA Piedmont, ARPA Lombardy, ARPA Veneto and APPA Bolzano produced both yearbooks and reports. It should be pointed out that under the regional laws establishing them, some Environmental Agencies do not have the task of drawing up these documents. In such cases the responsibility is assigned to other bodies.

The Environmental Agencies contribute to the diffusion of local environmental data by means of yearbooks and state of the environment reports.

The yearbooks and reports allow the Environmental Agencies to make a real contribution to dissemination of local data, and by reviewing and developing these products (for example, by updating indicator sets) it helps to bring about the growth of environmental awareness at national level. The reporting products diffused via the websites of the environmental agencies contain various examples of this. ARPA Piedmont, which has drawn up state of the environment reports since 1999 with the aim of diffusing exhaustive information on the environmental conditions in the region and on their evolution, has extended environmental reporting to various

[11] www.ambienteinliguria.it

publications, including Environmental Indicators and Indicator Maps, as well as developing dynamic versions of some of these documents. ARPA Veneto also publishes a regular Report on environmental indicators in the Veneto[12] in addition to its yearbooks and standard environmental reports. The 2009 environmental report of ARPA Piedmont was drawn up jointly with the state of the environment report developed by the Piedmont Region.[13] Over the years, the report, which is concerned with representing environmental phenomena, was also developed in relation to a document drawn up by the Region, which is more strategic in a nature and dedicated to identifying actions, trends and plans supporting planning activities. The report on the state of the environment in Lombardy in 2008/2009 (comprising a printed volume and CD titled "Segnali ambientali", Environmental signals, and "Resoconto dei dati ambientali", Environmental Data Summary, respectively) offers a concise assessment of socio-economic and environmental aspects in Lombardy as well as the main indicators related to the state of the environment and pressures, and can be considered a yearbook of environmental data. This report responds to the need to combine two aspects of environmental reporting – descriptive and tendential.

The Agency System also diffuses environmental information via mass media: press releases, articles, press conferences, radio and television presences, etc.

As far as the diffusion of environmental information via mass media is concerned (Table 11.3), the Agency System has further consolidated its position in the press, on radio and television. The number of articles in newspapers and periodicals and presences in press, radio and television have also increased with respect to last year.

[12] The most recent edition (2008) is available at http://indicatori.arpa.veneto.it/
[13] Access via http://rsaonline.arpa.piemonte.it/rsa2009/index.html

Table 11.3: Activities carried out using mass media (press, radio, television) (2008)[14]

Agency system		Press releases	Articles in newspapers and periodicals	Press conferences	Press presences	Radio presences	TV presences
		no.					
ARPA/APPA	Piedmont	26	8	5	1,533	156	207
	Aosta Valley	2	5	0	25	5	5
	Lombardy	15	13	1	3,800	100	53
	Bolzano	100	150	30	500	800	250
	Trent	14	1	5		-	-
	Veneto	50	-	20	3,247	-	-
	Friuli Venezia Giulia	64	38	1	630	2.249	524
	Liguria	14	4	4	1,000	25	250
	Emilia Romagna[d]	40	100	10	800	150	100
	Tuscany	19	0	4	3,163	-	-
	Umbria	35	14	6	1,145	25	75
	Marche	99	19	4	99	3	10
	Lazio	14	119	4	1,771	5	8
	Abruzzo	13	0	5	122	5	7
	Molise	30	30	0	150	30	30
	Campania	30	0[a]	1	277[b]		46[c]
	Apulia	28	6	1	434	8	20
	Basilicata	20	20	2	90	450	150
	Calabria	85	450	8	735	69	35
	Sicily	1	1	1	-	2	2
	Sardinia	2	0	2	15	0	6
	ISPRA	50	500	2	900[e]	35	50

[a] excluding products for ARPAC journal
[b] excluding newspapers diffused in the provinces of Avellino, Benevento, Caserta and Salerno and holidays
[c] overall estimate for radio and TV
[d] estimates
[e] including 200 press agency launches

Environmental information and communication on the web

As far as environmental information on the web is concerned, 2008 monitoring has remained steady with respect to 2007 in terms of all the variables monitored, with the exception of foreign language versions of Environmental Agencies, which have always

[14] Source: ARPA/APPA data processed by ISPRA

been scarce and have now registered a further drop on last year, probably due to the relatively high costs involved. Overall, the fundamental role played by the web in diffusing environmental information seems to be confirmed, as shown in Figure 11.1.

The web's key role in diffusing environmental information is confirmed.

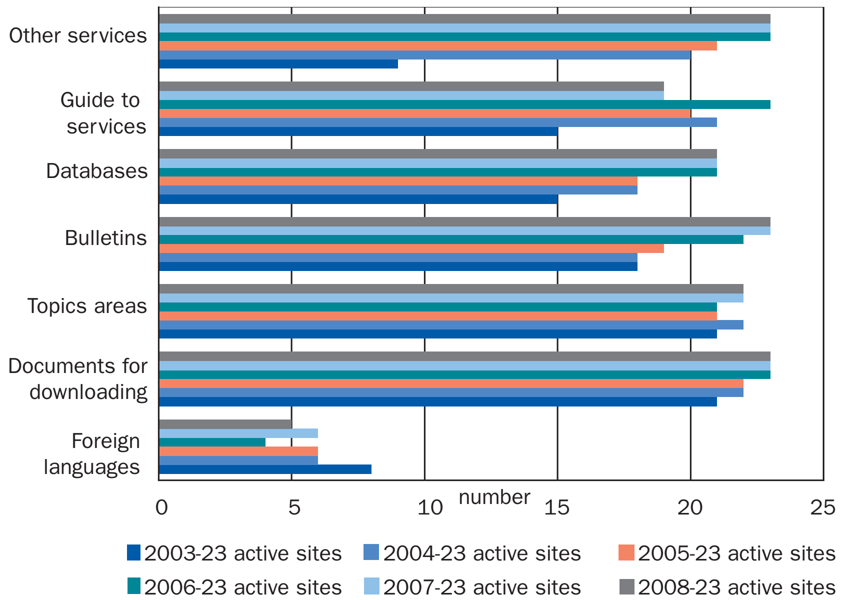


Figure 11.1: Trend of environmental information on the web[15]

As far as environmental communication on the web is concerned, Figure 11.2 shows a more dynamic trend of information variables, including the increase in the use of various communication tools with a reasonable degree of interactivity such as on-line forums and surveys, and press cuttings, while there has been a drop in the use of on-line tools for institutional events. E-mail and online forms, news and events are the most frequently present instruments, encountered on all sites monitored from 2006 onwards. Interactive tools such as e-mail and online forms, and environmental news and events are confirmed as the preferred environmental communication tools of the Environmental Agency system.

[15] Source: ARPA/APPA data processed by ISPRA

The Agency System's most widely used environmental communication tools are e-mails, on-line forms, news and events.

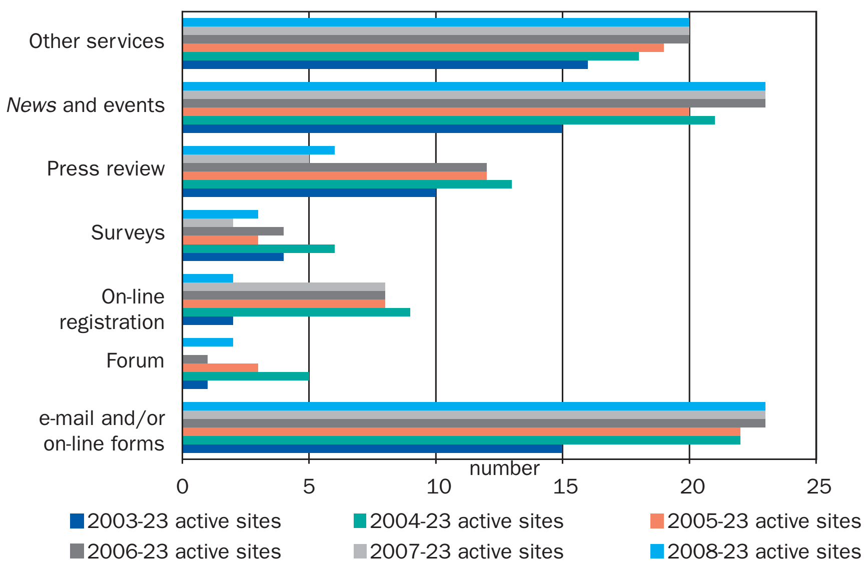


Figure 11.2: Trend of environmental communication on the web[16]

Library services and resources for users

As for the information services and resources available to users in libraries and/or documentation centres specialised on the Agency System environmental topics, data analysis continues to show uneven distribution of services and less than uniform levels of operating effectiveness within the national territory. The trend shows a fairly static overall situation, with some minor changes like the Arpa Sicily where a documentation centre was opened or the Arpa Apulia where improvements are being carried out to the library. However, many agencies continue to lack libraries and documentation centres including: Piedmont, Aosta Valley, Bolzano, Trent, Umbria, Abruzzo, Basilicata, Calabria. In some cases, like, for example, Friuli Venezia Giulia and Sardinia, there are no proper library services despite the considerable amount of documentation present.

The ISPRA library has extended the range of topics and research areas offered to users.

[16] Source: ARPA/APPA data processed by ISPRA

The ISPRA library – the result of the fusion of the libraries of the former APAT, ICRAM and INFS bodies – has extended the range of topics and research areas offered to users by giving them access to highly specialised sectoral material.

ENVIRONMENTAL EDUCATION AND TRAINING PROGRAMMES

In Italy the supply of environmental education initiatives and training programmes, by both institutions and non-institutions, is very high.

Environmental education does not begin and end in school, but concerns the whole of society, extending into adulthood via the fields of continuing education and professional training.
In Italy the supply of environmental education initiatives and training courses, both face-to-face and remote, is particularly extensive. It is provided by various subjects - both institutional and non-institutional, including the Agency System – in accordance with the principle of co-operation and integration underlying the "Decade of Education for Sustainable Development" (2005-2014), whose successes and failures five years on were examined in a stock-taking during the World Conference held in Bonn in April this year.
The Italian National Commission for UNESCO continued its coordination activities at home with the support of the National Committee which comprises numerous actors, both institutional and non-institutional, including the Ministry of the Environment, the Ministry of University and Research, ISPRA and the 21 ARPA/APPAs, regional education departments, bodies, networks and associations.
In addition to organising the "National Week of Education for Sustainable Development" – involving a series of initiatives linked to "Cities and citizenship" along with other sub-themes for 2009 - these organisations have also focussed on building links to reinforce information and dissemination as collaboration and integration of competences and services among actors belonging to the network in order to increase the effectiveness and visibility of the various activities proposed and contribute to their continuity in time.

The Local Agenda 21 committee promotes numerous activities on various themes implemented by work groups.

There are numerous networks dedicated to sharing best practices and creating international partnerships including the Local Agenda 21 committee which promotes numerous initiatives –

aimed at both information sharing and action – on a range of issues from waste to participatory democracy, from green tenders in public administrations implemented by work groups coordinated by local authorities. Another network that has been active for many years in the area of research and exchange of good practices at international level is the promoter of WEEC (World Environmental Education Congress), which brings together bodies and institutions from all over the world and organises an international congress every two years. In May 2009, the fifth congress held in Montreal (Canada), gave delegates from all over the world (including an Italian delegation) the opportunity to explore how environmental education can contribute to the well-being of individuals, to social innovation and integration of the environment in public policies in the twenty-first century.

Environmental education and training offer

This study reveals a vast panorama of education and awareness-raising initiatives promoting sustainability in which the Agency System is just a part, albeit a significant one in terms of both value and number.
As far as education is concerned, since 2008 the Working Group of the Agency System for Education Oriented to Sustainability (EOS), in line with the basic goals of the decade, has been trying to promote initiatives focussing on sustainability education, both from an epistemological and methodological point of view. It has involved national and local components of the education system, in particular the INFEA system (national environmental education, training and information) as well as local authorities and organisations, which will all contribute to identifying shared planning approaches and instruments at the service of an increasingly effective sustainability education capable of having a real influence upon society. Activities included the Modena Network Seminar held in June 2008 and the fine-tuning of communication tools such as a virtual workroom and electronic newsletter (currently being tested).
The environmental education initiatives examined were either promoted by the Agency System or carried out with its technical

In 2008 the Agency System promoted 492 environmental education initiatives comprising 234 projects and 258 single activities; 25 projects were multi-year and 162 were carried out throughout the region concerned.

Most of the environmental education initiatives carried out in 2008 concerned "Other topics", that is: sustainable tourism, management of marine coastal waters, quality of the local education network, etc.

and organisational support and are grouped in two categories: projects – structured activities taking place over a longer period of time, and activities – one-off education sessions.
A total of 492 environmental education initiatives were recorded for 2008 by the Agency System, of which 234 were projects and 258 single activities. Of the projects 25 (11%) were multi-year initiatives, 162 (69%) were carried out throughout the region involved, and 184 (79%) were developed in collaboration with other bodies and actors.
In terms of target, a slightly greater number of initiatives (projects plus other activities) involved adults rather than school-aged children.

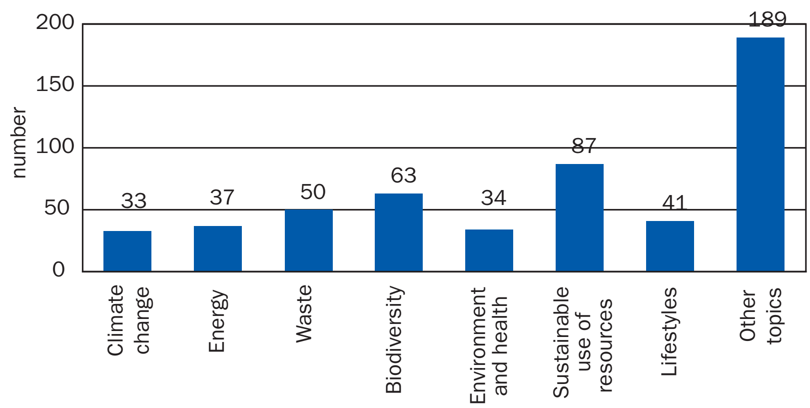


Figure 11.3: Environmental education initiatives (projects and one-off activities) by theme (2008)[17]

Most of the initiatives carried out in 2008 were classified under the heading "Other topics" (189 initiatives) including activities relative to a range of themes such as sustainable tourism, management of marine coastal waters, quality of the local education network and integrated local planning, etc. They were followed, in decreasing order, by "Sustainable use of resources" (87), "biodiversity and protected areas" (63), "Waste" (50), "Lifestyles" (41),

[17] Source: ISPRA

"Energy" (37), "Environment and health" (34), "Climate change" (33)[18].

The Agency System promotes a series of training initiatives in line with the principles expressed by the European strategies recognising the importance of enhancing human resources and strengthening technical skills in order to respond to environmental, economic and social challenges. To this end the Agency System provides training programmes designed to increase and consolidate the professional skills and know-how of technicians, researchers and other stakeholders operating in the environmental sector. Several Agencies have been awarded accreditation recognising them as training bodies.

European strategies recognise the importance of enhancing human resources in order to meet environmental challenges.

Environmental training activities include face-to-face specialist courses, internships, and dissemination of thematic contents via web-sites.
In 2008 the Environmental Protection Agencies and ISPRA held 352 face-to-face courses for a total of 6,779 hours with the participation of approximately 6,500 environmental experts. Most of the courses were short (333 provided under 50 hours of training), while less courses were medium or long (19 courses provided from 50 to 150 hours of training). The number of women participating was rather low (38%) compared to the number of men. 6% of courses promoted by the Agencies were financed with external funds. In-depth examination of environmental themes is also carried out by means of internships which give rise to positive opportunities for collaboration between Agencies and research and training bodies, including universities. In 2008 16 Agencies, including ISPRA, organised a total of 737 internships, 52% involving women graduates.
The Agencies and ISPRA also use their web-sites to promote the diffusion of specialist know-how on environmental themes, disseminating technical-scientific contents presented in the context of

In 2008 the Environmental Protection Agencies and ISPRA held 352 face-to-face courses involving 6,500 participants.

[18] The sum of the number of initiatives associated with the single thematic areas does not coincide with the total number of environmental education initiatives because some of them concern several thematic areas

face-to-face training courses, workshops, seminars and technical laboratories. In 2008, 40% of the Agencies, including ISPRA, put the contents of 81 training events on-line.

Operational performance of the local environmental education network

The “Operational performance of the local environmental education network” indicator reveals a more stable situation compared to previous years regarding integration and active participation of the Environmental Agencies in their respective local environmental education systems (both regional and provincial), at times with tasks of coordination (10 Agencies out of a total of 15 responses) or participation in co-ordinating groups (present in 10 Agencies) exercised under an institutional mandate within the regional/provincial education systems (normally involving the INFEA network).

The situation is similar with regard to supply of technical and methodological support for the activation and implementation of participatory local sustainability processes (Local Agenda 21) where 9 out of 15 Agencies have provided support in the form of promotional activities, information dissemination, public awareness-raising activities, education and communication in situations of environmental conflict etc, as part of a long-standing relationship of mutual knowledge and trust with the local area in which they are based. In conclusion, nearly all Agencies examined (14 out of 15) supply local bodies, schools and other actors with technical-scientific support and consultancy for the planning of educational activities.

Environmental Agencies supply local bodies and schools with technical and scientific support and consultancies for the planning of environmental education activities.

In the future, however, these efforts could be expanded through the collection of a greater amount of information, distinguishing between functions describing the operational offer of the Agencies (or of the bodies examined) in the local area (for example, education, local planning, research and documentation) and functions more closely linked to their capacity to integrate local or national networks (for example, coordination of the network itself, communication, monitoring and assessment tasks).

INSTRUMENTS FOR IMPROVING ENVIRONMENTAL SERVICES

The growing awareness that the protection of the environment must necessarily involve all stakeholders, specifically through the establishment of new forms of collaboration with the leading market operators (enterprises and consumers) places increasing importance on improving the environmental quality of companies, organisations and products; the primary reference sources for this objective are the European EMAS and Ecolabel Regulations, together with the international standards of the ISO 14000 series. The EMAS (EC Regulation no. 761/01) and Ecolabel (EC Regulation no. 1980/2000) schemes express the environmental policy launched by the European Union under the Fifth Action Programme (1992-1999). The traditional command-and-control mechanism has been supplemented with new voluntary participation tools designed to improve resource management and assumption of direct responsibility for the environment as well as favouring the promotion of public information with regard to the environmental performance of processes and products.

Improvement of the environmental quality of enterprises, organisations and products plays a key role in environmental protection.

The first years of application have confirmed the noteworthy value of the above regulations as instruments of environmental prevention and improvement. The key underlying objective of the Sixth Action Programme and Integrated Product Policy (IPP) is to develop and consolidate a set of measures focussing on environmentally-friendly forms of production and ecologically-aware consumption in order to create, in the medium-long term, a "green market" as well as to activate the principles of Sustainable Production and Consumption (SPC). The tangible manifestations of this new approach are:

The first years of application have confirmed the noteworthy value of EMAS and Ecolabel as instruments of environmental prevention and improvement.

- the intent, as expressed in the Sixth Action Programme of the EU, to increase the dissemination of EMAS and Ecolabel Regulations, to promote Green Procurement in order to accelerate the growth of the "ecological market", and to improve business-to-business and business-to-consumer environmental information, in part by providing incentives for the formulation of Environmental Product Declarations (EPDs);
- the request for the development in each Member State of strategies integrating the voluntary instruments available (EMAS, ECOLABEL, Product Declarations, ECO Design etc.) and the provi-

sions of legislative measures with the aim of putting into practice the principle of "environmental efficiency";

- the innovations introduced on the occasion of the revision of the EMAS and Ecolabel schemes, and in particular: a quantitative rather than a qualitative approach in order to focus attention on environmental performance indicators (EMAS III), the broadening of Ecolabel award criteria to include social aspects in addition to strictly environmental considerations, and the extension of its field of application to process chains not just products for end consumers;
- the strategic role assigned to the public sector and to citizens-consumers as subjects capable of developing the "demand for ecology".

The creation of a "green market" involves: companies, consumers and Public Administrations.

The creation of a "green market" involves:

- companies, which can improve the environmental characteristics of products and services during the design and commissioning phases;
- consumers, who may choose from an ecologically certified offer and use their purchases correctly;
- the Public Administration, which can provide environmentally adequate services, work towards a correct use of the local area, pay close attention to what it consumes, inform citizens and guide their awareness and behaviour, in addition to introducing bonus incentives, promoting research and harmonising development policies.

The "Green Paper" on IPP states that "Eco-efficiency [...] is a leadership practice" to be developed with the objective of working towards a new way of producing and consuming. Given that a great number of technically proven instruments are now available (EMAS, Ecolabel, GPP, EPD etc.), close attention must be paid to ensuring that they are applied using strategies drawn up at company level, on the basis of market competitiveness, and at the level of administrations, in relation to development policies and programmes.

In brief, harmonised strategies must be driven by the need to:

- impact economic interests by using taxes/subsidies to internalise external costs and identify the "right price" (introduction of the "pay as you pollute" and "producer responsibility" principles);
- develop instruments promoting better ecological consumption

through initiatives affecting demand and information and also involving awareness-raising with regard to administrations managing public tenders;
- introduce information comparison tools to be used in connection with ecological product and service offers, encouraging transparency and data dissemination and motivating the regulatory sector to intervene with regard to eco-compatible planning and environmental compatibility compliance.

In line with the approach of the European Commission, which included EMAS, Ecolabel and GPP in new sustainable production and consumption policies, the European Parliament adopted the new EMAS III and Ecolabel III texts (awaiting publication).
From 1997 (the year in which EMAS and Ecolabel Regulations became effectively operative in Italy) to the present, the penetration of the two schemes has grown constantly, showing significant annual increases (Figures 11.4 and 11.5).

From 1997 to today penetration of EMAS and Ecolabel has grown constantly, a significant annual rate of increase. 2009 saw a drop in the rate of increase in requests for EMAS certification.

The most "virtuous" regions in terms of number of EMAS-registered organisations are: Emilia Romagna, Tuscany, Lombardy, Veneto and Apulia. The uneven coverage reflects differing levels of awareness and/or local incentives.

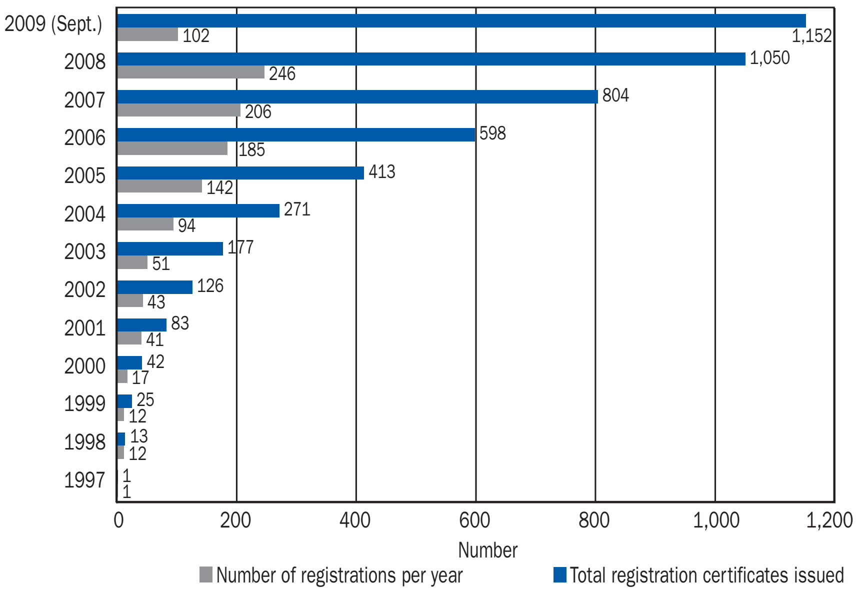


Figure 11.4: Evolution of the number of EMAS registration certificates issued in Italy[19]

[19] Source: ISPRA

In 2009 there was a slight drop in the increase of requests for EMAS certification for reasons that require further investigation but can ultimately be attributed to the economic crisis.

In Europe, Italy ranks third in terms of EMAS, after Germany and Spain, while it ranks first for Ecolabel, followed by France and Denmark. The most "virtuous" regions in terms of number of EMAS-registered organisations are: Emilia Romagna, Tuscany, Lombardy, Veneto with Apulia in fifth place. The greatest number of Ecolabel licences were issued in Trentino Alto Adige followed by Emilia Romagna, Tuscany, Lombardy and Piedmont.

The greatest number of Ecolabel licences were issued in Trentino Alto Adige followed by Emilia Romagna, Tuscany, Lombardy and Piedmont.

The increase in EMAS and Ecolabel was also favoured by the development of competences and professional know-how acquired in local EMAS and Ecolabel schools, whose aim is to train professionals qualified to assist organisations (EMAS environmental auditors and consultants and Ecolabel consultants), in addition to establishing, in agreement with academic institutions, specialist university courses.

Although this growth places Italy at the forefront in Europe it is not yet uniform. Local development is uneven due to differing levels of awareness and/or incentives in different regions, local administrations, production sectors, professional associations etc.

The growth of EMAS and Ecolabel (Italy is among Europe's leaders) is still uneven due to differing levels of awareness and/or incentives in different regions, local administrations, and production sectors.

Despite the good intentions regarding EMAS shown by the provisions of art. 18 of Italian Law no. 93 of March 23rd 2001 (though without the support, it should be said, of subsequent application measures), together with the new Consolidated Environmental Law (Legislative Decree 152/2006), an effective and incisive sponsorship of voluntary instruments by the competent administrative bodies and interested parties is still lacking.

The critical areas with regard to EMAS seem to be:

- the lack of systematic involvement of the interested parties in the formulation of strategies designed to integrate environmental needs and competitiveness on the market and develop incentive proposals for participants in the scheme;
- the large number of public bodies involved in authorisation and control procedures and the failure to promote prevention policies;
- the continued shortage of adequate professional skills and know-how at local level.

As far as the Ecolabel is concerned, in recent years there has been a two-figure growth rate both in terms of numbers of licences and numbers of products. Alongside promotion activities carried out in recent years, the inclusion of environmental criteria in public administration tenders and a points system for companies with certified products have led to a considerable increase in the interest shown by businesses in this type of instrument. This interest took the shape of an increase in certified products and licences in various product groups such as hard floor coverings, textile products, tissue paper and indoor paints and varnishes. Nevertheless, the greatest increase in the last three years occurred in the tourism sector where intense promotional coverage at local level combined with incentives offered by various local authorities stimulated the demand for participation in the scheme, increasing the number of licences three-fold.

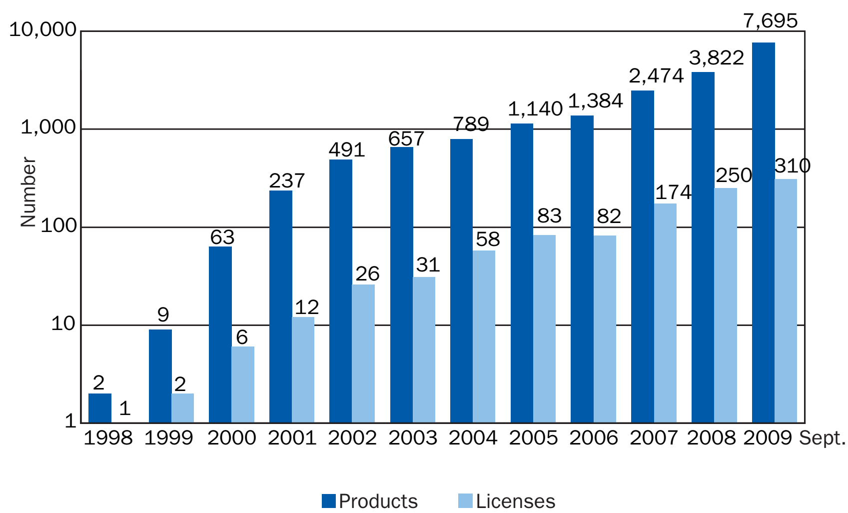


Figure 11.5: Evolution of Ecolabel licences and products/services in Italy[20]

Between 1998 and September 2009, 310 Ecolabel licences were issued for a total of 7,695 products/services. The positive trend regards both licences and products/services. Last year, the largest increases were registered in the “tourism” sector in terms of licences issued (+81) and in the “hard flooring” sector in terms of number of products (+3,635).

It should be noted that even though 7,695 certified products, goods and services are available on the Italian market, the general public is not sufficiently aware of either the Ecolabel or EMAS logo

[20] Source: ISPRA

to move the market towards a “green market”. However, market surveys have confirmed a gradual improvement in knowledge of the Ecolabel at both European and domestic level, leaving room to hope for a turnaround in the medium term.

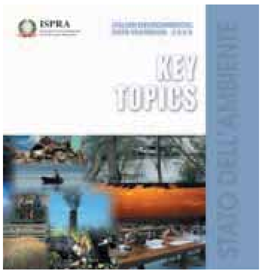
ISPRA
Institute for Environmental
Protection and Research

ITALIAN ENVIRONMENTAL
DATA YEARBOOK 2009

KEY TOPICS

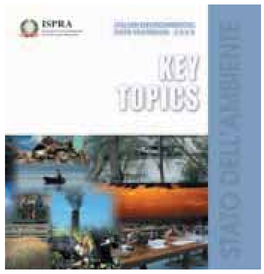
STATO DELL'AMBIENTE

ACRONYMS

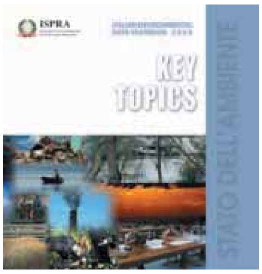


Listed below are the meanings of a number of the acronyms found in the publication.

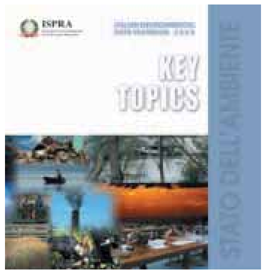
ACI	Italian Automobile Club
ACNP	Italian Union Catalogue of Serials
AE	Equivalent Inhabitants
AIA	Italian Association of Aerobiology
AISCAT	Italian Association of Motorway and Tunnel Concessionaire Companies
AM	Italian Air Force
AMP	Marine Protected Areas
ANCI	National Association of Italian Municipalities
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
ASL	Local Healthcare Enterprise
AWB	*Artificial Water Body*
BAT	*Best Available Techniques*
BCAA	Good Agronomic and Environmental Conditions
BEN	National Energy Balance
BIA	Low Environmental Impact
CAP	*Common Agricultural Policy*
CARG	Geological 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



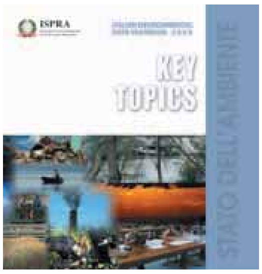
CGO	Statutory Management Requirements
CIA	Italian Farmers’ Confederation
CIPE	Inter-Ministerial Committee for Economic Planning
CIRIAF	Interuniversity Centre for Research on Pollution from Physical Agents
CLC	*CORINE Land Cover*
CNCC	National Conference on Climate Change
CNLSD	National Committee for the Fight against Drought and Desertification
CNR	National Research Council
CNT	National Transportation Report
CONACEM	National Co-ordination for Defence against Electromagnetic Fields
CONECOFOR	Control of Forest Ecosystems
COP	*Conference of the Parties*
CORINAIR	*COoRdination InformatioN AIR*
COVNM	Non-methane Volatile Organic Compounds
CPUE	*Catch per Unit of Effort*
CRA-CMA	Agricultural Research and Testing Council - Agricultural Climatology and Meteorology Research Unit
CTN	National Topic Centre
CTN-TES	National Topic Centre – Soil and Land
DAISIE	*Delivering Alien Invasive Species Inventories for Europe*
DBMS	*Database Management System*
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)*
EC	*European Commission*
ECC	*European Economic Community*
ECOEHIS	*Development of Environment and Health Indicators for EU Countries*



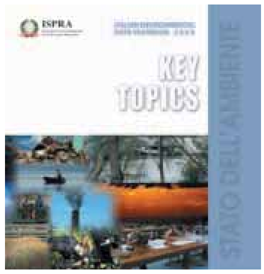
EEA	*European Environment Agency*
EEI	*Ecological Evaluation Index*
EFF	*European Fisheries Fund*
EFSA	*European Food Safety Authority*
ELF	*Extremely Low Frequency*
ENAC	Italian Civil Aviation Authority
ENEA	Agency for New Technologies, Energy and the Environment
EoI	*Exchange of Information*
EPER	*European Pollutant Emission Register*
EQB	Biological Quality Elements
EQR	*Environmental Quality Ratio*
EQV	*Ecological Quality Value*
ER	*Exposure Ratio*
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*
FSC	*Forest Stewardship Council*
GDF	Italian Treasury Police
GDP	*Gross Domestic Product*
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
GPP	*Green Public Procurement*
GPS	*Global Positioning System*



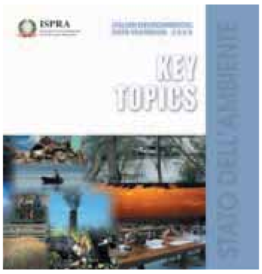
GSE	Energy Services Managers
HABs	*Armful Algal Blooms*
HEV	*Hepatitis E Virus*
HMWB	*Heavily Modified Water Bodies*
IAEA	*International Atomic Energy Agency*
IARC	*International Agency for Research on Cancer*
IBE	Extended Biotic Index
ICDM	Sea Defence Service of the Ministry of the Environment
ICNIRP	*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*
INES	National Inventory of Emissions and their Sources
INFC	National Inventory of Forests and of Forest Reservoirs of Carbon
INFEA	Environmental Information, Training and Education
INFS	National Institute for Wildlife (now ISPRA)
INGV	National Institute of Geophysics and Volcanology
INSPIRE	*Infrastructure for Spatial Information In Europe*
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
IRSA	Water Research Institute
ISAC – CNR	Institute of Atmospheric and Climate Sciences – National Research Council
ISPESL	National Institute for Occupational Safety and Prevention
ISS	Italian National Health Institute
ISSDS	Experimental Institute for the Study and Defence of the Soil



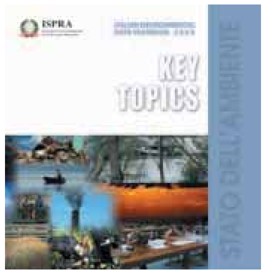
ISTAT	National Statistics Institute
ISTIL	Institute of Science and Technology of Luminous Pollution
ITHACA	*Italy Hazard from CApable faults*
IUCN	*International Union for Conservation of Nature*
JRC-IES	*Joint Research Centre-Institute for Environment and Sustainability*
LAN	Snow Level
LCA	*Life Cycle Assessment*
LDCs	*Least Developed Countries*
LIM	Level of Pollution from Macro-Descriptors
LPG	*Liquid Propane Gas*
LULUCF	*Land Use, Land Use Change and Forestry*
MAH	*Major Accident Hazard*
MAI	Italian MetaOPAC Azalai
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
MSE	Ministry of Economic Development
MUD	Consolidated Environmental Declaration Form
NAP	*National Action Plan*
NAPA	*National Adaptation Programmes of Action*
NEHAP	*National Environment and Health Action Plan*
NFP	*National Focal Point*
NIR	*Non Ionising Radiation*
NVZ	*Nitrate Vulnerable Zones*
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



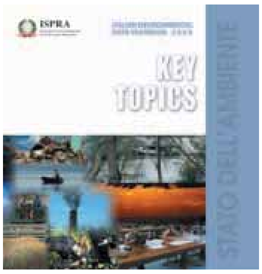
PAA	Environmental Action Program
PAI	Plan of Hydrogeological Array
PCAR	Plans of Noise Reduction and Abatement Measures
PEFC	*Programme for Endorsement of Forest Certification scheme*
PESERA	*Pan European Soil Erosion Risk Assessment*
PFR	Regional Focal Point
PIFFI	Landslide Event Identifying Point
PMP	Multizone Prevention Facilities
PN	National Park
PNA	National Allocation Plan
PNR	Regional Nature Park
POP	Multiyear Guidance Programs
PPAE	Provincial Mining Plan
PRAE	Regional Mining Plan
PSN	National Strategic Plan
PSR	*Pressure-Status-Responses*
PTA	Water Resources Protection Plan
PTS	Total Suspended Particulates
PYLL	*Pontential Years of Life Lost*
QUEST	*Quick Earthquake Survey Team*
R&D	*Research and Development*
RBS	*Radio base Stations*
REACH	*Registration, Evaluation and Authorisation of Chemicals*
ReNDIS	National List of Land Defence Interventions
RF	Radio Frequency
RFI	Italian Railway System
RIBES	Italian Network of Germplasm Banks for ex situ Conservation of Wild Plants
RICE	*Radium of Influence of Coastal Erosion*
RID	Italian Dikes Register
RNA	*RiboNucleic Acid*
RNR	Regional Nature Reserve
RNS	State Nature Reserve
ROD	*Reporting Obligation Databases*
RSA	Report on the State of the Environment
RTC	Risk Threshold Concentration



RTV	Radio and TV media
SAC	*Special Area of Conservation*
SAR	*Synthetic Aperture Radar*
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*
SECA	Ecological Status of Waterways
SEIS	*Shared Environmental Information System*
SEL	Ecological Status of Lakes
SIAS	Development of Soil Environmental Indicators
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
SITAP	Information System on the Territory, Environment and Landscape
SNAP97	*Selected Nomenclature Air Pollution*
SNI	Site of National Interest
SPA	*Special Protection Area*
SSN	*National Seismic Service*
ST	Total Surface Area
SWH	*Significative Wave Height*
TAF	Agrarian and Forestry Territory
TERM	*Transport and Environment Reporting Mechanism*
TOFP	*Tropospheric Ozone Forming Potential*
TVC	Threnshold Value of Contamination
UAA	*Utilised Agricultural Area*
UCEA	Agricultural Climatology and Meteorology Research Unit



UMTS	*Universal Mobile Telecomunications System*
UN	*United Nations*
UNCCD	*United Nations Convention to Combat Desertification*
UNCDS	*United Nations Committee on Sustainable Development*
UNCED	*United Nations Conference on Environment and Development*
UNECE	*United Nation Economic Commission for Europe*
UNEP	*United Nations Environment Programme*
UNFCC	*United Nations Framework on Climatic Changes*
US-EPA	*United States - Environmental Protection Agency*
USLE	*Universal Soil Loss Equation*
UV	Ultraviolets
VVF	Fire Fighters Corps
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


ISPRA
KEY
TOPICS
STATO DELL'AMBIENTE

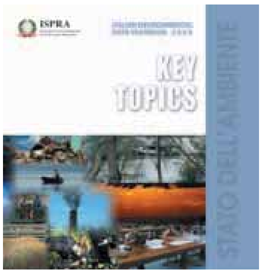
ISPRA
Institute for Environmental
Protection and Research

ITALIAN ENVIRONMENTAL
DATA YEARBOOK 2009

KEY TOPICS

STATO DELL'AMBIENTE

ANNEX



Yearbook Indicators Database
(http://annuario.apat.it/)

Introduction

Environmental information management and dissemination are among the most important functions performed by the ISPRA.

The strategies adopted by the ISPRA ensure extensive dissemination of statistical information by making them available on-line. The *Environmental Indicators Database* plays an important role in this context. Created by APAT in 2004, it has a two-fold function: to support the production of the Environmental Data Yearbook and to supply information for consultation.

The Database – which currently contains 270 indicator fact-sheets subdivided by themes (atmosphere, biosphere, hydrosphere, waste, etc.) – is one of the widest-ranging and complete environmental data collections available in Italy.
The design of the indicator fact-sheet was arrived at by reviewing and analysing existing national and international literature on the standardisation and harmonisation of environmental reporting tools and comprises two parts:

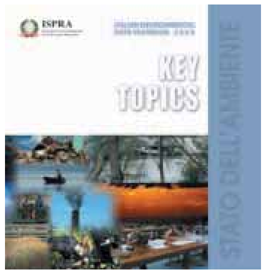
- Indicator meta-data
- *Data associated with the indicator*

The Environmental Indicators Database presents the same characteristics as those indicated by SISTAN for *Statistical Information Systems*, with the result that it has been included in the National Statistical Programme for 2008-2010 and for 2011-2013.

Website access statistics are positive: in 2009 there were 27,000 distinct visitors[1] and 37,000 visits.

Together with the preparation of the 2009 Yearbook, a new release of the *Environmental Indicators Database* was drawn up, in order to improve operational management while streamlining

[1] The item “distinct visitors” indicates the number of different during a given day. If a visitor accesses the site more than once during the day, then the number of visits and pages increases, but the number of “distinct visitors” stays the same

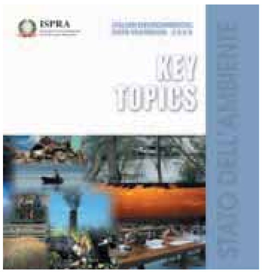


indicator processing and making the information collected easier to consult.

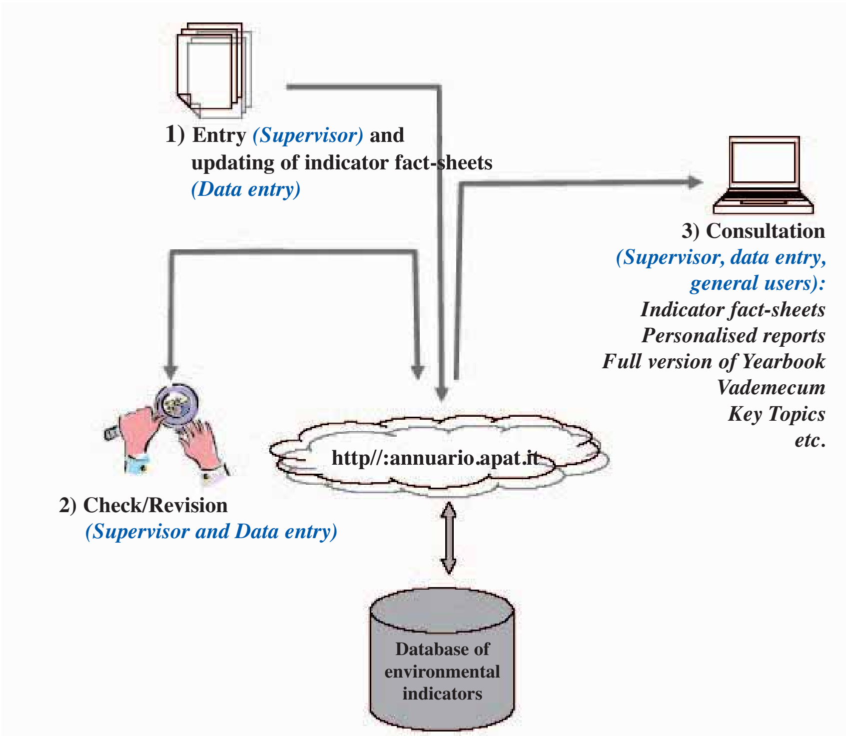
Prospects for development include a new consulting mode referred to as “Systematisation”, which will make it possible to view time-series from past Yearbooks, as well as the internationalisation of the Database.

Indicator database structure

The indicator database is a web-based application that allows you to manage and consult, with different access modes according to user profile, information relative to environmental indicators (metadata and associated data fact-sheets). It can be consulted at http://annuario.apat.it. or from the homepage of *www.isprambiente.it.* The client/server architecture of the application is designed to supply support to the yearbook preparation workflow and to interaction between users contributing to the edition. The application basically comprises a front end written in PHP while data are stored in a MySQL database server.
The application is designed for the management of metadata and indicator population data and permits the loading, memorisation and subsequent consultation of **indicator fact-sheets**.
The compilation of the indicator fact-sheets for the various Thematic Areas and respective themes (Temi SINANet) makes it possible to draw up a series of documents, initially in electronic format, including the complete version of the Yearbook, Key Topics, Vademecum etc..
The application allows the contents to be managed according to the previously published “versions” of the Environmental Data Yearbook, thus permitting “historical data handling”. Currently users can consult all indicator fact-sheets published from 2003 onwards. A “working version” of the database is created for every edition of the Environmental Data Yearbook, only accessible to users authorised to enter data and/or modify indicator fact-sheets. Each authorised user (*data entry*) is allocated one or more indicators by the thematic coordinator responsible. The updated fact-sheets are published after a



check/revision phase involving the yearbook user task force (supervisor) responsible for checking data together with the thematic coordinators.
During the iterative development process, fact-sheets can be "bulk loaded" and made non-modifiable if revised by the task force.



Consultation

Illustrated below is a guide exploring various functions of the "Yearbook indicator database" application.

The main page can be reached from http://annuario.apat.it and, as shown in Figure A.1, is divided into three sections: Environmental Data Yearbook (left part of page), Introduction (central part), Access Area (right part of page).

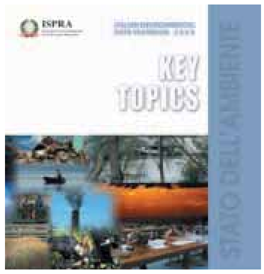


Figure A.1: Yearbook homepage

The "Environmental Data Yearbook" section gives you access to the main publications from 2001 to 2008: the menu heading "Annuario" takes you to the Italian-language publications divided by year; the menu heading "E*nvironmental data yearbook*" takes you to publications in English; lastly, the "Annuario versione multimediale" link takes you to the multimedia version.
The introduction (Figure A.1) contains a brief description of the information base and links that give you instant access to all the most recent publications. You can explore the single sections of the complete version and of the "Key Topics" in both Italian and English.
Finally, the "Area Accesso" is where users can login or register; a password recovery function is also featured.
Figures A.2 and A.3 show the pages of the annual collections in Italian. The number of products created, digitalised and available in pdf, changes from year to year in response to the aim of constantly improving products.

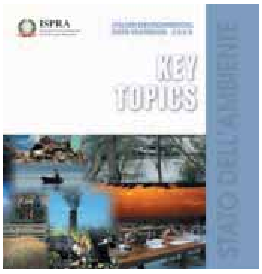


Figure A.2: Links to annual collections

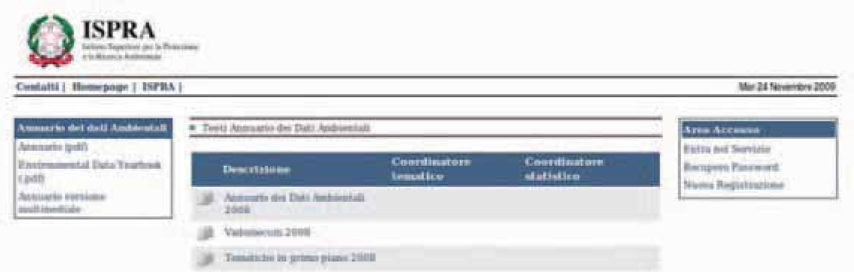


Figure A.3: Annual publications

Users wishing to consult the indicator database in addition to publications must register with the system. The user-friendly interface allows users to register online by entering a username and password. The registration form shown in Figure A.4 requires users to compile required fields (username, name, surname, e-mail are all required for access and management of users) in addition to supplying optional information useful for defining profiles of users consulting the site.

Once registration is completed, users may begin navigating after login (Figure A.5), which involves entering the username selected and the password automatically generated by the system and sent to the e-mail address supplied during the registration phase.

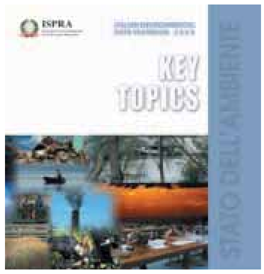


Figure A.4: "User registration" interface

Should users forget their username or password, the application includes a function that will send users their access credentials at their request.

Figure A.5: The login page

After login, users will be direct to the homepage, shown in Figure A.6, using the indicator menu on the left-hand side of the page they can consult consolidated indicators relative to the various editions of the Yearbook stored in the system.

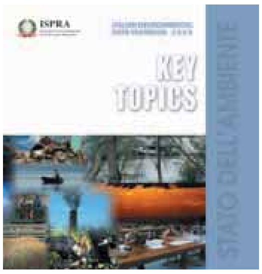


Figure A.6: User homepage

After selecting the desired edition of the yearbook, users can view the indicators by clicking on “Index” button. The indicator index, shown in Figure A.7, is represented by a tree structure with first-level nodes that are thematic areas, second-level nodes that are SINAnet themes and leaves that are indicators. This page allows you to search for indicators by clicking on the elements in the index.

To carry out an advanced search, select “Indicator search” from the indicator menu on the left and fill in (Figure A.8) one or more of the fields in the indicator form, based on:

- the name of the indicator, or words or characters that are part of the name;
- words or characters that are part of the “description” field;
- words or characters that are part of the “purpose” field;

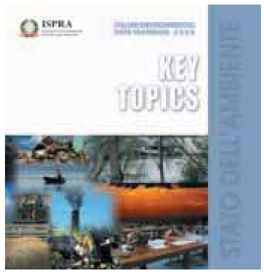
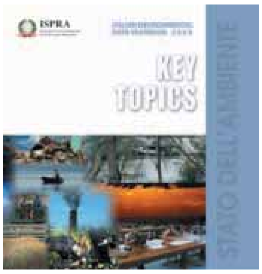


Figure A.7: "Indicator list" interface

Figure A.8: The "Search" interface

The outcome of the search is a list of indicators meeting the pre-requisites specified in advance by the user. Users may view the relative meta-data and data fact-sheet for each indicator (Figure A.9 and A.10).



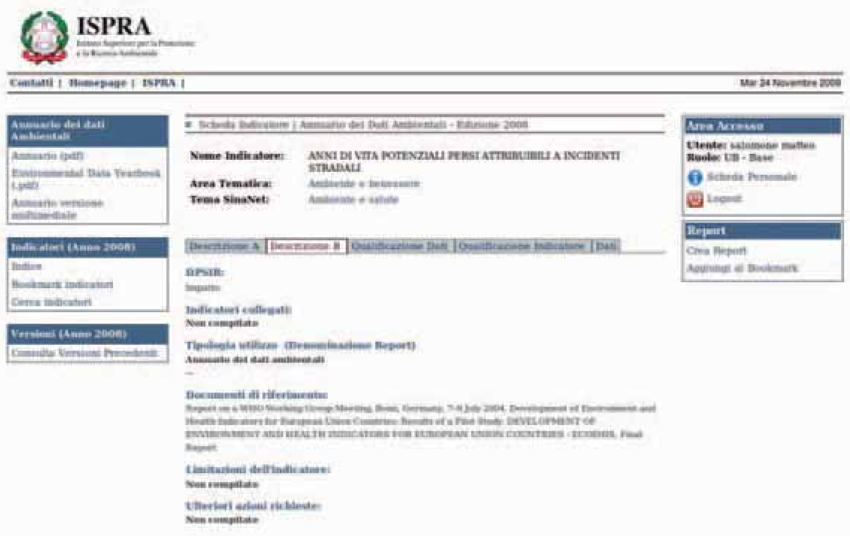


Figure A.9: The “Meta-data fact-sheet” interface

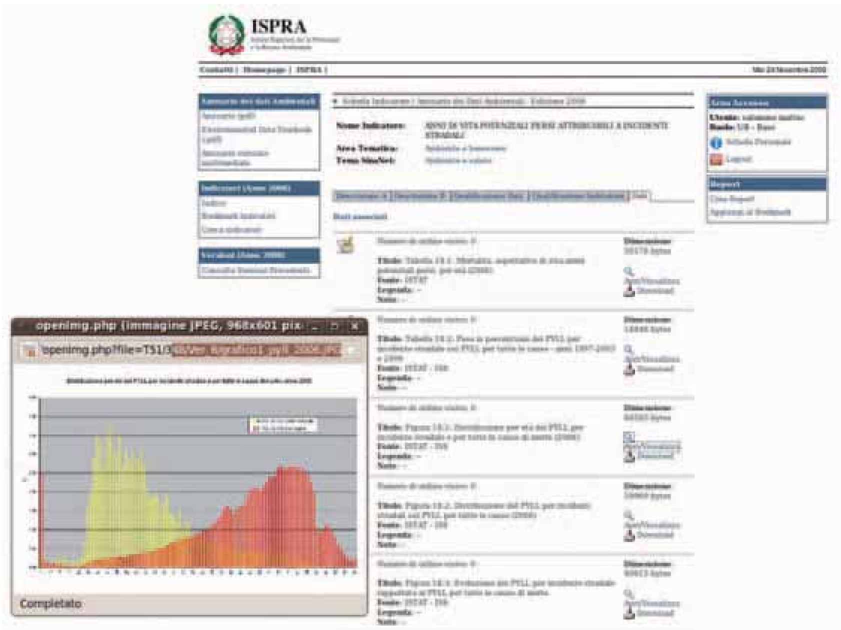
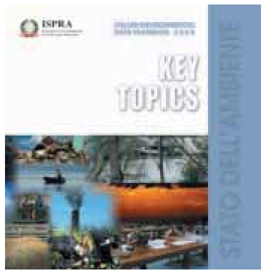


Figure A.10: The “Data section” interface

The indicators can be selected using the “Add to Bookmark” function, which makes it possible to create a report (in html) with the



same structure and information found in the indicator fact-sheets of the Yearbook.

Figure A.11: "Indicator bookmark" interface

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