

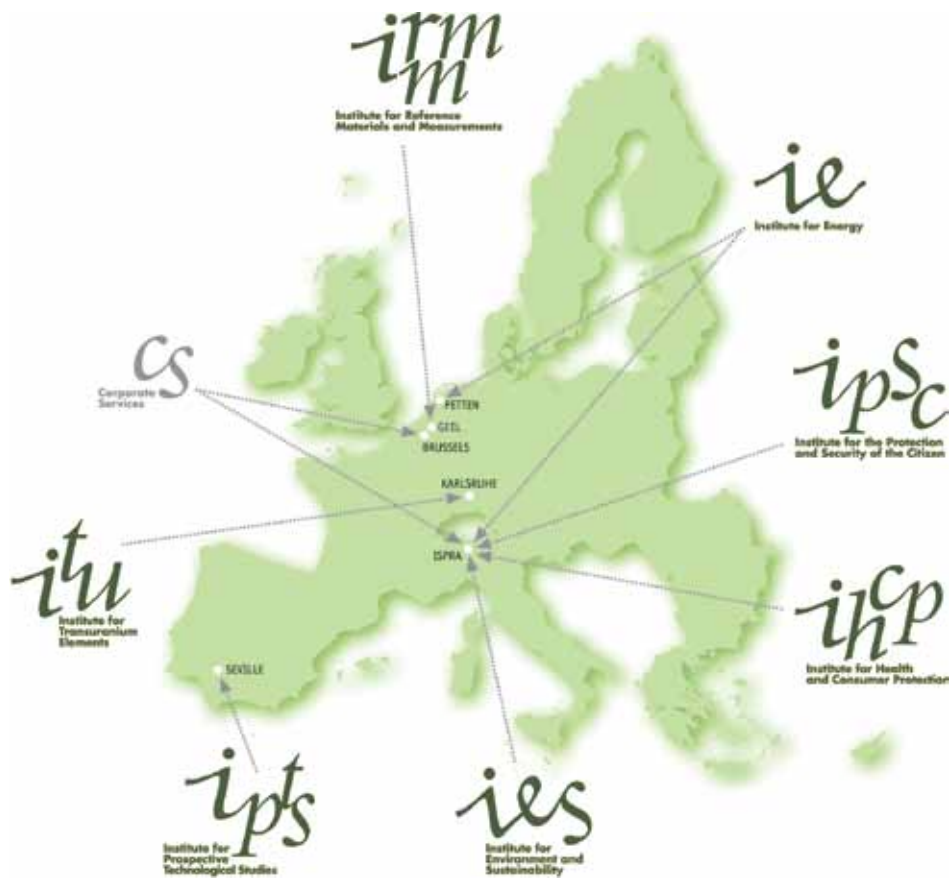


Science for the environment

**A spotlight on the activities of the JRC Institute for
Environment and Sustainability in 2008-2009**

2006 2007 2008 2009 2010 2011

JRC Structure



Robust science
for
policy making

Joint Research Centre

Mission

The mission of the Joint Research Centre is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of European Union policies. As a service of the European Commission, the Joint Research Centre functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

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A spotlight on the activities of the JRC Institute for
Environment and Sustainability in 2008-2009

2006 2007 2008 2009 2010 2011



Visit our website: <http://ies.jrc.ec.europa.eu/>

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The IES Mission

The mission of the Institute for Environment and Sustainability is to provide scientific-technical support to the European Union's Policies for the protection and sustainable development of the European and global environment.

FOREWORD

After the acting directorship of Dr Guido Schmuck, I started as the new Director of the JRC's Institute for Environment and Sustainability (IES) in Ispra on the 16th of May 2008. Before taking up my post I read with enthusiasm and great interest the previous IES brochure covering the period 2004-2007. This new report serves to provide an updated review of the IES' activities, focusing on selected highlights from 2008 and 2009. Links for further reading are provided for those wishing to delve deeper into the topics covered. Our main research partners throughout the world, the wide range of policies we support and our future challenges are also indicated.

Our scientific activities are presented according to the priorities laid down in the 7th EU Research Framework Programme (2007-2013). These are:

- **Environment and prosperity.** We are firmly convinced that environmental concerns are no obstacle for European competitiveness, but on the contrary can provide the impetus for achieving the EU's aim of becoming the most competitive knowledge-based society in the world.
- **Environment and solidarity.** A healthy environment is a cornerstone of the European model of sustainable development. We thus support the common EU goal of providing equal access to a healthy environment for all EU citizens.
- **Environment and security.** We are committed to contributing to a reduction of environmental risks, no matter whether these are related to natural hazards or the result of human activities.
- **The global dimension** of the sustainability equation can no longer be ignored. Major pressures for Europe and the rest of the world will arise concerning the availability, quality and use of strategic resources such as energy, food, water, air, minerals and land. We focus our research on the sustainability of forests, land use, water resources, environmental quality and biodiversity.

Since arriving at the Institute, I have made a concerted effort to promote the quality of our scientific output and to communicate our results to the popular media. In response to recommendations from the external review of the Institute just before I arrived, I have also strengthened the Institute's Exploratory Research Programme, which will render results in 2010-11.

I now invite you to read about the IES' achievements over the past two years and to look forward, as I do, to the new challenges lying ahead of us.

LEEN HORDIJK
Director, Institute for Environment and Sustainability



DR GUIDO SCHMUCK
Acting Director until 15 May 2008



Environment and Prosperity

“Then what is resource efficiency? It means living, producing and consuming within the physical and biological limits of this Planet. It’s a compelling idea and one that means we can have continued economic growth while managing our resources sustainably.”

JANEZ POTOČNIK

European Commissioner for Science and Research, 2004-2009



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<http://www.inspire-geoportal.eu/>
International Journal of Spatial Data
Infrastructures Research
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CUSTOMERS

DG Enterprise and Industry
DG Environment
DG Eurostat
DG Information Society and Media
DG Research
European Environment Agency (EEA)
Group on Earth Observations (GEO)
INSPIRE Legally Mandated National
Organisations (e.g. Ministries of Environ-
ment, Regional Public Authorities, Mapping
Agencies, Statistical Institutes, Environmental
Protection Agencies, Cadastres, Geological
Surveys)

POLICY SUPPORT

Directive of the European Parliament and of
the Council establishing an Infrastructure for
Spatial Information in the European
Community (INSPIRE) – 2007/2/EC
Communication: Towards a Shared
Environmental Information System (SEIS) –
COM(2008) 46
Communication: Global Monitoring for
Environment and Security (GMES): we care
for a safer planet – COM(2008) 748

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DATA WALLS COME TUMBLING DOWN!

Europe sets an example in sharing environmental information

In order to understand the complex relationships between our changing environment and society, we need to integrate different disciplines, environmental themes and policies into a single approach. By integrating information across systems and scientific domains, we can build a picture of the current state of affairs and evaluate the likely consequences of our actions, or lack of action.

Europe has a long tradition of sharing environmental information, but still more can be done to improve the effective use of this information in order to promote science, policy and informed public participation.



INSPIRE Geoportal connecting to the applications in the Member States

Working closely with DGs Environment and Eurostat, the IES has taken a leading role in laying the foundations of a new European infrastructure for sharing geographic and environmental data called INSPIRE (Infrastructure for Spatial Information in the European Community). The legal framework for INSPIRE was adopted in 2007, and the IES has since been working with the Member States and other partners to develop the technical and organisational instruments necessary to make this infrastructure a reality.

*A common understanding of environmental problems
is essential to help agree on joint action.
This can only be achieved by sharing information.*

Results achieved

The IES has drafted the following regulations:

- Commission Regulation (EC) No 1205/2008 which defines how environmental and geographic information should be documented;
- Commission Regulation (EC) No 976/2009 on Network Services for the discovery and view of environmental and geographic information;
- Draft Commission Regulation on the interoperability of spatial datasets and services and technical specification guidelines for data themes such as Geographical grid systems, Geographical names, Administrative units, Transport networks, Hydrography, and Protected sites.

Other results include:

- Design, launch and editing of the JRC-published online 'International Journal of Spatial Data Infrastructures Research'.

HIGHLIGHT

The INSPIRE Forum

Sharing information across 100 000 local authorities in 27 countries in 23 languages is no easy task. The only way to address this issue is to work together in a collaborative effort in which everyone can contribute resources and expertise. The IES is the technical coordinator of INSPIRE, which meets this challenge by mobilizing hundreds of experts and organisations across Europe to develop the technical standards and services that make it possible to search, find, access and use environmental and geographic information for a wide range of scientific and public policy uses.

To support these activities, the IES has developed a prototype web portal as a single entry point to the information catalogues held by the Member States, and a forum to facilitate interaction and exchange of experience. This participative model established by the IES shows how policy, legislation, and technical solutions can be formulated through consultation and dialogue, and is now being replicated in other parts of the world.



The INSPIRE Forum - facilitating participation in the development of the INSPIRE infrastructure

Challenges ahead

- Maintain the momentum in the technical development and in the participation and commitment of all the stakeholders involved in developing INSPIRE.
- Support the Member States in the technical, organisational and institutional implementation of the INSPIRE model, and measure the social and economic impacts of this effort, so that benefits can be documented and corrective action taken when necessary.
- Ensure that the infrastructure we build today can incorporate future social, policy, and technological developments, including new participative models in which citizens contribute directly to the collection and analysis of information about their environment.
- Ensure the effective collaboration and technical compatibility of European and global initiatives which aim to increase the availability of geographic and environmental information.

Benefit for Europe

At a time of financial constraints, it is imperative that we make the most effective use of available resources. Making information more accessible and re-usable will improve evidence-based policy, create new job opportunities, and increase accountability.

KEY PUBLICATIONS

- Friis-Christensen A., Lucchi R., Lutz M., Ostlaender N. (2009): Service Chaining Architectures for Applications Implementing Distributed Geographic Information Processing. *International Journal of Geographical Information Science* 23(5): 561-580.
- Annoni A., Friis-Christensen A., Lucchi R., Lutz M. (2008): "Requirements and Challenges for Building a European Spatial Information Infrastructure: INSPIRE" in van Oosterom, and S. Zlatanova (eds.) *Creating Spatial Information Infrastructures - Towards The Spatial Semantic Web*, CRC Press, United Kingdom: 1-18.
- Bernard L., Friis-Christensen A., Punty H. (eds.) (2008): "The European Information Society - Taking Geoinformation Science One Step Further" *Lecture Notes in Geoinformation and Cartography*, Springer, ISBN 978-3-540-78945-1.
- Lutz M., Sprado J., Klien E., Schubert C., Christ I. (2009): "Overcoming Semantic Heterogeneity in Spatial Data Infrastructures" in *Computers & Geosciences* 35 (4): 739-752.
- Craglia M., Goodchild M., Annoni A., Camara G., Gould M., Kuhn W., Mark D., Masser I., Maguire D., Liang S., Parsons E. (2008): Next-Generation Digital Earth. *International Journal of Spatial Data Infrastructures Research* 3: 146-167.

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- International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria
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<http://ies.jrc.ec.europa.eu/action-13202.html>

CUSTOMERS

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DG Environment
DG Transport and Energy
United Nations Economic Commission for Europe (UNECE), World Forum for Harmonization of Vehicle Regulations, Working Party on Pollution and Energy

POLICY SUPPORT

Regulations (EC) on type-approval of motor vehicles and engines and on access to vehicle repair and maintenance information – 595/2009, 692/2008, 715/2007

Regulation (EC) setting emission performance standards for new passenger cars – 443/2009

UNECE World Forum for Harmonization of Vehicle Regulations, Working Party on Pollution and Energy, Exhaust Emissions Test Protocol of Non-Road Mobile Machinery (NRMM)

TOWARDS ZERO-EMISSION ENGINES

Getting to grips with European vehicle exhaust emissions

Mobility is key to our quality of life and vital to competitiveness and innovation in the EU. However, the transport sector produces a wide range of negative 'side effects' with associated costs that are imposed on wider society, including air pollution and climate-altering emissions. In this respect, the environment remains the main policy area in which further improvements are essential. The IES supports the development and implementation of European legislation on emissions. It investigates how innovative technologies such as alternative vehicle concepts (hybrid cars, etc.) and alternative fuels may help to reduce the greenhouse gas intensity of transport and to alleviate pollutant sources.



IES staff preparing a heavy duty diesel engine for emissions testing

This research activity relies strongly on VELA, the Vehicle Emissions Laboratories, one of the JRC's largest experimental facilities. This is where the physical, chemical and toxicological characterisation of exhaust emissions takes place. VELA also assesses the energy efficiency of all types of vehicles and engines. All of these activities are carried out under legislative and realistic operating conditions. An emissions testing facility for testing full-scale trucks and buses (VELA 7) has recently been opened, complementing the facilities already in place for light duty vehicles and heavy duty engines.

Did you know that the pollutant emissions of European vehicles, expressed in g/km, have been reduced by more than 90% over the past 20 years?

Results achieved

- Validation of a methodology to count soot particles emitted by heavy duty engines and introduction of a number-based particle limit in the Euro VI emission standards.
- Development and introduction into EU legislation of a methodology, based on using Portable Emissions Measurement Systems (PEMS), for emissions testing of heavy duty vehicles during their normal life and under normal conditions of use.
- Official opening of VELA 7, the new laboratory for full-scale heavy duty vehicle testing.
- Experimental activities supporting the development of a new worldwide harmonised emissions certification procedure for heavy duty engines (WHDC) in the framework of the United Nations Working Party on Pollution and Energy (GRPE).
- Scientific-technical review of the Non-Road Mobile Machinery (NRMM) Directive 97/68/EC to help prepare an amendment to the Directive.



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HIGHLIGHT

A Global Technical Regulation for Non-Road Mobile Machinery: An IES success story

The World Forum for Harmonization of Vehicle Regulations (WP.29) is a permanent working party of the UNECE (United Nations Economic Commission for Europe) which aims to globally harmonise regulations on vehicles. Such harmonised regulations will lead to improved road safety, environmental protection and trade. The IES chaired the technical Working Group of WP.29, which in June 2009 successfully completed its mandate to produce a Global Technical Regulation (GTR) that harmonises the test procedures for non-road mobile machinery (NRMM) emissions contained in different national legislations, for example in Japan, the USA and Europe. The draft GTR was unanimously adopted by the signatory parties at the 27th session of the Executive Committee of the 1998 Agreement of WP.29. The new GTR (GTR #11) on Non-Road Mobile Machinery engines will be listed in the global registry dated 12 November 2009. The Executive Committee gave special thanks to the technical Working Group and commended them on their excellent contribution.



Use of Portable Emissions Measurement Systems (located in the boxes on the roof of the excavator) to monitor the exhaust emissions of non-road mobile machinery

Challenges ahead

- Finalise the Euro 6 emission standards which will enter into force in 2014 (particle number limit for gasoline vehicles, review of low temperature emissions test, review of the evaporative emissions test, *etc.*).
- Implement the new Directive setting CO₂ emission standards for passenger cars and development of a certification procedure for CO₂ emissions from heavy duty vehicles.
- Develop new type-approval procedures which are more representative of real world driving conditions for the assessment of fuel efficiency, pollutants and CO₂ emissions of new vehicles and engines.
- Assess the impact on regulated and unregulated emissions of conventional and alternative fuels (such as biofuels) in combination with advanced engines and end-of-pipe technologies (such as catalysers, scrubbers, filters, *etc.*).
- Develop and validate methods for measuring the pollutant emissions, energy efficiency, and energy consumption of advanced vehicles and fuels (hydrogen, fuel cells, electric, *etc.*).
- Worldwide harmonisation of emission legislation.

Benefit for Europe

The harmonisation of emissions testing procedures and their introduction in many countries will help to improve emissions levels. The possible international mutual recognition of emissions testing certificates will open up markets, thereby promoting trade and reducing costs for society and industries.

KEY PUBLICATIONS

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- Giechaskiel B., Stilianakis N. (2009): A Note on the Comparison of Particle Number Counters. *Measurement Science and Technology* 20 (7): 077003-1-077003-4.
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MAIN RESEARCH PARTNERS

- California Air Resource Board (CARB), USA
- Conservation of Clean Air and Water in Europe (CONCAWE) - The oil companies' European association for environment, health and safety in refining and distribution, Brussels, Belgium
- Environmental Protection Agency (EPA), USA
- European Automobile Manufacturers Association (ACEA), Brussels, Belgium
- European Council for Automotive R&D (EUCAR), Brussels, Belgium
- National Traffic Safety and Environment Laboratory (NTSEL), Tokyo, Japan
- Regional Government of Lombardy, Milan, Italy
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IES Sustainable Transport (Sustrans) Action
– merged with IES Transport Technologies
and Emissions (TransTech) Action in 2010
<http://ies.jrc.ec.europa.eu/action-13202.html>
Well-to-Wheels
<http://ies.jrc.ec.europa.eu/WTW.html>

CUSTOMERS

DG Environment
DG Transport and Energy
DG Enterprise and Industry
European Parliament
International Energy Agency (IEA)
United Nations Economic Commission for
Europe (UNECE), Transport Division (Vehicle
Regulations and Technological Innovation),
Working Party on Pollution and Energy
(GRPE)

POLICY SUPPORT

Directive on the promotion of the use of
energy from renewable sources and amend-
ing and subsequently repealing Directives
2001/77/EC and 2003/30/EC – 2009/28/EC
Communication “A sustainable future
for transport: Towards an integrated,
technology-led and user friendly system” –
COM(2009) 279/4
Communication “Keep Europe moving:
Sustainable mobility for our continent” –
COM(2006) 314
Green Paper: “Towards a new culture for
urban mobility” – COM(2007) 551
Green Paper: “Towards a European strategy for
security of energy supply” – COM(2000) 769

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GOING PLACES

New solutions for sustainable mobility

Many of the drawbacks associated with transport (air and noise pollution, traffic congestion, *etc.*) are based on the fact that technical and economic progress over the past centuries has been based largely on fossil fuels. There is an urgent need to improve the sustainability of the transport sector but there is, however, no silver bullet solution. An integrated range of transportation technologies (fuels, vehicles, system management) and policy options is needed to help the transition towards a safer, greener and more competitive future.



Testing Fuel Cell Vehicles at the VELA laboratories

The IES contributes to changing the general decisional stance from ‘transport’ to ‘sustainable mobility’ by assessing different transport modes, studying their real costs to the environment and society, and investigating new fuels and technologies that might contribute to sustainable mobility in the short- to medium term.

*Did you know that there are some
7 500 km of traffic jams on the EU’s roads every day?*

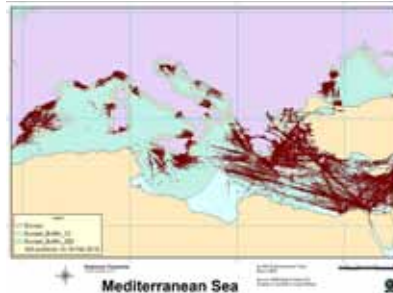
Results achieved

- Completion of Version 3 of the Well-to-Wheels (WtW) analysis, in collaboration with CONCAWE (the oil companies’ European association for environment, health and safety in refining and distribution) and EUCAR (the European Council for Automotive R&D). These results are used as a reference tool by the European Commission, the International Energy Agency and others (*see Highlight*).
- Design of a methodological approach to estimating the external costs of transport (noise, air pollution, *etc.*) which identifies the main impacts of transport and stipulates how these should be measured.
- Definition of a methodology that uses a retroactive analysis approach in creating scenarios for sustainable mobility policies, with an example of how to apply this approach in creating scenarios on how to reduce EU CO₂ emissions by 50% by 2050.
- Definition of a methodological approach for testing and calibrating dynamic road traffic simulation models. This approach includes new software architecture that tests the possibility of deriving reliable estimations of vehicle pollutant emissions.
- The IES tested two different types of vehicles and monitored the real-world driving behaviour of two FCHV (Fuel Cell Hydrogen Vehicle) fleets in order to assess the efficiency of electric motors compared to combustion engines as well as the potential to decarbonise road transport. Electric powertrains were found to be nearly twice as efficient.

HIGHLIGHT

Maritime transport

Maritime transport performs better, environmentally, compared to other modes of transport, and is still the most energy-efficient transport mode per single traffic unit (tonnes x km) performed. However, the volume of ship movements is increasing. Additionally, ships' air emissions have until recently remained largely unregulated. To design an environmental regulation for this sector we need to quantify the contribution of ships' emissions to air pollution and greenhouse gases, identify emission reduction technologies and explore the use of cleaner fuels. The IES determines the external costs arising from shipping activities and analyses the cost effectiveness of ship emissions abatement technologies. This is carried out in support of EU legislative actions which aim to improve sustainability by regulating pollutant levels and mechanisms for transferring these new abatement technologies to the market.



Shipping activities in the Mediterranean area

Cradle-to-grave of alternative fuels and drive-trains

The Well-to-Wheels (WtW) analysis (carried out by the IES, CONCAWE and EUCAR) estimates the projected greenhouse gas (GHG) emissions, energy efficiency and industrial costs of all significant automotive fuels and powertrains for the EU after 2010. This approach helps to understand “scale” issues associated with different fuel options, including competing demand from transport and other sectors on the same supply source (a key aspect when considering fleet electrification). For many alternative fuels, vehicle production, fuel distribution and re-fuelling infrastructures critically depend on energy and GHG balances at given scales, which eventually determine each option's viability.

Challenges ahead

- Define and estimate the external costs of transport activities (noise, air pollution, congestion, *etc.*), and provide policy options to internalise them.
- Outline policy options that will facilitate a shift from transportation to mobility management and re-balance transport modes in the transportation system (co-modality).
- Provide analytical tools to carry out integrated assessments of the environmental and socio-economic impacts of transport and the possible technological and policy options for addressing them.
- Develop alternative fuels and powertrains for vehicles in order to reduce their environmental impacts.
- Incorporate road transport electrification into the WtW analysis in order to get a clearer picture of its role in sustainable mobility.

Benefit for Europe

The combined study of both technological and socio-economic options for attaining sustainability in the transport sector provides a variety of possible instruments for changing from transport to a sustainable mobility approach in future decision-making policies.

KEY PUBLICATIONS

- Well-to-Wheels analysis of future automotive fuels and powertrains in the European context, Version 3 (downloadable from: <http://ies.jrc.ec.europa.eu/WTW.html>).
- Miola A. (2008): Backcasting approach for sustainable mobility. EUR 23387 EN. Office for Official Publications of the European Communities, Luxembourg.
- Andreoni V., Miola A., Perujo A.. (2008): Cost Effectiveness Analysis of the Emission Abatement in the Shipping Sector Emissions. EUR 23715 EN. Office for Official Publications of the European Communities, Luxembourg.
- Miola A., Paccagnan V., Mannino I., Massarutto A., Perujo A., Turvani M. (2009): External costs of Transportation. Case study: maritime transport. EUR 23837 EN. Office for Official Publications of the European Communities, Luxembourg.
- Perujo A., Ciuffo B. (2009): Potential Impact of Electric Vehicles on the Electric Supply System: A case study for the Province of Milan, Italy. EUR 23975 EN. Office for Official Publications of the European Communities, Luxembourg.

MAIN RESEARCH PARTNERS

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- Daimler AG, Strategic Energy Projects & Fuel Cell Market Development GR/AFP, HPC, Stuttgart, Germany
- European Council for Automotive R&D (EUCAR), Brussels, Belgium
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 DG Eurostat
 DG Research
 DG Transport and Energy
 European Environment Agency (EEA)
 Many European/international business associations

POLICY SUPPORT

Eco-Design Directive 2009/125/EC
 Waste Framework Directive – 2008/98/EC
 Eco-Label Regulation (EC) No 66/2010
 Communication on Integrated Product Policy – COM(2003) 302
 Thematic Strategy on the Sustainable Use of Natural Resources – COM(2005) 670
 Thematic Strategy on the Prevention and Recycling of Waste – COM(2005) 666
 Sustainable Consumption and Production Action Plan (SCP) COM(2008) 397

CALCULATING ENVIRONMENTAL FOOTPRINTS

Towards sustainable production and consumption

Environmental footprints are indicators of the potential impact that individual products (goods or services) have on the environment. Calculating environmental footprints requires a life cycle assessment (LCA). A life cycle assessment of a product systematically accounts for each stage of a product's lifetime, from supply chains, manufacturing and use, right through to what happens to the waste. The assessment quantifies emissions and resources consumed, as well as environmental and health pressures. It is an essential step behind many sustainable consumption and production policies and business instruments, including carbon footprints.



The ISO 14040/44 standard provides a framework for LCA, but further guidance is needed to ensure quality and coherence. Working together with the IES, DG Environment addressed this need by establishing the “European Platform on Life Cycle Assessment (LCA)” in 2005.

The European Platform on LCA aims to provide a one-stop-shop for LCA, with an emphasis on quality assurance, coherence, and data availability. This Platform helps to build and support a growing number of policies and business instruments. These include carbon footprinting, eco-design, eco-labelling, and environmental reporting by organisations. The Platform deliverables are developed in close collaboration with key stakeholders, including the EU Member States, several non-EU countries, businesses and the United Nations Environment Programme (UNEP). The Platform's implementation and maintenance is a joint responsibility shared by the IES, DG Environment and an EC Steering Committee.

Did you know that, unless properly managed, home composting can lead to increased greenhouse gas emissions, including methane (CH₄) and nitrous oxide (N₂O)?

Results achieved

- Establishment and coordination of the European Platform on Life Cycle Assessment.
- Preparation of the International Reference Life Cycle Data System (ILCD) Handbook (*see Highlight*).
- Compilation of the European Reference Life Cycle Database (ELCD) (*see Highlight*).
- Development of the LCA Resources Directory.
- Establishment and coordination of the Life Cycle Thinking (LCT) Discussion Forum.



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HIGHLIGHT

International Reference Life Cycle Data System (ILCD)

The International Reference Life Cycle Data System (ILCD), established and coordinated by the IES, gathers and analyses information that describes products and their potential impacts on the environment. The ILCD consists primarily of a Handbook and an upcoming Data Network.

The **ILCD Handbook** is a series of technical guidance documents for carrying out Life Cycle Assessment, developed through broad international cooperation and consultation. In line with the ISO 14040 series, this Handbook provides the basis for consistent and quality-assured calculations of environmental and carbon footprints. It is available online at <http://lct.jrc.ec.europa.eu/>.



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A **European Reference Life Cycle Database (ELCD)**, which is compliant with the ILCD Handbook requirements, is also maintained by the IES and is available online at <http://lct.jrc.ec.europa.eu>.

The ELCD provides data on emissions and resource consumption which is representative of the European market for key materials, energy carriers, transport, and waste management. As far as possible, these data are provided through formal agreements with European and international business associations.

Challenges ahead

- Establish the International Data Network, collecting data from different sources/owners in line with the ILCD Handbook guidelines to ensure a high level of consistent and quality-assured data.
- Develop guidance documents and assessments for specific product groups in order to provide cross-policy and business support.
- Develop robust life-cycle-based indicators for monitoring the environmental impacts arising from product consumption in Europe.

Benefit for Europe

The IES provides support for the growing number of policies and instruments in governments and businesses that rely on life cycle assessments, methods and data.

KEY PUBLICATIONS

Finnveden G., Hauschild M.Z., Ekvall T., Guinee J., Heijungs R., Hellweg S., Koehler A., Pennington D., Suh S. (2009): Recent developments in Life Cycle Assessment. *Journal of Environmental Management* 91: 1–21.

International Reference Life Cycle Data System (ILCD) Handbook (available online at <http://lct.jrc.ec.europa.eu/>).

Bersani R., Pant R., Pennington D., (eds.), Krutwagen B., Kortman J., Verbist K. (2008): Inventory of existing studies applying life cycle thinking to biowaste management. EUR 23497 EN. Office for Official Publications of the European Communities, Luxembourg.

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Environment and Solidarity

“Today’s policy makers must use their legislative power to engage and guide the wider society. Only by changing our collective behaviour will we achieve sustainable growth.”

JANEZ POTOČNIK

European Commissioner for Science and Research, 2004-2009



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AMIS – African Marine Information System
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DG Research
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Commission (Helsinki Commission)
Commission on the Protection of the Black
Sea against Pollution
European Environment Agency (EEA)
Group on Earth Observations (GEO)

POLICY SUPPORT

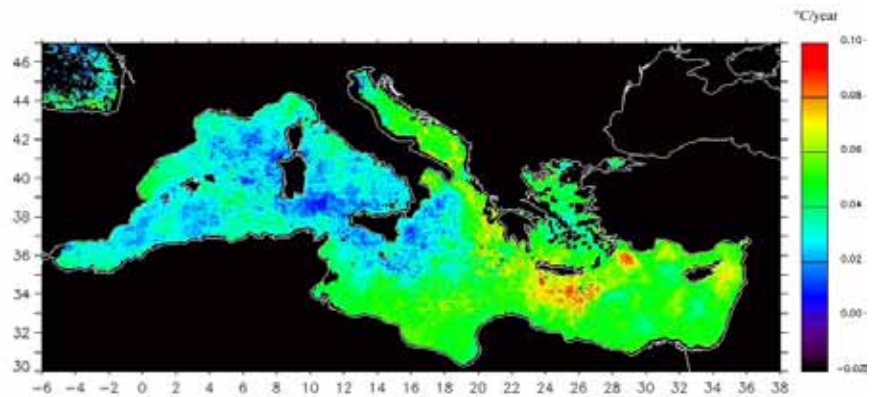
EU Marine Strategy Framework Directive
EU Integrated Maritime Policy
Communication 'Roadmap for Maritime
Spatial Planning: Achieving Common
Principles in the EU' – COM(2008) 791
Roadmap for a European Marine Observa-
tion and Data Network – SEC(2009) 499

MARINE MATTERS

Monitoring and reporting on European seas

The marine and coastal waters in Europe are constantly exposed to the impacts of climate change and increasing human pressure through activities such as fisheries, energy production, tourism, trade and commerce. The physical, biological, and morphological characteristics of the European seas and coasts are being affected accordingly, modifying their ecological structure, their functions, and the goods and services they provide.

The EU Marine Strategy Framework Directive (adopted in 2008) aims to protect the marine environment across Europe and to restore, where necessary, the structure and function of marine biodiversity and ecosystems, with a view to achieving “good environmental status” of all European seas and coasts by 2020. Through the analysis of satellite data and applications of hydrodynamic and biogeochemical models, the IES develops and monitors key marine indicators, thus contributing to an effective and long-lasting marine and coastal stewardship in Europe.



Annual rate of change of sea surface temperature (°C per year) in the Mediterranean Sea over the period 1985-2006

Did you know that the average annual temperature of surface water has increased in certain areas of the Mediterranean Sea by more than 2.0°C over the past 20 years ?

Results achieved

- Analysis of 22 years' observations of sea surface temperature in the Mediterranean Sea revealed an average increase of 0.04°C per year, with local maxima at 0.16°C per year.
- Report on the combination of satellite data and model simulations to assess the space-time heterogeneity of atmospheric forcing, vertical mixing and algal blooms in the northwestern Mediterranean basin.
- Publication of a peer-reviewed article addressing the phenological response of plankton biomass and communities to environmental changes in the coastal ecosystem of the Gulf of Trieste.
- Implementation of a 3-D hydrodynamic model to explain the processes responsible for the summer cyanobacterial blooms in the Baltic Sea, which are detrimental to local biodiversity and fisheries.
- Capacity building in Africa – training was delivered in Zanzibar on “Methods and Applications of Ocean Colour Remote Sensing in African Coastal and Regional Seas”.
- The design and implementation of the Environmental Marine Information System (EMIS) (*see Highlight*).



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HIGHLIGHT**The Environmental Marine Information System (EMIS)**

The conception, development, implementation and monitoring of environmental policies require the provision of timely, quality assured and easy-to-use data and information. EMIS is a web-based application developed by the IES that facilitates access to IES-derived marine and coastal scientific information by way of georeferenced maps (created in real time), and supplies users with basic navigation and query tools.



Environmental Marine Information System (EMIS): a web-based tool to support water quality assessment and resource monitoring in European Seas

The system includes:

- A database of relevant marine biophysical parameters as derived from optical and infrared satellite sensors;
- Biophysical indicators (such as primary productivity, eutrophication index) for the comprehensive diagnosis of the coastal state and analyses of changes in marine ecosystems;
- Tools for interdisciplinary analysis of the marine and coastal environment in order to enable decision makers to make full use of this information.

The system has been mirrored for application in Africa as the AMIS (African Marine Information System).

Challenges ahead

- Develop new marine ecosystem indicators using multiple satellite sensors and numerical modelling to detect hotspots and anomalies in the physical and biological condition of seas.
- Implement and validate a complete harmonised pan-European hydrodynamic model simulating the physical vulnerability of European seas over the past decade.
- Optimise the dissemination of science-based information addressing societal needs in relation to sustainable management of marine and coastal areas around Europe.
- Improve integrated regional assessment by combining cumulative impacts on coastal and marine areas, socio-economic evaluation and spatial planning methodologies.
- Increase efforts to coordinate actions and research with other DGs, marine/ environmental organisations and Member States in providing relevant input to the implementation of the Marine Strategy Framework Directive.

Benefit for Europe

The IES develops user-friendly tools which provide precise pan-European knowledge on marine matters - a prerequisite for any decision-making process related to coastal protection and the sustainable management of marine resources.

KEY PUBLICATIONS

Friedrichs M.A.M. et al (2009): Assessing the uncertainties of model estimates of primary productivity in the tropical Pacific Ocean. *Journal of Marine Systems* 76: 113-133.

Kamburska L., Fonda-Umani S. (2009): From seasonal to decadal inter-annual variability of mesozooplankton biomass in the Northern Adriatic Sea (Gulf of Trieste). *Journal of Marine Systems* 78: 490-504.

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Kabbara N. et al (2008): Monitoring water quality in the coastal area of Tripoli (Lebanon) using high-resolution satellite data. *ISPRS Journal of Photogrammetry and Remote Sensing* 63: 488-495.

Lilover M.-J., Stips A. (2008): The variability of parameters controlling the cyanobacteria bloom biomass in the Baltic Sea. *Journal of Marine Systems* 74: 108-115.

Platt T., Hoepffner N., Stuart V., Brown C. (eds.) (2008): *Why Ocean Colour? The Societal Benefits of Ocean-Colour Technology*. Reports of the International Ocean-Colour Coordinating Group, n7, IOCCG, Dartmouth, Canada: 140.

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European Soil Portal
<http://eusoils.jrc.ec.europa.eu/>

High Nature Value Farmland (HNV)
http://agrienv.jrc.ec.europa.eu/activities_HNV.htm

Soil Biodiversity
<http://eusoils.jrc.ec.europa.eu/library/themes/biodiversity/>

CUSTOMERS

DG Agriculture
DG Environment
DG Eurostat
European Environment Agency (EEA)
European Food Safety Authority (EFSA)
Convention on Biological Diversity (CBD)

POLICY SUPPORT

Communication "Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy" – COM(2006) 508

Communication "Towards a better targeting of the aid to farmers in areas with natural handicaps" – COM(2009) 161

Communication EC Biodiversity Communication "Halting the loss of biodiversity by 2010 – and beyond" – COM(2006) 216

Communication "The Soil Thematic Strategy" – COM(2006) 231

EU Biodiversity Action Plan – SEC(2006) 621

United Nations Pan-European Biodiversity and Landscape Strategy (PEBLDS)

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LIVING ECOSYSTEMS

Monitoring soils and farmland as reservoirs for biodiversity

The soil is home to a vast array of organisms, ranging from groups with which everyone is familiar such as rabbits and earthworms, to microorganisms which can be as small as 1 µm in size (about 1/50th the diameter of a human hair). Just one handful of grassland soil can contain more species than one hectare of above-ground Amazon rainforest. Soil organisms provide many important ecosystem services, including the cycling of nutrients, thereby improving soil fertility and structure, cleaning water supplies and removing pollutants. All of these services are also very important for the sustainability of agriculture.



Examples of just four different groups of soil organisms showing (from left to right) earthworms, a collembola, a ground beetle and an amoeba

Agricultural land benefits greatly from soil biodiversity, and at the same time farmed land can provide habitats for many species of plants, insects, amphibians, birds and mammals. The thousand-year history of agriculture in Europe has led to the development of specific ecosystems, which today account for a substantial part of Europe's biodiversity. These areas are referred to as High Nature Value (HNV) farmland areas. However, current trends in agriculture can deeply affect this heritage, which is threatened by land abandonment and agricultural intensification. Sustainable management of HNV areas is key to the achievement of biodiversity targets, especially considering that they account for roughly 30% of agricultural land in the European Union.

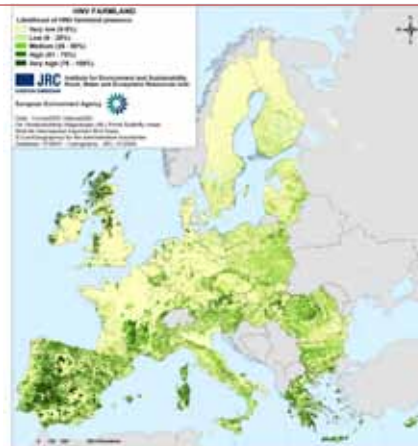
Did you know that a large part of European biodiversity is hosted in agricultural areas, and that this biodiversity provides ecosystem services valued at hundreds of billions of Euros per year?

Results achieved

- The first EU-wide map of high nature value farmland (*see Highlight*).
- Contribution to the TEEB (The Economics of Ecosystems and Biodiversity) Ecological and Economic Foundation report, including examples of maps of ecosystem services.
- Development of agri-environmental indicators of EU landscape state and diversity.
- Production of a booklet on soil biodiversity aimed at raising awareness of soil biodiversity among non-specialists, including policy makers (http://eusoils.jrc.ec.europa.eu/ESDB_Archive/eusoils_docs/other/EUR23759.pdf).
- Development of a prototype soil eco-region map for three selected countries (Portugal, Germany and Finland).
- Organisation of a symposium on soil biodiversity with high profile speakers at the American Association for the Advancement of Science (AAAS) in Chicago.
- Organisation and chairing of an IES workshop on raising awareness of soil biodiversity within the COP 9 (ninth meeting of the Conference of the Parties to the United Nations' Convention on Biological Diversity) in Bonn.

HIGHLIGHT
Mapping biodiversity hotspots

Europe's agricultural landscapes provide highly varied living conditions for many species. The IES, in collaboration with the European Environment Agency, and with input from BirdLife International and the Dutch Butterfly Conservation, has produced a map which shows where these areas of High Nature Value (HNV) farmland are situated in Europe. The map identifies biodiversity hotspots associated with traditional and extensively farmed landscapes.



Likelihood of HNV Farmland presence



Farmland bird indicator for France at national level (black), in HNV areas (green) and non-HNV areas (red)

Scientific evidence shows that farmland birds do better in HNV farmland than in land that has been subject to intense farming. HNV farmland areas play a crucial role in maintaining the variety of nature that has evolved over the past centuries. A new and ongoing approach at the IES to scientifically support the protection of the EU's biodiversity resources assesses and economically evaluates the services provided by ecosystems and landscapes.

Challenges ahead

- Carry out scenario analysis and modelling of policy impacts on European biodiversity.
- Map ecosystem services at different (local, regional, etc.) scales of analysis, and assess trade-off issues that arise as a result of altering the ecosystems' status.
- Carry out a European assessment of the services and associated economic benefits provided by ecosystems and biodiversity.
- Identify suitable indicators of soil biodiversity.
- Quantify how soil biodiversity is affected by soil threats such as soil erosion, soil compaction, etc., as outlined in the EU Thematic Strategy for Soil Protection.
- Produce an Atlas of European Soil Biodiversity.

Benefit for Europe

A better understanding of the drivers that contribute to the present loss of habitats and species facilitates effective policy-making and increases awareness of the human benefits that are provided by biodiversity and ecosystems.

KEY PUBLICATIONS

- Gardi C., Montanarella L., Arrouays D., Bispo A., Lemanceau P., Jolivet C., Mulder C., Ranjard L., Römbke J., Rutgers M., Menta C. (2009): Soil biodiversity monitoring in Europe: ongoing activities and challenges. *European Journal of Soil Science* 60: 807-819.
- Jeffery S., Gardi C. (2009): Soil Biodiversity. EUR 23759 EN. Office for Official Publications of the European Communities, Luxembourg.
- Pedroli B., van Doorn A., de Blust G., Paracchini M.L., Wascher D., Bunce F. (2007): Europe's living Landscapes. Essays exploring our identity in the countryside. KNNV Publishing (The Netherlands): 432 pp.
- Paracchini M.L., Petersen J.-E., Hoogeveen Y., Bamps C., Burfield I., van Swaay C. (2008): High Nature Value Farmland in Europe - An estimate of the distribution patterns on the basis of land cover and biodiversity data. EUR 23480 EN. Office for Official Publications of the European Communities, Luxembourg: 87 pp.

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<http://ies.jrc.ec.europa.eu/action-22001.html>

CUSTOMERS

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International Commission for the Protection of the Danube River (ICPDR), Austria
International Union of Pure and Applied Chemistry (IUPAC)
National environmental authorities, e.g. Federal Institute for Hydrology (BFG), Germany
United Nations Environmental Programme (UNEP)

POLICY SUPPORT

Water Framework Directive and its Daughter Directives – 2000/60/EC
Revision process of the Sewage Sludge Directive – 86/278/EEC
Stockholm Convention on Persistent Organic Pollutants Global Monitoring Plan (GMP)

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CHEMICALS OF CONCERN

Measuring chemicals in Europe's rivers

Research on chemical pollutants in waters as carried out by the IES pursues three distinct objectives:

- To better understand the pathways and processes of chemicals in water in order to support policies addressing the management of water resources;
- To investigate occurrences and levels of emerging pollutants, as a necessary step in proper risk assessment and scenario modelling;
- To develop and promote best practices on how to assess water quality in Europe in a reliable and comparable manner.



Images from JRC field and laboratory work

The IES applies its considerable range of chemical measurement capabilities, sampling equipment and scientific expertise to local and regional case studies and pan-European monitoring activities. By harmonising assessment methods, the IES helps understand the behaviour of chemicals. The resulting body of scientific knowledge built up by the IES directly helps in the development and implementation of European legislation designed to protect inland, coastal and maritime waters.

Almost any chemical used in households or industry can be found in rivers and streams across Europe!

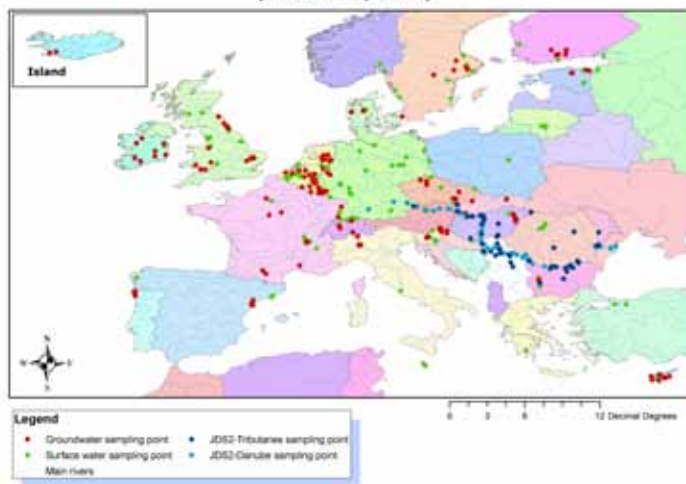
Results achieved

- Characterisation of 126 river sampling stations and 164 groundwater bodies in Europe for new and less-investigated contaminants, including pesticides and pharmaceuticals (*see Highlight*).
- Assessment of the occurrence and level of sucralose in European water bodies, in collaboration with the European Environment Agency (EEA). Sucralose (E955), an artificial sweetener, was introduced in 2005 to the Single Market and now appears in European groundwater.
- Provision of technical guidance and best-practices for sampling and analysing priority substances to support the implementation of the Water Framework Directive (WFD).
- Organisation of a collaborative on-site campaign for chemical monitoring, involving 27 Analytical Laboratories from eleven EU Member States and two non-EU countries, to compare various sampling and analytical methodologies with regard to WFD provisions.
- Provision of analytical data on water, sediments, suspended matter, and biota for the 2nd Joint Danube Survey. IES support allowed many compounds to be analysed quantitatively for the first time. The results revealed an overall good status of the Danube River.

HIGHLIGHT**Pan-European screening of rivers and groundwaters**

To obtain a pan-European perspective on the occurrence of emerging pollutants such as pesticides and their derived products (pharmaceuticals, hormones, antibiotics) in European waters, the IES organised two specially designed monitoring campaigns on European rivers and groundwater bodies during the 2008-09 period. The derived dataset on 36 chemicals in river waters and more than 70 chemicals and the same number of trace elements in groundwater, covered 126 river sampling stations and 164 groundwater samples from 27 countries. In total, more than 100 collaborators joined the campaigns and samples were analysed in five expert laboratories. The information produced is used to directly assess the pan-European relevance of the compounds investigated and can be used for further modelling applications.

FATE EU-Wide Monitoring - European map
(Status: May 2009)



Map of surface and groundwater sampling stations incorporated in IES monitoring campaigns

Challenges ahead

- Provide timely, reliable and EU-wide information about levels and occurrences of emerging environmental pollutants in water.
- Support the prioritisation of newly identified pollutants with respect to legal requirements.
- Promote consensus and establish guidance about best monitoring practices and standardised methodology among Member States.
- Actively support Member States to help them meet the requirements of technically demanding environmental legislation.

Benefit for Europe

Establishment of best practices and promotion of consensus for chemical monitoring are fundamental to a sound assessment and eventual management of environmental risks.

KEY PUBLICATIONS

Lepom P., Brown B., Hanke G., Loos R., Quevauviller Ph., Wollgast J. (2009): Needs for reliable analytical methods for monitoring chemical pollutants in surface water under the European Water Framework Directive. *Journal of Chromatography A* 1216: 302-315.

Loos R., Gawlik B. M., Boettcher K., Locoro G., Contini S., Bidoglio G. (2009): Sucralose screening in European surface waters using a solid-phase extraction-liquid chromatography-triple quadrupole mass spectrometry method. *Journal of Chromatography A* 1216: 126-131.

Loos R., Gawlik B. M., Locoro G., Rimaviciute E., Contini S., Bidoglio G. (2009): EU-wide survey of polar organic persistent pollutants in European river waters. *Environmental Pollution* 157: 561-568.

Liška I., Wagner F., Slobodník J. (eds.) (2008): ICPDR – International Commission for the Protection of the Danube River - Joint Danube Survey 2 – Final Scientific Report, 242 pp. http://www.icpdr.org/jds/files/ICPDR_Technical_Report_for_web_low_corrected.pdf

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DG Environment
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POLICY SUPPORT

Water Framework Directive – 2000/60/EC
Marine Strategy Framework Directive – 2008/56/EC
Nitrates Directive – 1991/676/EEC
Urban Water Waste Directive – 1991/271/EEC
Communication “A European Community Biodiversity Strategy” – COM(98) 42

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GOOD ECOLOGICAL STATUS

Defining the ecological status of EU surface waters

The IES seeks to provide the crucial link between science and water policy, developing and harmonising indicators for water ecological assessment and developing concepts for a sustainable use of natural resources.

The aim of the European Union’s ambitious Water Framework Directive (WFD) is to more effectively protect the aquatic environment across Europe. It aims to achieve “good ecological status”, defined as a slight deviation from natural conditions. From the beginning, the IES has played a leading role in defining and harmonising the concept of ‘good ecological status’ across Europe. Following an unprecedented effort involving hundreds of scientists and government experts, first results were formally published as a Commission Decision in 2008. The work is still ongoing and further results will follow in 2011. These will include ecological quality targets for all components of ecosystems, covering all water body types and regions of Europe.



Lago di Ledro, Italy

The new EU Marine Strategy Framework Directive (MSFD) has a similar objective – it aims to achieve ‘good environmental status’. Recently, the IES started a collaboration with the ICES (International Council for Exploration of the Seas) and DG Environment to develop a common European methodological toolkit for determining the main factors affecting good environmental status, including biodiversity, food web integrity, non-indigenous species, eutrophication and chemicals.

In addition, innovative techniques based on molecular biology are applied to develop molecular-level quantitative tools for tracking the effects of environmental stressors on aquatic organisms. The latest IES achievements are:

- Identification of molecular indicators for chemical pollutants in marine diatoms and in zebrafish liver cell lines, using DNA Microarray technology;
- Development of a sensitive method to assess the changes in microbial populations in water caused by anthropogenic stressors, and to monitor microbial biodiversity changes.

Did you know that 40% of surface waters in the EU are at risk of not achieving the environmental quality targets by 2015?

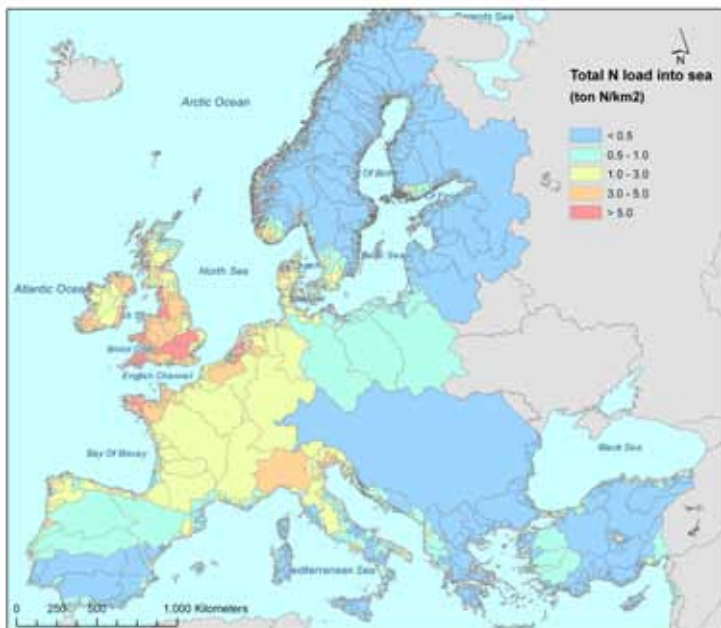
Results achieved

- Commission Decision (2008/915/EC) setting ecological status boundaries for European rivers, lakes, coastal and transitional waters.
- Harmonised ecological assessment systems for phytoplankton and macrophytes for lakes, for benthic invertebrates and phytobenthos for rivers, and for benthic invertebrates, phytoplankton, macroalgae and angiosperms for coastal waters.
- Quantification of nitrogen and phosphorus discharges from land to European inland waters and seas from 1985 to 2005.
- Assessment of the effects of European legislation to reduce nutrient losses on the quality of European surface waters during the past two decades (*see Highlight*).
- Spatial assessment of the respective contribution of agriculture, urban waste waters and other sources to water nutrient loads, in order to support policy assessment and planning.

HIGHLIGHT

Nutrient overdose?

Through modelling studies, the IES investigates the contribution of various sectoral activities (such as agriculture, industry, wastewater treatment) to nutrients (phosphates and nitrogen) entering European freshwaters. Excessive loads of nutrients can cause eutrophication (algae growth and oxygen depletion), thereby damaging the equilibrium of the ecosystems. Three major pieces of legislation aim at controlling and preventing eutrophication: the Water Framework Directive (WFD, 2000), the Nitrates Directive (1991) and the Urban Waste Water Directive (1991). In an attempt to alleviate the pressures on freshwater ecosystems and European seas, the IES assesses the effectiveness of the different Directives in controlling nutrient loads originating from human activities.



This map shows the nitrogen load, normalised per unit area, which enters the sea from different European river basins. The highest loads are found in western Europe, primarily due to intensive agricultural practices.

Challenges ahead

- Complete the missing information in ecological quality objectives for the WFD (benthic fauna and fish for lakes, macrophytes and fish for rivers, etc.).
- Define and streamline ecological quality objectives for the WFD, the MSFD and other relevant EU legislation.
- Develop more robust molecular tools for environmental monitoring.
- Evaluate the impact that current EU legislation is likely to have on water quality by 2020.
- Assess which measures need to be taken to reduce nutrient loading of European waters and to achieve good ecological status.

Benefit for Europe

Diverse communities of plants and animals provide indispensable ecosystem functions and services. IES research lays the foundation for sustainable water management policies designed to promote the clean and healthy aquatic ecosystem that provides the optimum habitats for these communities.

KEY PUBLICATIONS

- Bouraoui F., Grizzetti B., Aloe A. (2009): Nutrient discharge from river to seas for year 2000. EUR 24002 EN. Office for Official Publications of the European Communities, Luxembourg.
- Carletti A., Heiskanen A.-S. (eds.) (2009): Water Framework Directive intercalibration technical report – Part 3: Coastal and Transitional Waters. EUR 28838 EN/3. Office for Official Publications of the European Communities, Luxembourg.
- Noges P., Van de Bund W., Cardoso A.C., Solimini A., Heiskanen A.-S. (2009): Assessment of the ecological status of European surface waters: a work in progress. *Hydrobiologia* 633: 197-211.
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- Van de Bund, W. (ed.) (2009): Water Framework Directive intercalibration technical report – Part 1: Rivers. EUR 28838 EN/1. Office for Official Publications of the European Communities, Luxembourg.
- Cardoso A.C., Free G. (2008): Incorporating invasive alien species into ecological assessment in the context of the Water Framework Directive. *Aquatic Invasions* 3 (4): 361-366.
- Grizzetti B., Bouraoui F., De Marsily G. (2008): Assessing nitrogen pressures on European surface water. *Global Biogeochemical Cycles* 22: GB4023, doi:10.1029/2007GB30855.

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DG Eurostat
European Environment Agency (EEA)
European farmers

POLICY SUPPORT

Common Agricultural Policy (CAP):

- Good Agricultural and Environmental Conditions (Cross Compliance)
- Rural Development (Less Favoured Areas)

Water Framework Directive
Nitrates Directive
Sewage Sludge Directive
Communication "Towards a better targeting of the aid to farmers in areas with natural handicaps" – COM(2009) 161

SUSTAINABLE AGRICULTURE

Working towards environmentally-friendly farming

Agriculture occupies nearly half of the European land area, and consequently plays an important role in maintaining natural resources and cultural landscapes. The demands on agriculture for food, energy, protection of the environment, *etc.*, are increasing. Unsustainable farming practices and land use, such as mismanaged agricultural intensification and land abandonment, may have an adverse impact on natural resources and compromise production capacity.

Having recognised these challenges, the IES provides scientific advice to policy makers and the public at large on the links between environmental issues and agriculture within the framework of European legislation. Current fields of research include water pollution, irrigation, soil, pesticides use, biofuels and landscape.



Examples of sustainable farming systems. Left: reduced tillage (conservation agriculture). Right: olive grove with protective soil cover.

Under the 'Sustainable Agriculture and Soil Conservation' (SoCo) project, the IES carried out research to improve the understanding of soil conservation practices in agriculture. Two farming systems and ten agronomic practices were identified as being potentially useful in combating soil degradation and improving sustainability. Organic farming, conservation agriculture, agroforestry, buffer strips, grasslands, contour farming, intercropping and terracing were studied in detail. Environmental and economic benefits and drawbacks were investigated and proposals made to help improve the existing policies.

Did you know that rural areas cover 90% of the EU's territory and are home to approximately 50% of its population, and that 66% of rural land suffers from erosion?

Results achieved

- Raised awareness about soil conservation and options for using sustainable agriculture among farmers and policy makers through wide distribution of ten thematic brochures and two main reports (available from the SoCo Website <http://soco.jrc.ec.europa.eu>).
- Eight criteria (and threshold values) proposed by the IES are embedded in the Communication COM(2009) 161 on identifying agricultural Areas with Natural Handicaps (formerly known as Less Favoured Areas – see *Highlight*).



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HIGHLIGHT

Areas with Natural Handicaps

In support of the Common Agricultural Policy's redefinition of the Less Favoured Areas scheme, the IES delivers scientific information to help delimit Areas with Natural Handicaps in Europe according to biophysical criteria such as low soil productivity and poor climate and terrain conditions. The IES recently developed eight objective climate, soil and terrain criteria for the future delimitation of areas with natural handicaps, which were included in a Communication to the Council and the European Parliament (COM(2009) 161 – "Towards a better targeting of the aid to farmers in areas with natural handicaps"). The Communication was endorsed by the Agriculture and Fisheries Council in June 2009, asking the Member States to test and report on the application of the criteria in their territories, using national data.



An example of an area with natural handicaps in Ireland

The eight criteria were developed by a panel of soil, climate and land evaluation experts coordinated by the IES, and support a robust and transparent approach to identifying agricultural areas that experience natural constraints. Each criterion is described and an indicative threshold for assessing its impact on agriculture is provided in the technical annex to the Communication. These biophysical criteria can be used in Europe to discriminate land presenting severe limitations for agricultural production, assuming that soil and climate data of sufficient spatial and semantic detail are available.

Challenges ahead

- Raise awareness about sustainable farming.
- Further invest in indicators and monitoring measures for improved future evaluation of the impact of soil conservation measures.
- Translate the common biophysical criteria of Areas with Natural Handicaps into national databases to be elaborated on by Member States, in line with the original criteria, objectives and thresholds defined by the IES.

Benefit for Europe

Sustainable farming practices could significantly help to reduce negative environmental impacts of agriculture without a significant reduction of crop yields. The IES proposes robust and transparent science-based approaches to help reach a common understanding of sensitive political issues, such as the identification of Areas with Natural Handicaps.

KEY PUBLICATIONS

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- SoCo Team (2009): Final report on the Project 'Sustainable Agriculture and Soil Conservation (SoCo)'. EUR 23820 EN. Office for Official Publications of the European Communities, Luxembourg.
- SoCo Team (2009): Addressing soil degradation in EU agriculture: relevant processes, practices and policies. EUR 23767 EN. Office for Official Publications of the European Communities, Luxembourg.
- Van der Velde M., Bouraoui F., Aloe A. (2009): Pan-European regional-scale modelling of water and N efficiencies of rapeseed cultivation for biodiesel production. *Global Change Biology* 15 (1): 24-37.
- Wriedt G., van der Velde M., Aloe A., Bouraoui F. (2009): A European irrigation map for spatially distributed agricultural modeling. *Agricultural Water Management* 96 (5): 771-789.
- Van Orshoven J., Terres J.-M., Eliasson A. (2008): Common bio-physical criteria to define natural constraints for agriculture in Europe. EUR 23412 EN. Office for Official Publications of the European Communities, Luxembourg.

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Food and Agriculture Organization of the United Nations (FAO)
Group on Earth Observations (GEO)
United Nations Environment Programme (UNEP)
World Data Centre for Soils (ISRIC)

POLICY SUPPORT

Directive concerning the placing of plant protection products on the market – 91/414/EEC
INSPIRE Directive – 2007/2/EC
Renewable Energy Directive 2009/28/EC
Soil Framework Directive – COM(2006) 232
Thematic Strategy for Soil Protection – COM(2006) 231
Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy – COM(2006) 508

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THE EARTH BENEATH OUR FEET

Providing information on European soils

The European Soil Data Centre (ESDAC) was developed by the IES in 2006 within the framework of the EU's Shared Environmental Information System (SEIS). It is the single focal point for soil information, data and expertise at the European level, integrating and hosting soil data and information from EU Members States and neighbouring countries that is of relevance to EU policies and stakeholders. ESDAC covers the complete data production cycle, from raw data collection to the final integrated assessment of European soil resources. The EU Soil Portal, which forms part of ESDAC, is a major website that includes references to soil data and information from all over the world.



Soil is a living system

The IES manages the European Soil Bureau Network (ESBN) (see also page 71) a network of "Centres of Excellence" which is made up of national soil surveyors and national soil science institutions from all EU countries. Its main tasks are to contribute to the collection, harmonisation, organisation and distribution of European soil. The IES is developing similar networks in Africa and Latin America (the African and Latin American Soil Bureau Networks respectively).

The soil activities of the IES are also integrated within the GlobalSoilMap.net consortium, which aims to make a new digital soil map of the world using state-of-the-art technologies for fine resolution soil mapping and predicting soil properties. The IES is the GlobalSoilMap.net Node leader for Europe and Eurasia.

Did you know that soils contain the single biggest terrestrial carbon pool, storing more than 1500 Gt of carbon globally?

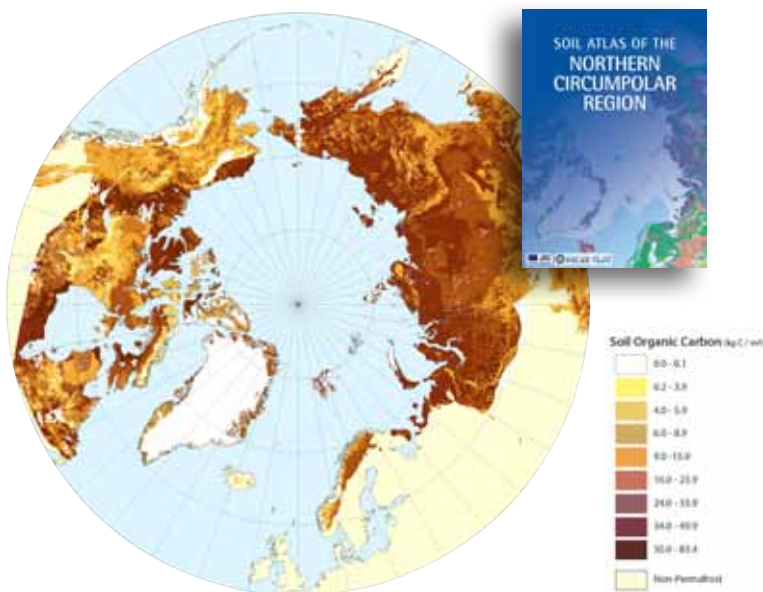
Results achieved

- The IES developed the operational European Soil Data Center (ESDAC) in the framework of the Group of Four (DG Environment, Eurostat, the European Environment Agency and the JRC).
- A Soil Atlas of the Northern Circumpolar Region, a unique reference publication for soil resources in the polar region, has been finalised for publication (see *Highlight*).
- The IES became the European Node in the new global soil mapping initiative, GlobalSoilMap.net, launched in February 2009.
- Completion of the largest ever centrally coordinated pan-European soil monitoring exercise in the context of the BioSoil project. On more than 5 000 sites, forest soil was sampled at various depths and full chemical and physical properties were determined and inserted into a geographic database.

HIGHLIGHT

Soil Atlas of the Northern Circumpolar Region

The IES contributes to the four main pillars of the EU Thematic Strategy for Soil Protection, in particular to research and to raising awareness. In this framework, one of the major IES contributions is the publication of a series of soil atlases, starting with the Soil Atlas of Europe in 2005. During 2008-09 a new major atlas, the Soil Atlas of the Northern Circumpolar Region, was finalised, ready for publication in 2010. This major reference work aims to raise the awareness of policy makers and the general public on the importance of northern circumpolar soils, currently under threat from climate change. As a major pool of organic carbon and methane, rapid warming of these soils may lead to massive emissions of carbon dioxide and methane, further exacerbating global climate change.



Map showing the variation in soil organic carbon levels in permafrost-affected ground. The darker colours indicate significant amounts of soil organic carbon. Permanently or seasonally frozen soils in the northern circumpolar region contain approximately 50% of the world's soil carbon stocks.

Challenges ahead

- Repeat the success story of ESDAC in Africa and in Latin America.
- Produce a Soil Atlas of Africa and a Soil Atlas of Latin America.
- Further develop the regional initiative in Asia.
- Achieve a common global soil information system bringing together data and experiences from all countries in the world in a coherent and participatory system through GlobalSoilMap.net.
- Develop the Global Soil Information System (GLOSIS).

Benefit for Europe

ESDAC, as the single point for soil information and data at the European level, provides a unified, quality-controlled platform free of charge to all European citizens. It demonstrates the diversity and variability of soil data and information within EU Member States.

KEY PUBLICATIONS

Bigas H., Gudbrandsson G., Montanarella L., Arnalds A., (eds.) (2009): Soils, Society and Global Change: Proceedings of the International Forum Celebrating the Centenary of the Conservation and Restoration of Soil and Vegetation in Iceland, 31 August-4 September 2007, Selfoss, Iceland. EUR 23784 EN. Office for Official Publications of the European Communities, Luxembourg.

Lacarcé E., Le Bas C., Cousin J., Pesty B., Toutain B., Durrant T., Montanarella L. (2009): Data Management for Monitoring Forest Soils in Europe for the Biosoil Project. *Soil Use and Management* 25 (1): 57-65.

Montanarella L., Carré F., Sanchez P., Ahamed S., Hartemink A., Hempel J., Huising J., Lagacherie P., Mcbratney A., Mckenzie N., Mendonça-Santos M., Minasny B., Okoth P., Palm C., Sachs J., Shepherd K., Vågen T., Vanlauwe B., Walsh M., Winowiecki L., Zhang G. (2009): Digital Soil Map of the World. *Science* 325 (5941): 680-681.

Verheijen F., Jones R., Rickson J., Smith C. (2009): Tolerable Versus Actual Soil Erosion Rates in Europe. *Earth-Science Reviews* 94 (1): 23-38.

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European Soil Bureau Network (ESBN):

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GlobalSoilMap.net consortium:

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International organisations:

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POLICY SUPPORT

Regulation concerning monitoring of forests and environmental interactions in the Community (Forest Focus) – 2152/2003/EC

Communication “Halting the loss of biodiversity by 2010 – and beyond” including biodiversity action plan – COM(2006) 261

EU Forest Action Plan – COM(2006) 302

EU Strategy for Biofuels – COM(2006) 34

EU Biomass Action Plan (BAP) – COM(2005) 628

FAO Forest Resource Assessment Remote Sensing Survey 2010

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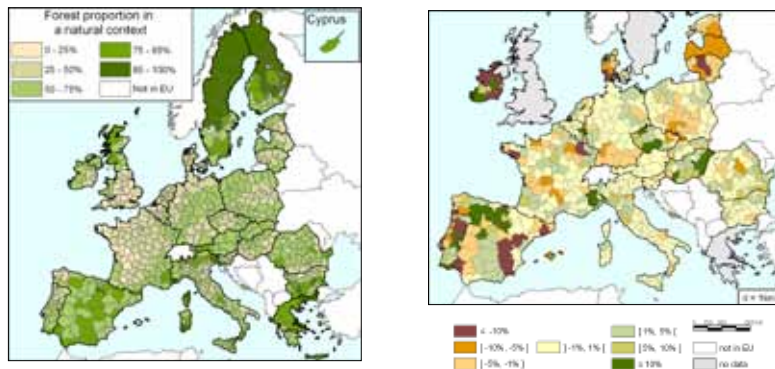
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SEEING THE WOOD FOR THE TREES

Mapping and monitoring European forests

Information concerning the spatial distribution of European forests is needed for forest protection and conservation, forest resource analysis, climate change research and other forest-related applications. Several initiatives have attempted to provide forest maps at different scales, but the disparity in the level of detail and the underlying definition of forests render them unusable for international reporting processes.

The IES develops new methods for consistent and comparable forest monitoring across Europe. It also investigates the characterisation, mapping and reporting on European forest spatial patterns, forest fragmentation and forest connectivity.



EU forest fragmentation and connectivity (Data: CORINE Land Cover 1990-2000; results aggregated per province)

As part of these efforts, the IES is updating the 2006 high-spatial-resolution forest map of Europe, following the production of the European forest maps of 1990 and 2000. These maps will be used for the analysis of forest trends in Europe over the past decades and will provide a major contribution to the Global Forest Resources Assessment Programme coordinated by the FAO (Food and Agriculture Organization of the United Nations). Although overall forest area is increasing when reported at a European level, local forest fragmentation still occurs and connectivity is threatened by building and construction activities. The IES measures how local forest spatial patterns change over time, and how forest fragmentation processes and changes in forest connectivity occur. As part of this endeavour, the IES has carried out a broad scale (25-hectare Mapping Unit) European-wide assessment summarised per province (see figure above).

Did you know that European forest area has increased by over 8 million hectares over the past 20 years?

Results achieved

- Development of methods for remote sensing of forest area and forest type mapping in Europe using high-spatial-resolution satellite imagery (see *Highlight*).
- Development of methods for analyzing forest change in Europe, in the context of the FAO Forest Resource Assessment Remote Sensing Survey 2010.
- Development and improvement of methods for landscape-level spatial pattern analysis.
- Provision of maps and analyses of forest pattern, fragmentation and connectivity through the European Forest Data Centre (EFDAC).
- Provision of a free software package with image viewer and processing routines to analyse shape and connectivity of objects in digital images. For more information, see <http://forest.jrc.ec.europa.eu/download/software/guidos> and the JRC press release on page 73.

HIGHLIGHT

A more detailed look at forests in Europe

Within its forest monitoring activities, the IES is currently working on the first high-resolution forest type map of Europe. This map shows the distribution of deciduous, conifer and mixed forests for the whole of Europe. Achieving this level of thematic detail in forest information at the pan-European scale posed several technical challenges. In order to meet these challenges, the IES developed a new mapping methodology. This methodology built on previous IES mapping experience at the European level and introduced some novel additions: together with the high-spatial-resolution satellite images (25m resolution) used in previous forest maps, the methodology also uses multi-temporal information from time series of satellite images at medium (250m) spatial resolution. This combination of satellite data from diverse sources ensures a robust and accurate final map database.



Snapshots of the forest type map for some test sites. The new forest type mapping methodology aims to provide a high level of thematic detail.

The first prototype has been produced and is in the validation phase. This forest type information will allow a more precise characterisation of European forests and a more detailed analysis of trends in forest patterns.

Challenges ahead

- Move from estimates of forest area in the IES forest map of Europe to estimates of biomass using ancillary information from national forest inventories.
- Further develop the IES forest type map of Europe to give a complete characterisation of forest species distribution in Europe.
- Complete the FAO Forest Resource Assessment Remote Sensing Survey 2010 for the whole of Europe – over 700 sites to be classified for three different dates (1990 / 2000 / 2006).
- Carry out high resolution (1-hectare Mapping Unit) landscape-level spatial pattern analysis.

Benefit for Europe

By monitoring the forests in Europe, the IES contributes to the assessment of the multi-functionality of European forests in order to enhance their sustainable management and the preservation of their functions as water and air filters, biodiversity reservoirs and carbon sinks.

KEY PUBLICATIONS

- Estreguil C., Mouton C. (2009): Measuring and reporting on forest landscape pattern, fragmentation and connectivity in Europe: methods and indicators. EUR 23841 EN. Office for Official Publications of the European Communities, Luxembourg.
- Pekkarinen A., Reithmaier L., Strobl P. (2009): Pan-European forest/non-forest mapping with Landsat ETM+ and CORINE Land Cover 2000 data. *ISPRS Journal of Photogrammetry and Remote Sensing* 64: 171-183.
- Riitters, K.H., Vogt, P., Soille, P., Estreguil, C. (2009): Landscape patterns from mathematical morphology on maps with contagion. *Landscape Ecology* 24: 699-709.
- Soille P, Vogt P. (2009): Morphological segmentation of binary patterns. *Pattern Recognition Letters* 30: 456-459.
- Vogt P., Ferrari J.R., Lookingbill T.R., Gardner R.H., Riitters K.H., Ostapowicz K. (2009): Mapping Functional Connectivity. *Ecological Indicators* 9: 64-71.
- Ostapowicz K., Vogt, P., Riitters, K.H., Kozak, J., Estreguil, C. (2008): Impact of scale on morphological spatial pattern of forest. *Landscape Ecology* 23: 1107-1117.

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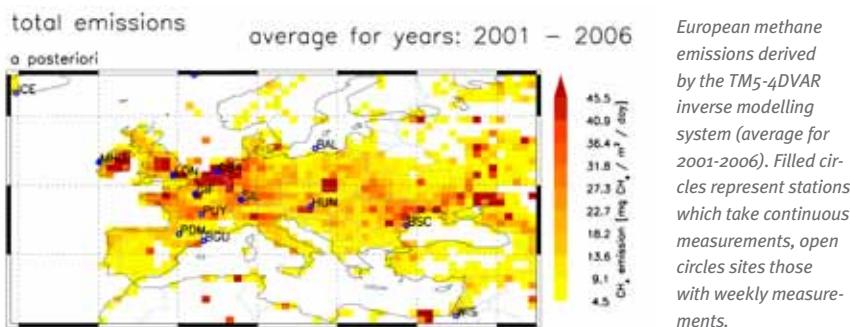
POLICY SUPPORT

United Nations Framework Convention on
Climate Change (UNFCCC)
Kyoto Protocol

GREENHOUSE GAS INVENTORIES

Atmospheric monitoring and inverse modelling

Atmospheric measurements combined with inverse atmospheric models can provide independent top-down estimates of greenhouse gas (GHG) emissions, tracing back the observed atmospheric GHG concentrations to the origin of the emissions. This technique can be used to check consistency with emission estimates based on bottom-up inventories, such as the national GHG emissions reported to the United Nations Framework Convention on Climate Change (UNFCCC). This is important in particular for the non-CO₂* GHGs, such as CH₄* or N₂O*, for which considerable uncertainties still exist, while bottom-up estimates of CO₂ emissions are generally assumed to be relatively accurate. The IES developed a sophisticated inverse modelling system (TM5-4DVAR)



for atmospheric CH₄ and N₂O, based on a global 3-D atmospheric transport model. Atmospheric observations from monitoring stations are assimilated by the inverse model, which optimises the emissions applied in the model until an optimal agreement between simulated and observed concentrations is achieved.

Significant information about emission estimates is provided by regional monitoring stations, such as the one recently installed at the IES site (see *Highlight*), which continuously measure atmospheric GHG concentrations. Global remote monitoring stations provide accurate measurements of the atmospheric background. In addition to surface measurements, atmospheric CH₄ can also be monitored by satellites (such as the SCIAMACHY instrument onboard the European Environment Research Satellite ENVISAT) which provide important complementary global information (particularly useful for tropical regions which are poorly monitored by surface observations).

Did you know that current atmospheric CH₄ concentrations are about 2.5 times higher than pre-industrial levels? Anthropogenic CH₄ emissions come mainly from agriculture (ruminants, rice cultivation), landfills, coal mining, and oil and gas production.

Results achieved

- CH₄ emissions for the period 2001-06 have been estimated for Europe.
- With the existing monitoring stations, top-down estimates calculated by the IES are relatively robust for northwest Europe. They are somewhat higher than the values reported by the parties of the UNFCCC, but are still consistent within the estimated uncertainties of 30% for both bottom-up and top-down approaches.



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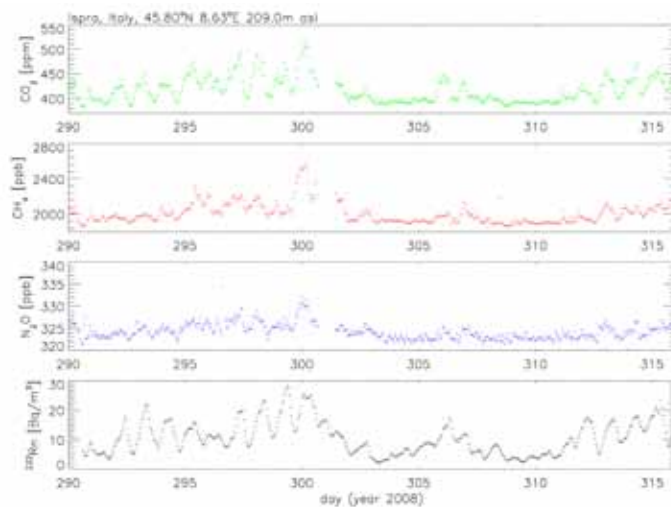
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HIGHLIGHT

The Ispra site GHG monitoring station

In 2007, the IES set up a monitoring station on its site in Ispra for continuous high-accuracy measurements of CO₂, CH₄, N₂O, and SF₆*. This station is an important complement to the European monitoring network, which is still very sparse in southern Europe. It provides information on emissions mainly from the Po valley area in northern Italy.

Besides the use of these measurements for inverse modelling, parallel Radon (²²²Rn) measurements allow for model-independent estimates of regional GHG emissions. ²²²Rn is a good tracer for atmospheric transport (especially vertical mixing), since it is relatively homogeneously emitted by soils and has a short lifetime of 3.8 days (²²²Rn tracer method).



Snapshots of the forest type map for some test sites. The new forest type mapping methodology aims to provide a high level of thematic detail.

The station has been included in the WMO (World Meteorological Organization) 2009-2011 world intercomparison exercise for GHGs (CO₂, CH₄, CO*, N₂O, SF₆). The IES GHG monitoring station contributes to the WMO/GAW (Global Atmospheric Watch) network (of 44 GHG monitoring laboratories worldwide). The latter provides high quality atmospheric GHG measurements to the global GHG modelling community.

Challenges ahead

- Establish an operational European network to ensure the availability of long-term, high-quality atmospheric measurements (as proposed by the European Integrated Carbon Observation System (ICOS) project).
- Improve global monitoring of GHG concentrations from space.
- Improve the quantification of overall uncertainties and the intercomparison of inverse models.

Benefit for Europe

Due to the large uncertainties of bottom-up emission estimates (especially for CH₄ and N₂O), independent verification is essential. Furthermore, atmospheric measurements and inverse modelling are important for monitoring the natural GHG sources and their potential feedback to climate change.

KEY PUBLICATIONS

Bergamaschi, P., Meirink J. F., Krol M., Villani M.G., Dentener F., Schmidt M., Ramonet M., Meinhardt F., Vermeulen A., Fisher R., Nisbet E., Aalto T., Dlugokencky E. (2009): Improved European CH₄ top-down estimates based on the TM5-4DVAR inverse modelling system, Fifth International Symposium on Non-CO₂ Greenhouse Gases, Wageningen, The Netherlands, 30 June-3 July 2009.

Bergamaschi, P., Frankenberg C., Meirink J. F., Krol M., Villani M. G., Houweling S., Dentener F., Dlugokencky E. J., Miller J. B., Gatti L.V., Engel A., Levin I. (2009): Inverse modelling of global and regional CH₄ emissions using SCIAMACHY satellite retrievals. *Journal of Geophysical Research* 114, doi:10.1029/2009JDO12287.

Meirink, J. F., Bergamaschi P., Krol M. (2008): Four-dimensional variational data assimilation for inverse modelling of atmospheric methane emissions: Method and comparison with synthesis inversion. *Atmospheric Chemistry and Physics* 8: 6341–6353.

Scheeren H.A., Bergamaschi P., Seufert G., Raes F. (2009): Set-up of a new continuous greenhouse gas monitoring station for CO₂, CH₄, N₂O, SF₆ and CO in Northern Italy. In: Tuomas Laurila (ed.), Report of the 14th WMO/IAEA Meeting of Experts on Carbon Dioxide, Other Greenhouse Gases and Related Tracers Measurement Techniques, Helsinki, Finland 10-13 September 2007. WMO GAW Report No. 186: 108-111.

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* Chemical formulae: ²²²Rn: Radon; CH₄: Methane; CO: Carbon Monoxide; CO₂: Carbon dioxide; N₂O: Nitrous oxide; SF₆: Sulfur hexafluoride

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European Monitoring and Evaluation Programme (EMEP)
United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (CLRTAP)
World Meteorological Organization (WMO)

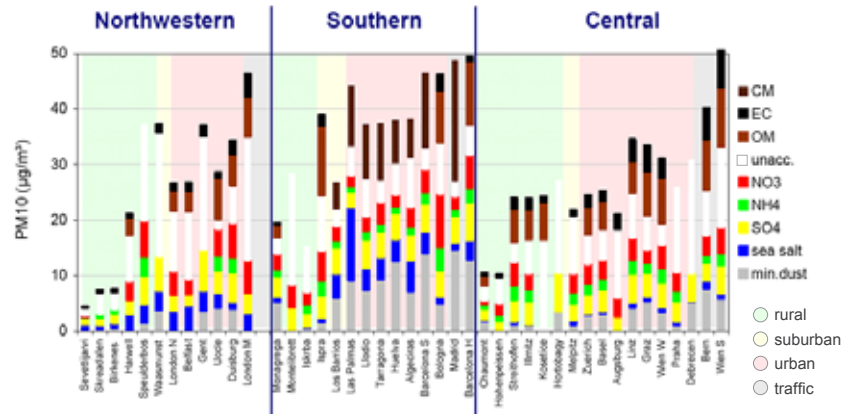
POLICY SUPPORT

Directive on ambient air quality and cleaner air for Europe – 2008/50/EC
Directive on national emission ceilings for acidifying and ozone-forming air pollutants – 2001/81/EC
Directive relating to a reduction in the sulphur content of certain liquid fuels – 1999/32/EC
UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP) – Revision of the Gothenburg protocol

GOOD ATMOSPHERE?

Improving our knowledge about atmospheric particles

Atmospheric particles – also known as aerosols or particulate matter – are prominent climate actors: they reflect solar radiation and modify cloud brightness and the probability of precipitation. Air particulate pollution also has adverse impacts on health, ecosystems and cultural heritage. These effects are not only linked to mass concentrations of particulate matter (PM₁₀, PM_{2.5}), but also to more specific physical and chemical properties.



Annual average PM₁₀ mass concentration and chemical composition at 43 rural, suburban, urban and traffic sites in northwestern, southern and central Europe, showing regional variations under different local conditions across Europe (CM = carbonaceous matter = EC + OM, EC = elemental carbon, OM = organic matter, unacc. = unaccounted mass, min.dust = mineral dust).

The IES researches these fundamental characteristics in order to assess the current and likely future impact of climate and air pollution policies on global warming, ecosystems and human health. The research activities include detailed atmospheric measurements, critical assessment of existing data, and modelling at the local, regional, continental and global scales. For example, while mass concentrations of particulate matter are measured locally by air monitoring networks across Europe, the European aerosol data analysis carried out by the IES gives an overview of the similarities and differences in atmospheric particle number, size, and chemical composition across the whole of Europe.

Did you know that black carbon is one of the top three climate warming agents, alongside carbon dioxide (CO₂) and methane (CH₄)?

Results achieved

- Two years of quality controlled advanced aerosol characterisation data collected at the JRC-EMEP (European Monitoring and Evaluation Programme) super-station in Ispra.
- Compilation, analysis and harmonisation of a European database of advanced aerosol properties, obtained independently of regulatory monitoring networks.
- Three annual intercomparisons for carbonaceous aerosol involving 12 to 20 regional background monitoring stations across Europe.
- A standard method developed at the IES for measuring carbonaceous aerosol was adopted by EMEP (see *Highlight*).
- Editing and publication of answers to policy-related questions regarding the upcoming revision of the Gothenburg Protocol on atmospheric pollutants ('Answers to the Gothenburg Questions', see *Key publications*).
- A global analysis of the impact of ozone on agricultural crop yields.
- Development and application of the inverse modelling technique for the reconstruction of European and global methane (CH₄) emission inventories.

IES STAFF MEMBER



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HIGHLIGHT

Black Carbon: You can't manage what you don't measure

Black carbon is particulate matter (PM) which is ubiquitous in Europe's atmosphere, from southern Spain to northern Finland. It results from the incomplete combustion of biomass and fossil fuels. Unlike most other PM constituents (which tend to reflect light from the sun back into space), black carbon acts as a climate warming agent (see also page 56). Furthermore, it is probably more dangerous to health than the more abundant PM components such as sulfate, nitrate and ammonium.



A sampling device developed and validated by the IES in Ispra for measuring carbonaceous aerosols.

A standard measurement protocol is a prerequisite for a better understanding of the environmental impacts of particulate black carbon. The IES, in collaboration with 21 partners from 16 countries across Europe, has developed a method which minimises the biases that usually affect carbonaceous aerosol measurements. This method is being applied at regional background stations of the EMEP network, which monitors background air pollution across Europe, and underpins the United Nations Convention on Long-range Transboundary Air Pollution (CLRTAP). It is being considered by the European Committee for Standardisation (CEN) as a possible reference method in Europe.

Challenges ahead

- Assess the interaction between air pollution and greenhouse gas emissions on the one hand, and the uptake by vegetation of CO₂ and air pollutants on the other.
- Monitor the efficiency of policies that target the reduction of particulate matter (PM).
- Calculate the current effect of aerosols on climate using detailed measurements and local scale modelling, and improve confidence in 3-D global climate modelling.
- Integrate remote sensing and ground-based measurements in order to obtain robust information on the effect of pollution on cloud albedo.
- Evaluate the synergies of climate policies and air quality legislation in Europe and the rest of the world for the coming decades.

Benefit for Europe

The concentration and composition of aerosols will continue to evolve in Europe and worldwide over the next decade. A more profound knowledge of aerosols' features allows us to anticipate the pros and cons of future climate change and air pollution policies.

KEY PUBLICATIONS

- Cavalli F., Viana M., Yttri K. E., Genberg J., Putaud J.-P. (2009): Toward a standardised thermal-optical protocol for measuring atmospheric organic and elemental carbon: the EUSAAR protocol. *Atmospheric Measurement Techniques Discussions* 2: 2321-2345.
- Hjorth J., Raes F. (2009): Answers to the Gothenburg Questions. ACCENTS Second Policy-driven Synthesis, ACCENT Project Office, ISBN 978-92-79-1344-9.
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- Kloster S., Dentener F., Feichter H., Raes F., Van Aardenne J., Roeckner E., Lohmann U., Stier P., Swart R. (2008): Influence of Future Air Pollution Mitigation Strategies on Total Aerosol Radiative Forcing. *Atmospheric Chemistry and Physics* 8: 6405-6437.

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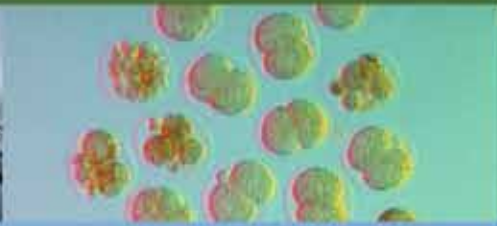
Sebastião Martins dos Santos

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Rita Van Dingenen

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Environment and Security

“We need to set out now the world we want for our children in 2050. The world population is projected to reach 9 billion people. If you add to this the impact of wealthier emerging economies we must radically change our production and consumption patterns if we want our planet to remain a good place to live in.”

JANEZ POTOČNIK

European Commissioner for Science and Research, 2004-2009



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<http://rem.jrc.ec.europa.eu/>

EUropean Community Urgent Radiological Information Exchange (ECURIE)

<http://rem.jrc.ec.europa.eu/40.html>

European Radiological Data Exchange Platform (EURDEP)

<http://eurdep.jrc.ec.europa.eu/>

ENSEMBLE Project

<http://ensemble.jrc.ec.europa.eu/>

European Forum on Radon Mapping

<http://radonmapping.jrc.ec.europa.eu/>

CUSTOMERS

DG Energy

Competent Authorities of the EU Member States and Candidate Countries

International Atomic Energy Agency (IAEA)

National meteorological and Emergency Centres

POLICY SUPPORT

Euratom Treaty, Art. 35-36

Council Directive 96/29/EURATOM laying down the basic safety standards for health protection of workers and the general public against the dangers arising from ionizing radiation

Council Decision 87/600/EURATOM on Community arrangements for the early exchange of information in the event of a radiological emergency

Commission Recommendation 2000/473/EURATOM on the application of Article 36

REM

Monitoring radioactivity in Europe's environment

The Radioactivity Environmental Monitoring (REM) Action of the IES provides the European Commission with qualified information on levels of radioactive contamination of the various compartments of the environment (air, water, soil). Its main responsibilities include:

- Improving procedures for, and collection, evaluation and harmonisation of data on radioactivity (through the REM database and EURDEP, the European Radiological Data Exchange Platform);
- Modelling the dispersion of radioactivity (using ENSEMBLE, a system which reconciles disparate national forecasts of medium- and long-range atmospheric dispersion);
- Developing an early notification system (ECURIE – European Community Urgent Radiological Information Exchange) that will alert national authorities in the case of radiological emergencies and that is compatible with the early notification system of the International Atomic Energy Agency (IAEA);
- Collecting, verifying and storing the radiological measurements of some 4 400 stations in 33 European countries in almost real time (EURDEP).



Screenprint of the latest beta-release EURDEP Map

EURDEP has become the standard in Europe for the exchange of automatic radiological monitoring data in the context of emergency preparedness. It is used in 33 countries for international, bi-lateral and national data-exchange. The entire system is likely to be used in the future by the IAEA. Intense collaboration of the IES and EU Member States with the

IAEA has resulted in the development of commonly agreed standards as set out in IRIX – the International Radiation Information eXchange. These will be implemented in the IAEA and European Commission's information and data-exchange systems, allowing EU Member States to fulfil their legal obligations to both the IAEA and the European Commission through a single system. The IES is developing a new version of its early notification system (Web ECURIE) that implements these IRIX standards.

Did you know that everyone can check the radiation level anywhere in Europe through the EURDEP website?

Results achieved

- A first prototype of the new EU early notification website (Web ECURIE) which is compatible with the internationally agreed IRIX standards.
- A first prototype of the new EURDEP website, which is much faster, has many new features and can be extended to apply filters in order to facilitate a better comparison of measurements from different networks.
- The ENSEMBLE system has been developed by the IES to operate globally at any scale. Its application has been extended to include the evaluation of air quality models applied to other air pollution incidents in Europe (see *Highlight*).
- The REM database has been further improved to accelerate its handling and reporting of environmental data.
- The mapping of indoor radon in view of preparing a European Atlas on Natural Radiation – data from 16 countries has been recorded to date.

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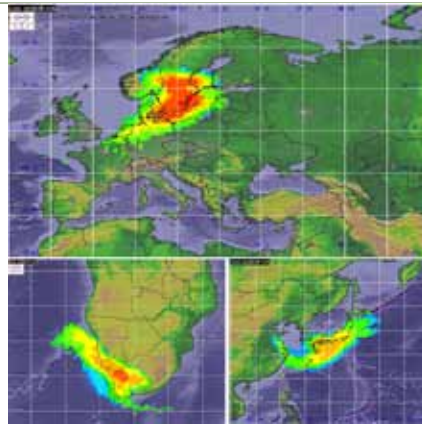


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HIGHLIGHT

ENSEMBLE dispersion

In order to deal with nuclear emergencies, the IES tries to anticipate the future developments of a situation by using models, usually computational models that include all the known physics relevant to the situation. In the case of a release to the atmosphere of a radioactive gas, an ‘atmospheric dispersion model’, coupled with weather prediction data, is used to anticipate the rate and amount of dispersion of the released substance. Decisions can then be made on whether and how to protect the population. However, model predictions are not always precise, and different models can lead to different results, as they tend to emphasise different aspects of the physics that govern the process. A technique has been developed within the IES that uses these discrepancies to produce a composite picture that statistically better represents reality. This is done by combining the predictions of several models. This is the concept on which the ENSEMBLE system has been developed.



Examples of ENSEMBLE model predictions of radioactivity distribution under fictitious radioactivity release scenarios in different parts of the world (top: Europe; bottom left: South Africa; bottom right: East Asia). The intensity of radioactivity is represented from red (high) to blue (low).

Originating from research addressing the needs of nuclear emergencies, the IES’ ENSEMBLE concept can also be applied to any other suite of models, for example, in air quality. The paper “Est Modus in Rebus” (see *Key publications*) is a first attempt to define a theoretical framework for the definition of an ‘ensemble’ of models’ results. The devised technique allows the *a priori* definition of the characteristics of an ensemble and provides clear definitions of assumptions widely used in the atmospheric dispersion and air quality community, but never before specified. The ultimate aim is to reach an optimal composite representation with the minimum effort.

Challenges ahead

- Develop the current prototype websites into reliable and operative early notification and data-exchange systems.
- Make EURDEP compatible with the new IRIX standards.
- Further develop and test the ENSEMBLE system by using model inter-comparisons and participating in international emergency exercises.
- Finalise the European Atlas on Natural Radiation.
- Explore the feasibility of a geogenic (soil-based) radon map of Europe to complement the indoor radon measurements already collected for the European Atlas on Natural Radiation.

Benefit for Europe

The IES collects, compares and evaluates the environmental radioactivity data submitted by the Member States for normal and emergency situations all over Europe to provide transparent information to a wide community.

KEY PUBLICATIONS

- Galmarini S., Vinuesa J.F. (2009): Radon a Natural Tracer for Boundary Layer Studies. Large-eddy Simulation and Data Analysis in Proceedings of the 30th NATO/SPS International Technical Meeting on Air Pollution Modelling and its Application, San Francisco, USA, 18-22 May 2009.
- De Cort M., Tollefsen, A., Marsano T., Gitzinger C. (2009): Monitoring Report 2004 – 2006. EUR 23950 EN. Office for Official Publications of the European Communities, Luxembourg.
- Bossep P. (2009): Uncertainty of Block Estimates introduced by Mis-allocation of Point Samples; on the Example of Spatial Indoor Radon Data. *Journal of Environmental Radioactivity* 100 (3): 274-279.
- Potempski S., Galmarini S. (2009): Est Modus in Rebus: Analytical properties of Multi-Model Ensembles. *Atmospheric Chemistry and Physics* 9 (24): 9471-9489.
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DG Environment
DG Health and Consumer Protection
European Environment Agency (EEA)
Organisation for Economic Cooperation and Development (OECD)
World Health Organization (WHO)

POLICY SUPPORT

European Environment and Health Strategy – COM(2003) 338
European Environment and Health Action Plan 2004-2010 – COM(2004) 416
The European Environment Council (Conclusions on Environment and Health from the 284th meeting on 20 December 2007)

A GOOD LIFE IN A HEALTHY ENVIRONMENT

Environmental quality, human health and well-being

Our life, health and well-being is very much determined by the environment in which we live. Access to pristine environments, green areas and a rich biodiversity promotes good health, well-being and social harmony. Urbanisation, industrial activities and intense agricultural practices have led to environmental degradation which also has a detrimental effect on human health. The IES analyses the relationships between human health and the environment and compiles information on how factors such as air pollution, chemicals in the environment or exposure to electromagnetic fields (mobile phones, electrical power lines) affect our health and well-being. This work is carried in collaboration with the European Environmental Agency and the World Health Organization, with the aim of supporting Europe and the Member States in making environmental and human health policies.



Nature – a source of rest, reflection and tranquility

More and more medical evidence shows that access to nature and natural environments improves human health and well-being, prevents disease and helps people to recover from illness and stress-related disease.

Results achieved

- The CEHIS (Connectivity between Environment and Health Information Systems) project showed the way forward on how to integrate dynamic environmental and human health data flows into a uniform system.
- Contributed to the 'Report on the Status of Health in the European Union', the final deliverable of the EU Public Health Programme Project (EU-GLOREH), with chapters on 'Exposure' and 'Physical Environment Determinants'.
- Organised a session on the "Environmental Benefits of Nanotechnologies" for an OECD workshop which concluded that nanotechnologies can be used for efficient water purification.
- Organised a workshop together with the European Environment Agency at the 2nd European Conference on Public Health in Lodz. The workshop concluded that the importance of green environments for human health and well-being has been neglected by public health professionals.
- Organised a workshop with the European Centre for Disease Control and Prevention and the European Environment Agency, which reported that Climate change in combination with ecosystem changes could have important consequences for the dynamics of infectious diseases.



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HIGHLIGHT

CEHIS - Bringing human health and environment together

There is a lot of information available on human health in Europe today from various sources such as research results, epidemiological studies and registries. The European environment is also well monitored with a wealth of information available on air quality, water quality, soil contamination and chemicals, to mention but a few. An easily accessible Environment and Health Information System is needed to bring all this information together.



The IES brings environmental and health information together through the CEHIS project

Identification of the negative effects that some environmental factors have on health, such as smoking, asbestos and lead, has resulted in environment and public health authorities taking measures to alleviate these factors. The systems put in place by these authorities show how such combined environment and health information systems can help to identify actual or potential health threats and target interventions where they are most needed. Designing such a system requires that users and providers first agree on standards for

how to collect and register data. This calls for the definition of data architectures and terms, common systems of classification, compatible reporting protocols and other technical specifications that allow different systems to be compared and linked. The IES has recently finalised the CEHIS project (Connectivity between Environment and Health Information Systems) which identifies components to be included in an environment and health information system, where research needs to be carried out, and how to optimise the use of modern informatics. CEHIS explores how spatial data collected under the INSPIRE Directive can be introduced, and proposes data collection based on INSPIRE principles (*see page 8*). Important points raised by the project concern the ethical issues involved and how they should be addressed.

Challenges ahead

- Evaluate the importance of green, biodiverse and pristine environments for human health and well-being.
- Assess the impacts and consequences of climate change on human health, well-being and social security.
- Develop the application of new technologies (nanotechnology) to reduce environmental pollution and associated health risks.
- Develop realistic health impact assessment models and tools.

Benefit for Europe

An Environment and Health Information System will assist in reducing the environmental burden of disease and will promote good health and well-being.

KEY PUBLICATIONS

- Boulanger P., Nowack B., Scheinost A.C., Wahner A., Ammann M., Charlet L., Dillmann P., Gin S., Lieven T., Morrison M., Nenner I., Rickerby D., Worsnop D.R., Zanotti J.M. (2009): Specific Challenges in Nanomaterials Technologies: Environment. GENESYS White Paper (eds. Dosch H., Van de Voorde M.H.) Max Planck Institute, Stuttgart: 219-238, ISBN 978-3-00-027338-4.
- Rickerby D. (2009): Potential Application of Biosensor Networks for Monitoring Aquatic Systems in Support of the Water Framework Directive. *Bollettino di Geofisica Teorica ed Applicata* 50, 341-360.
- Rickerby D. (2009): Nanotechnological Solutions for Monitoring and Treatment of Drinking Water and Groundwater. In Conference Proceedings: Proceedings of the International Conference on the Environmental Implications and Applications of Nanotechnology. Amherst (United States of America): The Environmental Institute: 81-84. The full proceedings can be downloaded from: <http://scholarworks.umass.edu/tei/2/>
- Skouloudis A. (Guest Editor) (2009): Special issue: The tenth European conference on harmonization within atmospheric dispersion modelling for regulatory purposes. *International Journal of Environment and Pollution*, Vol. 40, Nos 1/2/3.

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AQUILA Project
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ERLAP server for downloading reports and publications
ftp://ftp_erlap_ro:3rlapsyst3m@ipscftp.jrc.it/erlap/ERLAPDownload.htm

CUSTOMERS

DG Environment
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POLICY SUPPORT

“4th Daughter Directive”: relating to arsenic, nickel, cadmium, mercury and polycyclic aromatic hydrocarbons in ambient air – 2004/107/EC

Directive of the European Parliament and of the Council on ambient air quality and cleaner air for Europe – 2008/50/EC

Clean Air For Europe (CAFE) Strategy
European Environment and Health Strategy – COM(2003) 338

CATCH YOUR BREATH!

A better understanding of air pollution and its sources

The European Reference Laboratory for Air Pollution (ERLAP) of the Joint Research Centre was established nearly 15 years ago. As a reference centre for monitoring and measuring air quality it has contributed considerably to the harmonisation of air pollution measurements and the correct implementation of air quality legislation in Europe. ERLAP has also been very active in training new EU Member States, and Accession and Associated Countries. Intercomparison exercises are regularly carried out for gaseous air pollutants at the ERLAP facility. These exercises test the proficiency of the participants and offer a forum for quality improvement and knowledge exchange. To compare the quality of particle measurements, the ERLAP mobile laboratory audits monitoring stations in the EU Member States. Source apportionment methods (which link the pollutant to a specific source) are being developed and tested in order to find the most significant sources of pollution and to support abatement strategies.



The ERLAP mobile laboratory auditing a monitoring station in Hungary (2009)

Together with the JRC's Institute for Reference Materials and Measurements (IRMM), the IES is developing reference materials for hazardous constituents of particles in ambient air. New measurement methods and sensors are being developed, tested and validated in order to improve measurement capabilities in the EU and to address new challenges in the assessment of air pollution.

Research shows that pollution from fine particles is especially harmful to human health, and that the air pollutant 'ozone' causes breathing problems and significant reductions in crop growth.

Results achieved

- A new method for measuring polycyclic aromatic hydrocarbons (PAH) has been developed and validated, allowing for shorter sampling times and less use of organic solvents in sample preparation.
- New air pollution sensors have been validated: the benefits and limitations of using electrochemical or semi-conductor-based sensors in air pollution assessment have been evaluated for the air pollutant ozone.
- A novel approach to source apportionment has been developed, linking concentrations of certain PAH to source markers.



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HIGHLIGHT

Remote measurements of ship emissions

Ships are major emitters of air pollutants such as sulphur dioxide (SO₂) and nitrogen oxides (NO_x). It has been estimated that, if no further policies are implemented, emissions of SO₂ and NO_x in sea areas will be as large as all emissions from land-based sources in the EU by 2020. On special request by the European Commissions' DG Environment, the IES is screening potential remote sensing techniques for the detection of SO₂ in ships' exhaust gas plumes. An assessment system is being developed that can be routinely used by regulatory authorities in the Member States as a means of identifying major polluting vessels, thereby increasing the effectiveness of state port controls. In order to screen the performance of existing and new measurement methods, the IES organised a comparative measurement campaign which was performed in Rotterdam in autumn 2009. Remote cameras,



ERLAP mobile laboratory measuring ship emissions from the shore (left) and from a helicopter (right)

laser-based-, absorption-spectrometric and air quality monitoring instrumentation were tested. Measurements were performed from the shore, from boats and from a helicopter. The outcome of the project will help to improve our knowledge about emissions from marine traffic and its contribution to air quality. This will also help to control the proper implementation of legislative requirements on using cleaner fuels in shipping.

Challenges ahead

- Develop, test and validate new sensors for possible use in air quality monitoring, in order to help develop new monitoring strategies.
- Investigate the importance of indoor and workplace air in human exposure assessment.
- Bring the measurement and modelling communities together to better understand the health effects of human exposure to air pollution.
- Improve our understanding of the effects of air pollution on crop growth (especially important as security of food supply becomes a global issue).
- Estimate the impact of ozone on forests' ability to absorb CO₂ as a means of assessing whether our climate calculations are on the right track.

Benefit for Europe

The IES' research activities help understand the sources and processes of air pollution and thus allow for the development of effective abatement strategies. The comparability of air quality data has considerably improved since EU air quality directives and the related JRC harmonisation programmes and exercises for air pollutant measurements were introduced.

KEY PUBLICATIONS

Buzica D., Gerboles M., Plaisance H. (2009): The equivalence of diffusive samplers to reference methods for monitoring O₃, benzene and NO₂ in ambient air. *Journal of Environmental Monitoring* 10: 1052 – 1059.

Gerboles M., Buzica D. (2009): Evaluation of Micro-Sensors to monitor Ozone in Ambient Air. EUR 23676 EN. Office for Official Publications of the European Communities, Luxembourg.

Van Drooge B. L., Nikolova I., Pérez Ballesta P. (2009): Thermal desorption gas chromatography-mass spectrometry as an enhanced method for the quantification of polycyclic aromatic hydrocarbons from ambient air particulate matter. *Journal of Chromatography A* 1216 (18): 4030-4039.

Van Drooge B. L., Perez Ballesta P. (2009): Seasonal and Daily Source Apportionment of Polycyclic Aromatic Hydrocarbon Concentrations in PM₁₀ in a Semirural European Area. *Environmental Science & Technology* 43, 7310-7316.

Pérez Ballesta P., Field R. A., Fernández-Patier R., Galán Madruga D., Connolly R., Baeza Caracena A., De Saeger E. (2008): An approach for the evaluation of exposure patterns of urban populations to air pollution. *Atmospheric Environment* 42 (21): 5350-5364.

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FAIRMODE

Forum for Air Quality Modelling in Europe

<http://fairmode.ew.eea.europa.eu/>

TFEIP Expert Panel on Transport

<http://transportpanel.jrc.ec.europa.eu/>

CUSTOMERS

DG Environment

DG Research

DG Transport and Energy

European Environment Agency (EEA)

European Aviation Safety Agency (EASA)

Member States' emissions and air quality experts

United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (CLRTAP)

POLICY SUPPORT

Air Quality Directive – 2008/50/EC

National Emission Ceilings Directive – 2001/81/EC

EU Emission Trading Scheme for Aviation – Directive 2008/101/EC

European Commissions Thematic Strategy on Air Pollution – COM(2005) 446

Sixth Community Environment Action Programme

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CAN WE MODEL WHAT WE MEASURE?

Modelling the future of air quality and transport

Air quality modelling is used to assess existing air pollution and forecast the impact of future decisions and legislation. However, although great improvements have been made in the past years, models still cannot replicate air quality measurements. In order for policy makers to trust the results of models, a European quality assessment programme and comprehensive guidance on the use of models have to be put in place. The IES has been working towards this for several years, organising a variety of European and international model intercomparison exercises (CITY-DELTA, EURODELTA, POMI, ENSEMBLE, AQMEII, FAIRMODE) for both scientific and legislative purposes.

Transport produces significant environmental pressures, particularly at the local level (cities, ports, airports), and is one of the major contributors to climate change. Accurate and reliable emission inventories from transport are the best way to assess the impact of the various transport modes and technologies. The new ERMES (European Research on Mobile Emission Sources) group, led by the IES, is working on improving transport emission models and will coordinate the relevant research in Europe in the coming years.



The Po-Valley in the North of Italy has been selected for the POMI modelling intercomparison study as one of the most polluted areas in Europe.

Did you know that CO₂ from road transport in the EU-15 increased by 21% between the years 1990 and 2008?

Results achieved

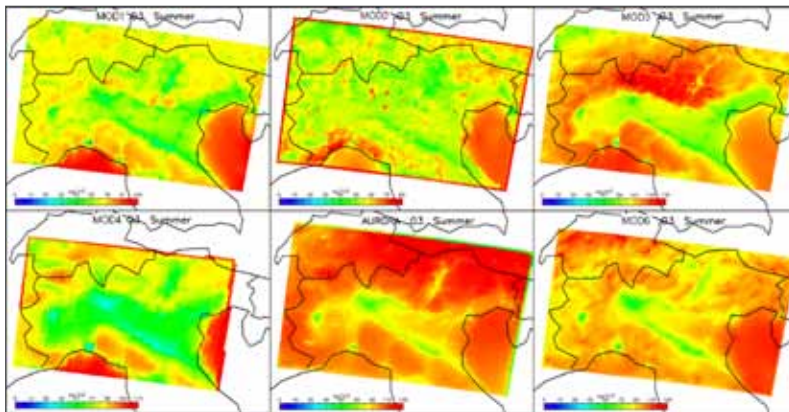
- Compilation of local emission inventories and measurement datasets to produce a common basis for performing an air quality modelling intercomparison (POMI – Po Valley Modelling Intercomparison) exercise at the regional level with the participation of major modelling teams in Europe (<http://aqm.jrc.it/POMI/>).
- The EURODELTA project (a model intercomparison exercise in support of integrated assessment modelling) contributed to the assessment of uncertainties in regional scale modelling and highlighted the importance of taking a sectoral approach within integrated assessment modelling.
- The spatial variability of emissions within a computational grid cell of air quality models can be very high. The IES developed new ways of incorporating this level of complexity in models of highly urbanised areas where this can have large implications on population exposure.
- New research at the IES showed that using Portable Emission Measurement Systems (PEMS) for measuring emissions from vehicles while travelling on the road can be useful in validating and improving emission models (see also page 10).

HIGHLIGHT



The Air Quality Model Evaluation International Initiative

The Air Quality Model Evaluation International Initiative (AQMEII) was launched in 2008 to bring together North American and European regional-scale modelling experts on the issue of model validation. It is led by the IES, Environment-Canada and the US Environment Protection Agency. In 2009, AQMEII organised a very successful international workshop, hosted by the IES, where common categories in air quality evaluation practices, missing aspects and guidelines for future research and community activities were identified by an international community of experts. Common practical activities that should involve the two (European and North American) communities are organised for 2010 and a science plan including the most important open issues has been drafted. AQMEII has also been proposed as one of the leading activities in air quality in the Global Earth Observation System of the Systems (GEOSS).



Ozone concentrations during the summer as predicted by 6 different air quality models. This is an example of disparities in model predictions, highlighting the need for intercomparison exercises and standardisation.

Challenges ahead

- Link the available air quality models in an integrated platform to assess the impact of transport and air quality policies in Europe.
- Ensure that models are reliable enough to be used in checking compliance with the Air Quality Directive and also provide robust air quality forecasts (long-term and short-term).
- Improve the quality and quantity of the air quality measurements datasets used for the validation of air quality models.
- Improve the completeness, accuracy, and spatial and temporal resolution of emission inventories used in air quality models.
- Assess the environmental impact of innovative transport technologies and eco-innovations.
- Improve our understanding of the traffic situation and its impact on emissions, and apply more sophisticated transport emission models for calculating local and regional emission inventories.

Benefit for Europe

Models for air quality can support or complement actual measurements, and are the only tools available to help understand the likely impact of policies related to the air we breathe. They are also crucial in identifying the best strategy for improving air quality.

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European Flood Alert System
<http://efas-is.jrc.ec.europa.eu>

EU FLOOD GIS Metadata Catalogue
<http://eufloodgis-catalogue.jrc.it>

MOLAND
<http://moland.jrc.ec.europa.eu>

CUSTOMERS

DG Enterprise and Industry

DG Environment Civil Protection MIC

DG Environment Water Unit

DG Regional policy

European Environment Agency (EEA)

International River Basin Commissions (IKSO/ICPOR (Oder), IKSE/ICPER (Elbe), IKSD/ICPDR (Danube))

National and regional hydrological and meteorological services

POLICY SUPPORT

Directive on Flood Risk Management

EU Action Plan related to disaster and crisis management, including the Civil Protection Mechanism (MIC)

EU Climate Change Policy including Adaptation

Global Monitoring for Environment and Security (GMES)

EU Regional Policies (including the European Solidarity Fund – EUSF)

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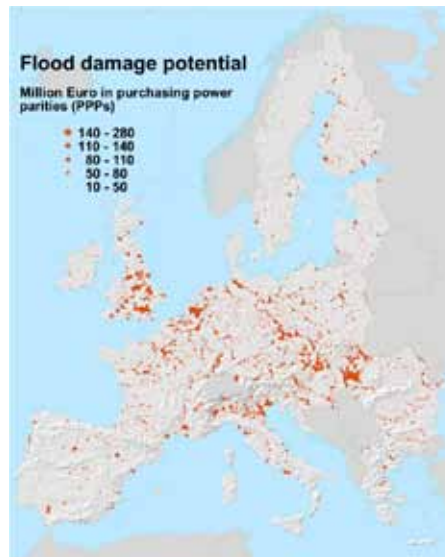


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SWAMPED UNDER

Floods and flood risk in Europe

Recent local and transnational flood disasters, as well as the possible impacts of climate change on the occurrence of floods, have demonstrated to the European Commission and EU Member States the paramount importance of efficient flood risk management and adaptation to climate change related to flood risk. Sound land management is essential in identifying and implementing adaptation strategies for climate change and flood prevention, and also in ensuring the sustainability of regional developments in the EU.



Flood Risk Map (Flood Damage Potential)

The IES provides policy support to several ongoing European Commission initiatives on floods: flood risk mapping and management, flood warning for civil protection, adaptation to flood risk caused by climate change, and regional development policies. The IES uses an integrated modelling framework which aims to simulate the impact of climate change and land use change on flood risk, as well as feedback mechanisms which include the influence of flood risk on land use development and the influence of land use changes on climate change. This modelling framework builds on the ongoing development and testing of the European Flood Alert System (EFAS).

The IES estimates the expected annual damages of river flooding to increase by EUR 8-12 billion by 2080 as a consequence of climate change.

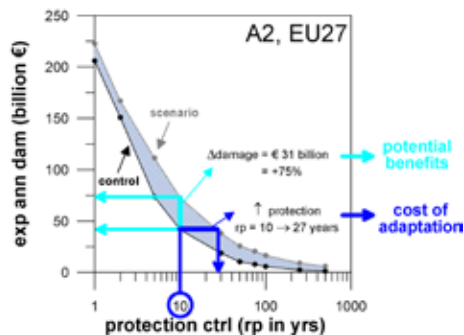
Results achieved

- 43 flood alerts sent out by EFAS to National Flood Authorities and the DG Environment's MIC (Monitoring and Information Centre), covering serious floods in Romania, Hungary, Sweden and Italy. In more than 50% of the alerted cases floods did actually occur. Average early warning time achieved is about 4-5 days before a flood.
- EFAS achieves with a 7-day forecast today the same quality as a 5-day forecast 10 years ago, suggesting that the preparedness for both floods and international aid management can be further increased in the future.
- Contributions to several chapters in the EEA/JRC/WHO joint report on climate change effects, including the chapters on water quantity, river floods and droughts, agriculture & forestry, and the economic consequences of climate change (see JRC press release, page 72).
- First high-resolution European map of flood damage potential in economic terms.
- Establishment of an integrated land-use modelling framework.
- A pilot study on flood forecasting in Africa yielded successful hindcasts with a leadtime of five days.

HIGHLIGHT

Increasing potential flood damages due to climate change

First results of the IES' historical analyses of major flood disasters in Europe show that total economic losses due to floods over the 1970–2006 period amounted to EUR 95 billion, with an average annual flood loss of EUR 2.8 billion (as of 2006). Evidence was also found that the observed increase in the original flood losses is mostly driven by societal factors such as increased population and wealth, and hence exposure to floods.



Potential benefits of flood mitigation
Example: expected annual flood damage for IPCC A2 ('worst case') scenario, as compared to current climate (control). Damage is estimated as a function of the protection level, expressed in return periods.

The IES climate change impact analyses show a consistent tendency towards a higher flood risk in several major European rivers by the end of this century, with increases in flood magnitude ranging from 10 to 40% compared to 1961–90. In northeastern Europe, a general decrease in extreme river discharge is projected by the end of this century, suggesting a reduction in the risk of extreme snowmelt floods. Expected annual damages of river flooding are projected to increase by EUR 8–12 billion by 2080. Averaged at EU level, to maintain a flood protection designed to cope with future 100-year floods, the capacity of flood protection systems should be increased to cope with current 400-year floods.

Streamflow droughts will become more severe and persistent in most parts of Europe by the end of this century, except in the most northern and northeastern regions. The southern parts of Europe are most prone to an increase in drought risk, where minimum river flows are projected to decrease by up to 50%, and flow deficits to increase by up to 75%.

Challenges ahead

- Transform EFAS (currently a research system) into a fully operational system.
- Develop a global flood forecasting system with a pan-African pilot.
- Expand historic and real time meteorological and hydrological data collection projects to improve the early flood warning capability.
- Expand the land-use modelling platform by integrating economic models, in order to achieve improved consistency between land-use scenarios, climate scenarios and impact studies.
- Carry out a pan-European coastal flood risk study, particularly with respect to the impacts of global climate change.

Benefit for Europe

Increased disaster preparedness and improved long-term risk prevention in EU Member States through early flood warnings of the European Flood Alert System (EFAS), and integrated land use, climate change and disaster analysis.

KEY PUBLICATIONS

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- Dankers R., Feyen L. (2009): Flood hazard in Europe in an ensemble of regional climate scenarios. *Journal of Geophysical Research* 114: D16108, doi: 10.1029/2008JD011523.
- Feyen L., Dankers R. (2009): Impact of global warming on streamflow drought in Europe. *Journal of Geophysical Research* 114: D17116, doi: 10.1029/2008JD011438.
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- Pappenberger F., Bartholmes J., Thielen-del Pozo J., Cloke H., Buizza R., De Roo A. (2008): New Dimensions in Early Flood Warning Across the Globe Using Grand-Ensemble Weather Predictions. *Geophysical Research Letters* 35: L10404-1 L10404-7.

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European Drought Observatory
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DG Environment
DG EuropeAid
DG Regional Policy

POLICY SUPPORT

Directive establishing a framework for Community action in the field of water policy – 2000/60/EC

Communication “Addressing the challenge of water scarcity and droughts in the European Union” – COM(2007) 414

Regulation establishing the European Union Solidarity Fund – 2012/2002/EC

Communication “Limiting Global Climate Change to 2 degrees Celsius – The way ahead for 2020 and beyond” – COM(2007) 2

Communication “A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development” – COM(2001) 264

Communication “Towards a Global Partnership for Sustainable Development” – COM(2002) 82

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DROUGHT IN EUROPE AND AFRICA

Assessing, monitoring and forecasting

Drought is one of the major weather-related disasters. Persisting over months or years, droughts can affect large areas and may have serious environmental, social and economic impacts. These impacts depend on the duration, severity and spatial extent of the precipitation deficit, but also on the environmental and socio-economic vulnerability of affected regions.

Droughts occur on all continents and in all climates. In the past, extended parts of Africa have been hit by recurrent droughts with devastating effects on vulnerable societies. Many European countries have also been affected repeatedly over the last decades, causing considerable economic damage. Climate change studies indicate a trend towards increasing climate variability in many parts of the world, most likely resulting in more frequent drought occurrences.

As a drought can affect the entire water cycle (*e.g.*, precipitation, soil moisture, stream flow and groundwater) and has direct impacts on vegetation cover, all these components need to be carefully monitored.



Drought impacts on water resources in southern Spain.

The IES is developing methods and tools for assessing, monitoring and forecasting droughts in Europe and Africa. It is also developing a European Drought Observatory (EDO) to complement national activities with an overall European picture. While the EDO will present a timely and consistent picture of droughts in all parts of Europe, national, regional and local authorities will provide more detailed information at their geographical scales. Similar tools are being developed by the IES for Africa.

Droughts are slow-developing, creeping phenomena that can cause considerable damage to nature, society and the economy!

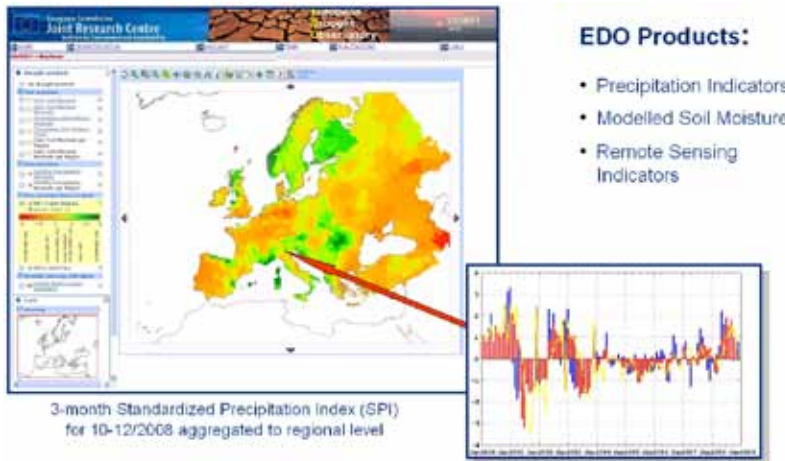
Results achieved

- A first prototype Map Server of EDO with daily updated information on droughts for Europe (*see Highlight*).
- A first monthly meteorological drought forecasting product based on the Standardized Precipitation Index (SPI), including forecast skill analysis.
- Meteorological and remote sensing drought indicators tested for selected regions of Africa.
- Capacity building through an international drought workshop co-organised with the Drought Management Centre for Southeastern Europe, and contribution to a drought monitoring workshop held in Nairobi, Kenya.

HIGHLIGHT

A prototype map server for the European Drought Observatory

At the core of the European Drought Observatory (EDO) is a map server which presents up-to-date drought-relevant information for the whole of Europe to both the public and decision makers in policy and water resources management. The current version of the EDO Map Server publishes continental overview information as produced at the IES using various data sources.



EDO Map Server providing various types of drought-relevant information for Europe, with an example of the Standardized Precipitation Index

Available drought products of the EDO Map Server include a monthly updated Standardized Precipitation Index (SPI), daily updated modelled soil moisture anomalies, and remote sensing observations on the state of vegetation cover. These latter observations include the anomaly of the fraction of Absorbed Photosynthetically Active Radiation (fAPAR) and the Normalized Difference Water Index (NDWI) produced from the MERIS and MODIS sensors respectively. A one-week soil moisture anomaly forecast complements the picture. Time series of drought indices can also be retrieved for all regions in Europe, displaying the temporal evolution of droughts over several years.

Challenges ahead

- Validate the prototype EDO Map Server products and include further drought-relevant information.
- Expand interoperability with national and regional drought information systems to allow seamless up- and downscaling within the EDO.
- Develop drought monitoring tools for Africa and other regions of the world.
- Develop long-range drought forecasting products.
- Develop methodologies for monitoring drought impact.

Benefit for Europe

The monitoring, assessing and forecasting of droughts are key contributions to Europe's policies for the sustainable management of water resources.

KEY PUBLICATIONS

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- Rossi S., Weissteiner C., Niemeyer S. (2009): Remote sensing drought indicators within the European Drought Observatory. Proceedings of the 33rd. International Symposium on Remote Sensing and Environment, Stresa, Italy, 4-8 May 2009.
- Laguardia G., Niemeyer S. (2008): On the comparison between the LISFLOOD modelled and the ERS/SCAT derived soil moisture estimates. *Hydrology and Earth System Sciences Discussions* 5: 1227–1265.
- Niemeyer S. (2008): New drought indices. Proceedings of the 1st International Conference "Drought management: Scientific and technological innovations", Zaragoza, Spain. 12-14 June 2008: 267-274.

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European Forest Fire Information System

<http://effis.jrc.ec.europa.eu>

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DG Environment

DG Regional Policy

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POLICY SUPPORT

Communication on Reinforcing the Union's Disaster Response Capacity – COM(2008) 130

Commission Staff Working Document, Towards Better Protecting Citizens against Disaster Risks: Strengthening Early Warning Systems in Europe – SEC(2007) 1721

Council Conclusions on the development and establishment of Early Warning Systems in the EU

European Parliament resolution of 7 September 2006 on forest fires and floods in Europe, O.J. C 305 E, 14.12.2006, p. 240

European Parliament resolution of 16 September 2009 on forest fires in the summer of 2009

BURNING ISSUES

EFFIS in action during the fire season

Although forest fires are a common component of European ecosystems, changes induced by human behaviour (such as increased population density in some areas and rural exodus in others) are shaping fire frequency and fire intensity in Europe. The IES works closely with national and European authorities to monitor forest fires and to minimise their negative effects on the environment. It has developed the European Forest Fire Information System (EFFIS), which covers the full cycle of forest fire events. Through its website, EFFIS provides fire danger predictions up to six days in advance, as well as daily updated information on active fires and fire damages in Europe. Additional modules in EFFIS analyse post-fire effects such as soil erosion and gas emissions, and use satellite imagery to monitor the recovery of vegetation in the burnt areas.



A new application that provides the Monitoring Information Centre (MIC) of the European Commission with detailed information on potentially critical fires across Europe during the fire season has recently been included in EFFIS. This application provides information on fire danger forecasts, the evolution of fire perimeters, populations at risk in nearby towns and infrastructures, and hospitals at risk. It is designed to help decision-makers to decide when to dispatch firefighting aircraft to extinguish major fires in Europe.

Did you know that more than 90% of the area burned by forest fires in the EU is concentrated in only 5 Mediterranean countries?

Results achieved

- Enhanced EFFIS module for fire danger prediction, which makes it possible to forecast fire danger up to six days in advance of an event.
- Enhanced Rapid Damage Assessment, providing sequential mapping of fire perimeters in near real time. These perimeters will provide key information for the analysis of the behaviour of large fires.
- New EFFIS module supporting the coordination of forest firefighting efforts in Europe. Critical information about the fire danger forecast, the evolution of fire perimeters and potential areas at risk is provided to the MIC.
- The European Fire Database of EFFIS now contains information on 1.8 million individual fire events recorded in 21 European countries over 25 years.



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Madrid, Spain

HIGHLIGHT

EFFIS supports fire prevention and firefighting in the EU

Critical weather conditions in southeastern Europe in 2007 caused dramatic fires in Greece. The fires also burned extensive areas of Italy and the Balkans. These fire events destroyed nearly one million hectares in Europe and caused over 80 casualties among civilians and fire fighters. Large fire events occurred in the same region in the summer of 2009. The enhanced fire danger forecast module of the European Forest Fire Information System (EFFIS) predicted critical fire danger up to six days before fires occurred and provided near real time information that supported international collaboration for forest firefighting in the region.



Detail of the extent of fires in Greece as monitored by EFFIS in 2009

Challenges ahead

- Predict forest fire behaviour, which would enable improved firefighting and ensure human safety in major fire events.
- Estimate fire emissions and model the dispersion of smoke plumes.
- Harmonise the nomenclature the causes of fires in Europe, which could improve fire prevention.
- Develop a map of forest fire fuels, detailing the conditions in which fires ignite and spread.
- Analyse the socio-economic impact of forest fires, which will permit the quantification in economic terms of the damages caused by fires to the environment and to human assets.

Benefit for Europe

EFFIS provides European institutions and citizens with near real time harmonised information on forest fires and their effects. Furthermore, EFFIS permits an improved prediction of critical fire danger situations in Europe and facilitates international collaboration in forest firefighting in critical fire events.

KEY PUBLICATIONS

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- Barbosa P., Camia A., Kucera J., Liberta G., Palumbo I., San Miguel Ayanz J., Schmuck G. (2009): Assessment of Forest Fire Impacts and Emissions in the European Union Based on the European Forest Fire Information System, *Wildland Fires and Air Pollution. Developments in Environmental Science 8*: 197-208.
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- San-Miguel-Ayanz Pereira J. M. C., Boca R., Strobl P., Kucera J., Pekkarinen A. (2009): Forest fires in the European Mediterranean region: Mapping and analysis of burnt areas. In: Chuvieco E. (ed.), *Earth Observation of Wildland Fires in Mediterranean Ecosystems*, Springer: 189-204.
- San-Miguel-Ayanz J., Camia A. (2009): Forest fires at a glance: Facts, figures and trends in the EU, in Birot Y. (ed.), *Living with Wildfires: What science can tell us*: 11-21.
- Boschetti L., Roy D., Barbosa P., Boca R. (2008): A MODIS assessment of the summer 2007 extent burned in Greece. *International Journal on Remote Sensing 29* (8): 37-41.
- Gabban A., San-Miguel-Ayanz J., Viegas, D. X. (2008): A comparative analysis of the use of NOAA-AVHRR NDVI and FWI data for forest fire risk assessment. *International Journal of Remote Sensing 29* (19): 5677-5687.
- Schmuck G., San-Miguel J., Camia A., Kucera J., Liberta G., Boca R., Durrant T., Amatulli G. (2008): Forest Fires in Europe 2007 report. EUR 23492 EN. Office for Official Publications of the European Communities, Luxembourg.

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The Global Perspective

“Staying open to the world is essential.”

MÁIRE GEORGHEGAN QUINN

European Commissioner for Research, Innovation and Science



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DG Environment

DG EuropeAid

United Nations Convention to Combat Desertification (UNCCD)

United Nations Environment Programme/
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Coordination (UNEP/GEF)

POLICY SUPPORT

Communication on the European Union
Strategy for Sustainable Development –
COM(2001) 264

Communication “Towards a Global Part-
nership for Sustainable Development” –
COM(2002) 82

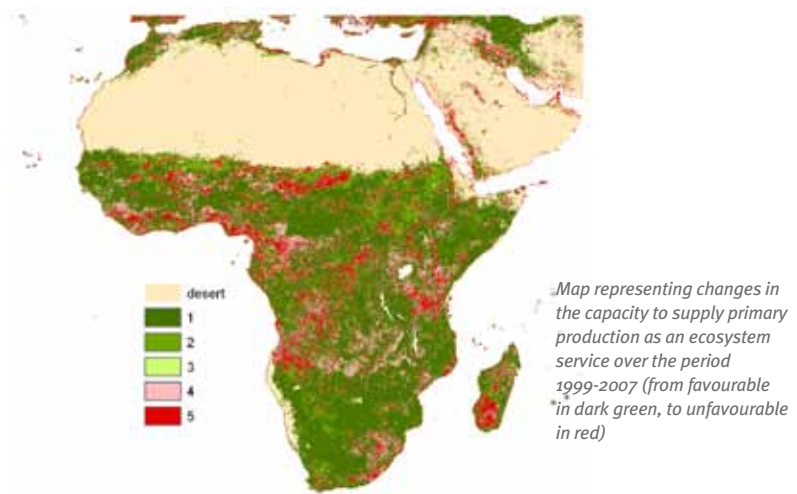
United Nations Convention to Combat
Desertification (UNCCD)

DESERTIFICATION - A GLOBAL THREAT?

Monitoring desertification and land degradation

Desertification is one of the major threats to the global environment with direct impact on human well-being and social welfare. Climate change is expected to expand the world's fragile drylands through an increased frequency, duration and severity of droughts. This may lead to an accelerated rate of desertification which, in turn, is likely to lead to increased poverty. While drought is a natural phenomenon, desertification is a coupled human-environment issue where drought is a major natural driver.

The IES covers the different aspects of these coupled phenomena, and monitors and assesses regional and global desertification, land degradation and drought (DLDD). Integrated methodologies and indicators for assessing DLDD are being developed in the framework of compiling the new World Atlas of Desertification, which is being coordinated by the IES and UNEP (United Nations Environment Programme).



The IES also provides scientific and technical support regarding desertification to the European Commission, which is a signatory of the United Nations Convention to Combat Desertification (UNCCD).

41% of the Earth's surface is covered by drylands, home to 2 billion people. 10-20% of these drylands is affected by desertification. Climate change and human pressure will worsen this situation.

Results achieved

- Chaired a global network of experts and organised an international scientific conference on Integrated Methods for Monitoring and Assessing Desertification (see *Highlight*).
- Kick-off of the compilation process of the new World Atlas of Desertification (WAD), and development of a concept and first implementation plan for the WAD with an international network of experts.
- Development of remote-sensing-derived phenological metrics, describing the functional behaviour of land cover for evaluating various aspects of land degradation.
- Development of a global database on desertification indicators, linked to relevant issues (such as deforestation and overgrazing) and conceptual frameworks (such as the Syndromes model and the Human-Ecosystem model).



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HIGHLIGHT

Understanding Desertification Trends

In conjunction with the UNCCD COP9, the IES, as a member of the Dryland Science for Development (DSD) Consortium, co-organised the first Scientific Conference of the UNCCD entitled “Understanding Desertification and Land Degradation Trends”. The conference addressed the theme “Bio-physical and socio-economic monitoring and assessment of desertification and land degradation, to support decision-making in land and water management”. In preparation for the conference, the IES chaired one of three global working groups of high-level experts which drafted White Papers and a Synthesis Paper on different aspects of the Conference theme, including recommendations for further policy action.



First UNCCD Scientific Conference on Understanding Desertification and Land Degradation Trends

The conference was attended by more than 100 leading scientists from around the world and attracted a large number of delegates from the UNCCD Parties. It highlighted the importance of implementing integrated methods for monitoring and assessing land degradation, and underlined the need for a holistic approach to understanding desertification processes and for combating its impacts. The IES organised the session on integrated methods for monitoring and assessment, where the corresponding White Paper and policy recommendations were presented and discussed.

The scientific outcomes and policy recommendations from the Conference will be reviewed by the UNCCD Committee on Science and Technology in 2010 in order to explore possible avenues for policy action.

Challenges ahead

- Complete the new World Atlas of Desertification (WAD).
- Implement a web-based Desertification Information System.
- Integrate biophysical and socio-economic information to derive robust desertification indicators.
- Develop integrated methods for monitoring desertification using harmonised indicators and benchmarks.

Benefit for Europe

Monitoring and assessment of desertification worldwide is key to developing mitigation strategies, thus improving the living conditions in affected areas and supporting European policies to alleviate poverty.

KEY PUBLICATIONS

- Ivits-Wasser E., Cherlet M., Mehl M., Sommer S. (2009): Estimating the Ecological Status and Change of Riparian Zones in Andalusia Assessed by Multi-Temporal AVHRR Datasets. *Ecological Indicators* 9 (3): 422-431.
- Vogt J. (ed.) (2009): Integrated Methods for Monitoring and Assessing Desertification and Land Degradation Processes and Drivers (White Paper of DSD Working Group 1).
- Hill J., Stellmes M., Udelhoven T., Roeder A., Sommer S. (2008): Mediterranean Desertification and Land Degradation - Mapping Related Land Use Change Syndromes Based on Satellite Observations. *Global and Planetary Change* 64 (3-4): 146-157.
- Ivits-Wasser E., Cherlet M., Sommer S., Mehl W. (2008): Characterization of Pan-Mediterranean Riparian Areas by Remote Sensing Derived Phenological Indices. EUR 23498 EN. Office for Official Publications of the European Communities, Luxembourg.

MAIN RESEARCH PARTNERS

- Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), Damascus, Syria
- Australian Commonwealth Science and Research Organisation (CSIRO), Alice Springs and Canberra, Australia
- Council for Scientific and Industrial Research, Pretoria, South Africa
- Desert Research Foundation of Namibia, Windhoek, Namibia
- IADIZA-CONICET, Mendoza, Argentina
- Institute of Soil Sciences, Chinese Academy of Sciences, Nanjing, China
- International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM), Bari, Italy
- Sahara and Sahel Observatory (OSS), Tunis, Tunisia
- United Nations Environment Programme (UNEP), Nairobi, Kenya
- Food and Agriculture Organization of the United Nations (FAO), Rome, Italy
- Universities in Argentina, Chile, Ethiopia, Germany, Greece, Hungary, Iceland, Israel, Italy, Senegal, Sweden, Switzerland, The Netherlands, UK, USA
- World Overview of Conservation Approaches and Technologies (WOCAT), Bern, Switzerland
- World Soil Information Database – ISRIC, Wageningen, The Netherlands

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Intergovernmental Panel on Climate Change (IPCC)
United Nations Environment Programme (UNEP)
World Health Organization (WHO)

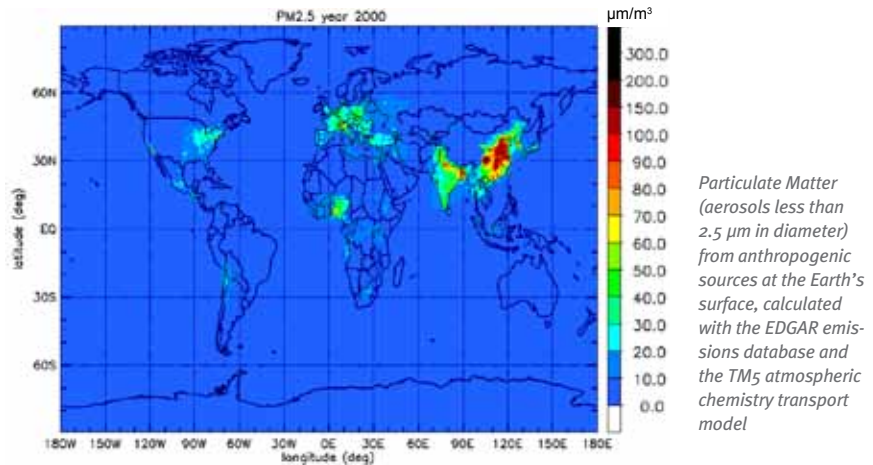
POLICY SUPPORT

EU post Kyoto Climate Policy
UN Convention on Long-range Transboundary Air Pollution (CLRTAP)

A BUMPY ROAD TOWARDS A STABLE CLIMATE

Impact of climate change and air pollution policies

The IES links global greenhouse gases (GHGs) and air pollutant emission scenarios with atmospheric chemistry and climate modelling to assess the impacts of climate policies on the climate and environment. The combustion of biomass and fossil fuels leads to emissions of GHG and air pollutants. While GHGs, particularly CO₂, warm the planet, aerosols – small, suspended particles of varying composition and size – have an overall cooling effect, by blocking incoming solar radiation and modifying the properties of clouds (see also page 34).



Climate policies aim to reduce GHG emissions, typically by addressing energy use or emissions from the agricultural sector. In contrast, air quality policies try to reduce emissions by encouraging the use of add-on technologies, such as filters and catalysts. Major reductions in aerosol emissions are expected in the decades to come due to the worldwide implementation of both policies. This will have large benefits for human health, but is likely to lead to more rapid temperature increases over the next decades. Using integrated assessment modelling, the IES investigates how a sophisticated combination of air pollution and climate policies might avoid the latter, *i.e.* the “bump” in the future temperature.

While climate policies limiting greenhouse gas emissions aim to prevent significant climate change beyond 2100, unless carried out selectively the simultaneous reduction of air pollution is likely to lead to more rapid temperature increases over the next 20-30 years.

Results achieved

- Coupled the POLES (Prospective Outlook on Long-term Energy Systems) energy forecast model of the IPTS with EDGAR (Emissions Database for Global Atmospheric Research) (see *Highlight*).
- Constructed four emission scenarios for the coming decades covering a range of air pollution and climate policies.
- Calculated atmospheric pollution and impacts on human and ecosystem health connected with these scenarios.
- Calculated the impacts of each of the four emission scenarios on global climate.

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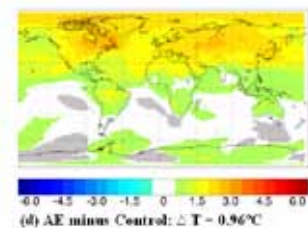
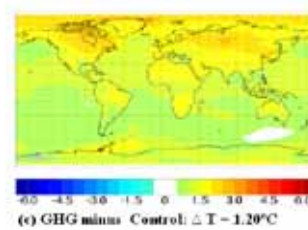
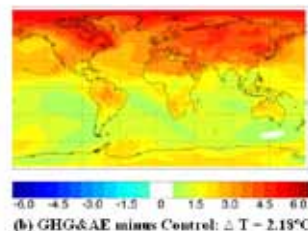
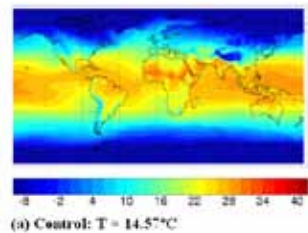


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HIGHLIGHT

Faster climate change in the coming decades

Data from the POLES energy forecast model is used to make predictions of GHG emissions in the case of implementing a climate policy as compared to a ‘business-as-usual’ (BAU) scenario, *i.e.* where no policy measures are taken. The corresponding amount of air pollutant emissions resulting from, for instance, electricity production and traffic, is calculated using the EDGAR emissions database, which was developed by the IES in collaboration with the Netherlands Environmental Assessment Agency (PBL). These climate policy and BAU scenarios are combined with assumptions on current and future policies to reduce air pollution. The resulting emission scenarios are used in a high resolution global air pollution climate model (ECHAM5-HAM, developed by the Max-Planck-Institute for Meteorology in collaboration with the IES) to forecast concentrations of air pollution and the likely impacts on human health and climate. The IES model calculations suggest that air pollution controls enforced in conjunction with increasing GHG concentrations may actually lead to substantial rises in temperature over the coming decades. A greater focus on emission reductions in the transport sector (especially diesel) and in the domestic sector (especially wood burning) would help to alleviate rapid temperature increases due to air pollution control.



ECHAM5-HAM climate model calculations:

- Present day equilibrium surface temperature for a control experiment and the surface temperature response relative to present day for
 - a future scenario considering increasing levels of GHG emissions and reduced air pollution due to air pollution policies,
 - the impact of increasing GHG alone and
 - the impact of controlling air pollution alone.
- Gray shading indicates changes that are below a 95% significance level.

Challenges ahead

- Further advance our knowledge about the climate system and its response to natural and anthropogenic changes.
- Assess the costs associated with GHG reduction and air pollution abatement policies.
- Identify strategies that are optimised for both short- and long-term air pollution and climate change mitigation issues.

Benefit for Europe

Europe has an increased capacity to analyse the various aspects of global climate and air pollution policies, allowing for faster delivery of science-based advice to policy makers.

KEY PUBLICATIONS

- Casper Anenberg S., West J., Fiore A., Jaffe D., Prather M., Bergmann D., Cuvelier C., Dentener F., Duncan B., Gauss M., Hess P., Jonson J., Lupu A., Mackenzie I., Marmer E., Park R., Michael S., Schultz M., Shindell D., Szopa S., Garcia Vivanco M., Wild O., Zeng G. (2009): Intercontinental Impacts of Ozone Pollution on Human Mortality. *Environmental Science and Technology* 43: 6482-6487.
- Isaksen I., Benestad R., Raes F., Berntsen T., Bousquet P., Collins B., Cox A., Dalsoren S., Eyring V., Gauss M., Granier C., Joeckel P., Klimont Z., Lohmann U., Myhre G., Prevot A., Richter A., Rognerud B., Schulz M., Shindell D., Stevenson D., Storelmo T., Wang W., Van Weele M., Wild M., Wuebbles D., Fowler D., Fuzzi S., Laj P., Maione M., Monks P. (2009): Atmospheric Composition Change: Climate-Chemistry Interactions. *Atmospheric Environment* 43 (33): 5138-5192.
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DG External Relations
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European Commission Delegations
Food and Agriculture Organization of the United Nations (FAO)
Group on Earth Observations (GEO)
Global Terrestrial Observing System (GTOS)

POLICY SUPPORT

Addressing the challenges of deforestation and forest degradation to tackle climate change and biodiversity loss – COM(2008) 645/3
Global Monitoring for Environment and Security (GMES) – COM(2008) 748
Reducing Emissions from Deforestation and forest Degradation in developing countries (REDD) mechanism of the UN Framework Convention on Climate Change – FCCC/SBSTA/2009/L.9
Forest Law Enforcement of Governance and Trade (FLEGT) – Commission Regulation 1024/2008 – Council Regulation 2173/2005

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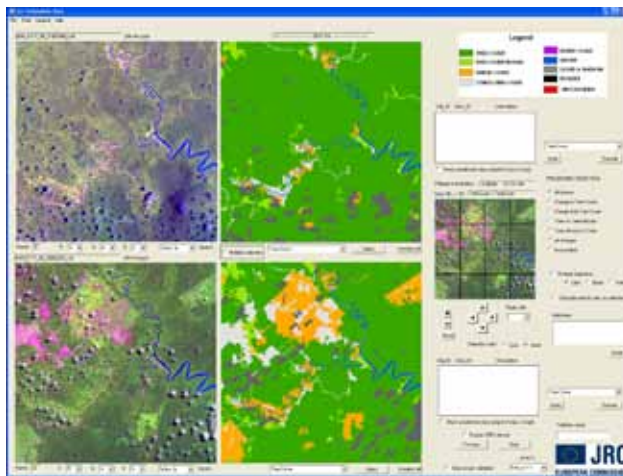
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GLOBAL FOREST MONITORING

A focus on deforestation in the tropics

Deforestation in the tropics is thought to be a major contributor to CO₂ emissions. Despite the growing public attention being given to global deforestation, there is still a debate on the actual magnitude of this process.

The IES provides quantitative measurements of changes in forest resources in support of EU policies and international agreements on forestry issues. Using Earth-observing satellites, the IES has provided estimates of tropical deforestation in the 1990's and the effects of human activity on Russian boreal forests (wildfires and forest clearings). The IES now focuses mainly on tropical and European forests, using more sophisticated methods to produce more precise, statistically valid estimates of forest cover change for the current and previous decades. Due to persistent cloud cover in the tropics, the IES is also developing forest monitoring techniques based on radar technologies.



Example of automatic interpretation of Landsat satellite imagery over a forest sample site in Northern Kalimantan, Indonesia, presented via the JRC validation tool

*Did you know that an area the size of Greece
(approximately 13 million hectares)
is deforested worldwide every year?*

Results achieved

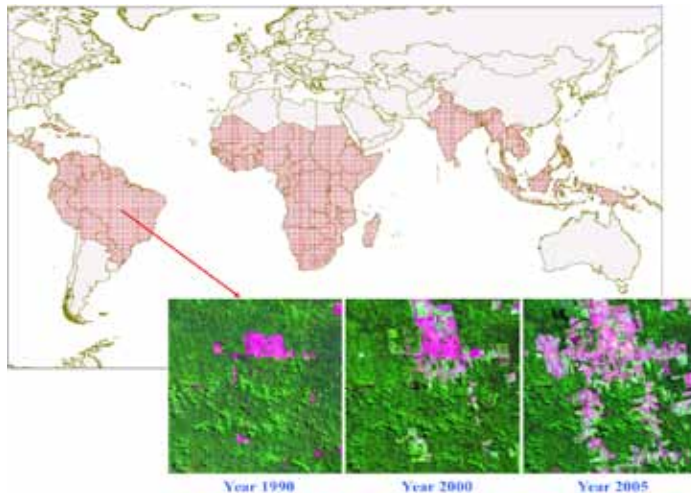
- Developed a system for assessing and documenting forest cover changes, including tools for the automatic interpretation of satellite imagery.
- Established a large database of satellite imagery covering the tropical belt.
- Produced a new radar mosaic of Central Africa at 50m resolution with imagery for 2007 from the PALSAR sensor onboard the Japanese Advanced Land Observing Satellite (ALOS).
- Validation of the GlobCover global land-cover map at 300m resolution for the year 2005, which was released at the end of 2008. The GlobCover project, led by the European Space Agency, was carried out by a European consortium.
- Contributed to the negotiation process for the post-2012 climate agreement in the context of REDD (Reducing Emissions from Deforestation and forest Degradation) by summarising technical capabilities for estimating emissions from deforestation in the tropics (e.g. sourcebook on REDD published by the GOFC-GOLD panel of the Global Terrestrial Observing System) and through active participation in the meetings of Conferences of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC).

HIGHLIGHT

The IES contributes to FAO's global forest monitoring

The IES works closely in a collaborative partnership with the Global Forest Resources Assessment 2010 (FRA-2010) Remote Sensing Survey (RSS) of the Food and Agriculture Organization of the United Nations (FAO) to calculate rates of forest cover changes for current and previous decades.

Together with the IES, the FAO has selected a systematic sample across the tropics for its FRA-2010 RSS.



Example of time-series of 30m resolution satellite imagery over a sample site in the Amazon Basin (20 x 20km areas). Forests appear in dark green, deforested areas (agriculture and pastures) appear in light green or pink.

The IES analyses forest cover changes of all tropical sites (circa 4 000 sites). The survey is based on the analysis of 20 x 20km areas for which 30m resolution satellite (Landsat) data were collected for three different dates (1990, 2000 and 2005). 2010 will be included at a later stage. An operational system has been developed for the processing of multi-temporal imagery. Validation is being carried out with a network of regional forest and remote sensing experts.

Challenges ahead

- Reduce uncertainty in the estimation of carbon fluxes arising from deforestation at global levels.
- Expand the analysis of forest cover changes to boreal Eurasia.
- Improve dedicated tools for monitoring forest cover using the most recent satellite image technology.
- Sustain effective technology transfer on forest monitoring using remote sensing to partners throughout the world.

Benefit for Europe

By monitoring the world's forests from space, the IES helps Europe to target climate policies and environmental aid packages, and to support the sustainable use of forest resources.

KEY PUBLICATIONS

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- Belward A.S., Bartholomé E., Achard F., Brink A.D. (2009): Land Cover. *Bulletin of the American Meteorological Society* 90: 543-544.
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- Achard F., Eva H.D., Mollicone D., Beuchle R. (2008): The effect of climate anomalies and human ignition factor on wildfires in Russian boreal forests. *Philosophical Transactions of the Royal Society B: Biological Sciences* 363: 2331-2339.
- Bucha T., Stibig H.-J. (2008): Analysis of MODIS imagery for detection of clear cuts in the boreal forest in north-west Russia. *Remote Sensing of Environment* 112: 2416-2429.

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- CIRAD - Unité Ressources forestières et politiques publiques, Montpellier, France
- EMBRAPA (Brazilian Agricultural Agency) – National Centre for Satellite Monitoring, Campinas, Brazil
- European Space Agency (ESA) – ESRIN, Frascati, Italy
- Forest Survey of India (FSI), Dehra Dun, India
- Group on Earth Observations (GEO) – Network of the Forest Carbon Tracking Task, Geneva, Switzerland
- Institut de Recherche pour le Développement (IRD) – Unité Espace, Cayenne, French Guiana
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Food and Agriculture Organization of the United Nations (FAO)
Group on Earth Observations (GEO)
New Partnership for Africa's Development (NEPAD)
United Nations Environment Programme (UNEP)

POLICY SUPPORT

Communication on the European Community's Development Policy – COM(2000) 212
Communication on integrating environment and sustainable development into economic and development cooperation policy – COM(2000) 264

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GREEN GOLD FOR AFRICA

Helping Africa to sustainably exploit natural resources

Water, forests, agricultural and grazing land and their biological diversity have high economic and social value. Dynamic information on the location, condition and evolution of environmental resources in developing countries is necessary for the EU and its Member States to properly define, target, deliver and evaluate their development aid strategies and programmes. It also gives decision-makers in the governments and regional organisations of these developing countries access to ready-to-use environmental information on which to base appropriate policy responses.



The Rift Valley in Kenya – Natural vegetation is under threat from agriculture and livestock

The IES is establishing dedicated monitoring techniques for promoting the sustainable management of natural resources in ACP (Africa, Caribbean and Pacific) countries. By combining satellite data, advanced geospatial analysis and socio-economic models, the IES monitors land cover and land use dynamics, fresh water availability and management, land degradation, fire dynamics and regimes, and the assessment of, and threats to, biodiversity in protected areas and in specific ecosystems.

Did you know that agriculture in Africa has increased by more than 50% but malnutrition has remained nearly constant over the past 25 years? At 2.4% per annum, population growth in Africa is the highest in the world.

Results achieved

- Development of a decision support system for assessing the relative threats and pressures on protected areas in Africa through a pressure-state-response system, and identification of protected areas which have the greatest biological value.
- Development of a consistent methodology across the tropics to produce estimates on land cover and tree cover change for the years 1990-2000-2005 derived from high resolution Landsat satellite imagery in collaboration with the IES TREES-3 Action (*see pages 58-59*).
- Development of tools for extracting vegetation, water and fire-related biophysical parameters from European observation satellite data for the long-term time series analysis of these parameters.
- Design and development of the e-station and its distribution to African partners through the AMESD (African Monitoring of the Environment for Sustainable Development) project (*see Highlight*).
- Contribution to the European Union Water Initiative (EUWI) through the development of web-based knowledge management and data analysis information systems. The EUWI is an international initiative designed to reinforce the political commitment to water and sanitation. One of its main aims is to improve aid in order to help the poorest countries of Africa.

HIGHLIGHT

The IES e-station

To help address the question of how best to help Africa exploit its natural resources in the most efficient and sustainable manner, the IES has developed the e-station, a system that processes satellite imagery acquired over Africa to generate factual information about the environment. The e-station runs on standard computers connected to an “EUMETCast” data-receiving satellite station. Based on open-source solutions, it provides an automated and standardised working environment with three main functionalities: user-defined processing of satellite imagery, data display and analysis, and a wiki-like cooperative report production environment.



The IES provides the e-station, training and technical advice free of charge to African institutions that are active in environmental monitoring through a partnership with the AMESD project. This project is implemented by the African Union Commission on behalf of the regional economic commissions of Africa South of the Sahara and the ACP Secretariat, and is financially supported by the European Development Fund.

Challenges ahead

- Develop a dynamic, interoperable, web-based protected areas assessment information tool.
- Consolidate and harmonise land-cover-change statistics over sub-Saharan Africa for the years 1990, 2000, 2005 and 2010.
- Increase the capacity of the e-station in line with user needs and new data, and consolidate technology transfer of the e-station through use and information sharing throughout Africa.
- Develop an operational knowledge management platform in the water sector which collects updated relevant information and offers dynamic tools to enhance and share knowledge on water issues.
- Create an African network of centres of excellence in the water sector.

Benefit for Europe

The IES activities help foster long-term partnership and dialogue as per the Africa-EU partnership. European Earth observation satellites are further used to aid international cooperation programmes, and improved sustainable use of natural resources in Africa helps to alleviate demands on Europe for development aid.

KEY PUBLICATIONS

- Brink A., Eva H. D. (2009): Monitoring 25 years of land cover change dynamics in Africa: a sample based remote sensing approach. *Applied Geography* 29: 501-512.
- Nelson A., Hartley A., Dubois G., Punga M. (2009): Geoinformatics for the Environmental Surveillance of Protected Areas in Africa. Proceedings of StatGIS09: Geoinformatics for Environmental surveillance. Milos Island, Greece, 17-19 June 2009.
- Tansey K., Grégoire J.-M., Defourny P., Leigh R., Pekel J.-F., van Bogaert E., Bartholomé E. (2008): A New, Global, Multi-Annual (2000-2007) Burnt Area Product at 1 km Resolution and Daily Intervals. *Geophysical Research Letters* 35: L01401, doi: 10.1029/2007GL031567.
- Verstraete M. M., Brink A., Scholes R. J., Beniston M., Stafford Smith M. (2008): Climate change and desertification: where do we stand, where should we go? *Global and Planetary Change* 64: 105-110.
- Haas E., Bartholomé E., Combal B. (2009): Time Series Analysis of Optical Remote Sensing Data for the Mapping of Temporary Surface Water Bodies in Sub-Saharan Western Africa. *Journal of Hydrology* 370 (1): 52-63.

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- Centre for International Forestry Research (CIFOR), Bogor, Indonesia
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- Commission des Forêts d'Afrique Centrale (COMIFAC), Yaoundé, Cameroon
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- Institut de recherche pour le développement (IRD), Marseille, France
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POLICY SUPPORT

EU – Africa Strategic Partnership, partnership
agreed upon during the Lisbon Summit of
Heads of State of Europe and Africa in
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Joint Statement by the Council and the rep-
resentatives of the governments of Member
States on EU Development Policy:
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THE ACP OBSERVATORY

Science at the service of African, Caribbean and Pacific countries

The ACP Observatory, coordinated by the IES, was designed to establish a reference centre for scientific and technical information in support of decision-making processes in the African, Caribbean and Pacific (ACP) regions. It was set up as an inter-institute Thematic Programme which aims to advance sustainable development in ACP countries. The ACP Observatory provides added-value environmental information in the form of maps, data and tools to decision makers and development projects. The thematic domains covered include soil, biodiversity, forests, food security, rural development, rangelands, marine and coastal ecosystems, water management, land degradation, desertification, natural hazards, civil protection and spatial data infrastructure.



Thematic domains covered by the ACP Observatory

The main activities of the ACP Observatory, which currently focus mainly on Africa, include:

- Forward-looking analyses of emerging development issues and the science behind them;
- Management of the ACP Observatory information portal, which serves as a reference centre for geospatial information on the abovementioned themes for ACP countries;
- Exchange of added value information, capacity building and reinforcing scientific networks through training and the secondment of experts.

Did you know that the EU is the world's largest donor of official development aid?

Results achieved

- Design and implementation of Capacity4Dev.eu, an open forum for the sharing of knowledge among European Commission staff, development practitioners, partner countries, donors, academics and civil society representatives.
- Establishment and development of the Observatory of Forests of Central Africa in Kinshasa, which compiles scientific knowledge on forests in the Congo Basin (deforestation, forest management, biodiversity).
- Secondment of JRC staff to the African Union Commission (Addis Ababa) to explore how best to use geospatial information to fulfil the African Union Commission's mandate and to implement the AU-EU Strategic Partnership.
- Development of Aquaknow, the dynamic virtual space for collaboration and information sharing designed specifically for the stakeholders of the water sector in the framework of the EU Water Initiative.

HIGHLIGHT

GMES Africa – Earth observation for development policies

The EU's GMES (Global Monitoring for Environment and Security) Africa Action Plan aims to help African decision makers implement policies targeting the sustainable management of the African environment.



Building on local capacities is essential for GMES Africa

The preparation of the GMES Africa Action Plan is jointly coordinated by the African Union Commission (AUC) and the IES, with the contribution of other JRC institutes. This Action Plan aims to improve the use of Earth observation

data in development policies for the next ten years. Its comprehensive capacity-building strategy, which includes training and exchange of experts, ensures that European Commission services and stakeholders in Africa can access and use the scientific information needed for decision-making. A multi-disciplinary approach is required to address emerging issues such as the link between climate change and international security, the future of tropical forests in the aftermath of the economic crisis and the demand for biofuels. As a step towards developing such an approach, the IES is analysing the factors affecting land allocation in two regions that have been selected as case studies: Central Africa and the Horn of Africa. These factors include the interaction between the drivers of the competition for land, the different ecosystem services, biophysical limitations and socio-economic constraints.

Challenges ahead

- Transfer knowledge, expertise and technical facilities to regional and national services in ACP countries.
- Encourage the use of scientific information by decision-makers engaged in poverty alleviation.
- Increase the analysis of cross-cutting issues in integrated assessment models.
- Develop alert systems for natural disasters (floods, droughts, fires, hurricanes) based on geospatial information in ACP countries.
- Improve the management of forests and protected areas by deploying regional reference centres and by maintaining permanent monitoring systems in ACP countries.

Benefit for Europe

The repository of environmental information and activities kept by the ACP Observatory will benefit European Commission services and ACP stakeholders in supporting decision-making processes in development policies and programmes.

KEY PUBLICATIONS

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- Buchanan G., Nelson A., Mayaux P., Hartley A., Donald P. (2009): Delivering a Global, Terrestrial, Biodiversity Observation System through Remote Sensing. *Conservation Biology* 23 (2): 499-502.
- Brink A., Eva H. D. (2009): Monitoring 25 years of land cover change dynamics in Africa: a sample based remote sensing approach. *Applied Geography* 29: 501-512.

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<http://gem.jrc.ec.europa.eu/index.php/pages/EarthObservation/2>
Ocean Colour Portal
http://oceancolour.jrc.ec.europa.eu/data_portal/oc_portal/
Radiation Transfer Model Intercomparison
<http://rami-benchmark.jrc.ec.europa.eu>

CUSTOMERS

DG Enterprise and Industry
DG Environment
Committee on Earth Observations Satellites (CEOS)
European Space Agency (ESA)
Global Climate Observing System (GCOS)
Group on Earth Observations (GEO)

POLICY SUPPORT

European Climate Policy
European Space Policy
Global Monitoring for Environment and Security (GMES)

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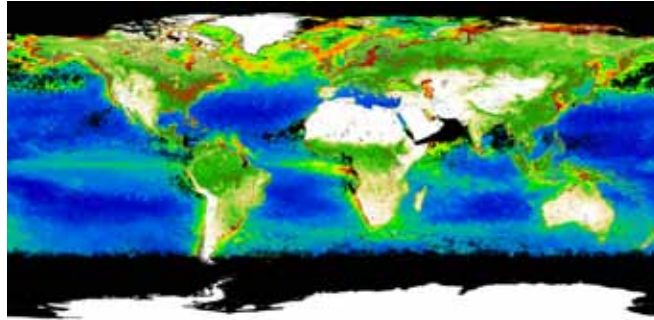


Monica Robustelli
Angera, Italy

AN OBJECTIVE VIEW OF EARTH

A satellite view of the land and ocean biosphere

Environmental degradation and climate change threaten the habitability of our planet and the sustainability of economic activities, and therefore the social cohesion of our societies. Space-based technologies, together with research and development in physics and mathematical analysis, provide unique and appropriate means for gathering relevant information on the state and evolution of our environment. For instance, the international Global Climate Observing System (GCOS) has identified a limited set of the Essential Climate Variables (ECV) required to properly monitor the climate system and drive or constrain current and future models of the climate and the environment.



Composite image showing combined biosphere products for land and ocean; chlorophyll-a concentration is mapped over the ocean and fraction of Absorbed Photosynthetically Active Radiation (fAPAR) is mapped over land.

Reliable and accurate information is critical to help guide environmental policies in order to identify and understand the issues, propose solutions, and monitor the effectiveness of corrective measures (mitigation and adaptation). Within the IES, scientists address these issues by focusing efforts on the development of state-of-the-art processing methodologies and the implementation of stringent quality control and benchmarking techniques, to ensure that consistent quantitative data are obtained from satellites.

Did you know that land and ocean biospheres provide roughly equivalent contributions to global carbon fixation?

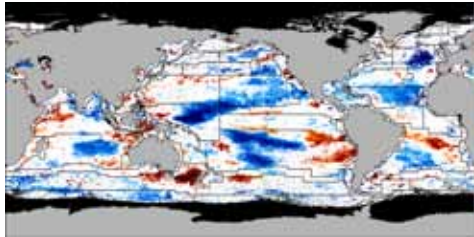
Results achieved

- A NASA-funded international model intercomparison study compared *in-situ* primary production values collected in the tropical Pacific with modelled outputs. The models proposed by the IES showed excellent results.
- Contributed to the first systematic study of global maritime aerosols, the Global Maritime Aerosol Network (MAN), which was developed as a component of the international Aerosol Robotic Network (AERONET).
- Collected more than 10 years of fAPAR (fraction of Absorbed Photosynthetically Active Radiation) over land (*see Highlight*). This has been used by various IES activities, for example the European Drought Observatory (EDO) (*see pages 48-49*) use it for drought forecasting, detection, and monitoring in Europe. Near real time data products over Europe are estimated in collaboration with the European Space Agency.
- Prepared a reference report which provided the first systematic review of the combined efforts of the European Commission, the European Space Agency and the EUMETSAT, documenting the state and prospects of the EU's capacity for satellite observation of ECV.
- Published a review on "Climate Change and Desertification" in the JRC-edited special issue of the Global and Planetary Change Journal. This compendium of manuscripts provides a definitive review of the state-of-the-art on the addressed topic of research (*see Key Publications*).

HIGHLIGHT

Ten-year trends in the land and ocean primary producers

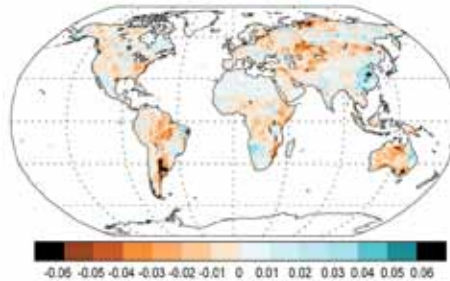
The global satellite dataset processed and maintained at the IES now offers a 10-year time-series of consistent, well-calibrated, ocean colour and fraction of Absorbed Photosynthetically Active Radiation (fAPAR) data records suitable for analysing temporal variability of primary producers. Daily, weekly and monthly observations of fAPAR over land and chlorophyll-*a* over the oceans provide a basis for monitoring the seasonal cycle and long-term trends of vegetation. These data have been used in diagnostic models, for example in examining the role of the oceanic and terrestrial biosphere in climate-carbon feedbacks.



The trend in chlorophyll-*a* concentrations (in % per year) plotted using 10 years of satellite data. Darker reds represent higher positive values; darker blues represent higher negative values. Overlaid black lines indicate the boundaries of ocean provinces.

For the ocean domain, the relative importance of the seasonal changes in chlorophyll-*a* concentration is assessed using statistical techniques of temporal decomposition. Linear changes observed over a decade of continuous ocean colour records agree globally with previous observations made over shorter time periods. Significant positive and negative changes are detected in various regions of the world's oceans, but generally chlorophyll-*a* decreases in the mid-oceanic gyres, which may be linked to changes in ocean stratification.

An analysis of the anomaly map for fAPAR in 2008 showed that the strongest negative anomaly reflected severe drought in Argentina's steppe and grassland regions. Southeastern Amazonia had negative anomalies, arising partly from intense land use. There were also major negative anomalies in Australia and central Asia. In contrast, much of China, southern Africa's savannas, and northern high latitudes enjoyed better-than-average vegetation growth in 2008.



Global fAPAR anomaly map for 2008 derived from MERIS and SeaWiFS data products at 0.5 x 0.5 degrees (anomaly reference calculated over the period January 1998 to December 2008)

Challenges ahead

- Document the unpredictable complex positive and negative climate change feedbacks across land, ocean and atmospheric domains as they occur.
- Maintain and carry out constant analyses of the IES' combined land and ocean biosphere datasets.

Benefit for Europe

Systematic observations are key to defining initial conditions for climate models, particularly for estimates on climate adaptation time scales. Its position as global leader in measuring and analysing Essential Climate Variables guarantees Europe the highest possible accuracy in these observations for planning adaptation strategies.

KEY PUBLICATIONS

- Zibordi G., Holben B. N., Slutsker I., Giles D., D'Alimonte D., Mélin F., Berthon J. F., Vandemark D., Feng H., Schuster G., Fabbri B. E., Kaitala S. and Seppala J. (2009): AERONET-OC: A Network for the Validation of Ocean Color Primary Products. *Journal of Atmospheric and Oceanic Technology* 26: 1634-1651.
- Vantrepotte V., Mélin F. (2009): Temporal variability of 10-year global SeaWiFS time series of phytoplankton chlorophyll *a* concentration. *ICES Journal of Marine Science* 66: 1547-1556.
- Gobron N., Belward A. (2009): Global Vegetation Condition, in State of the Climate in 2008. Peterson, T.C., M.O. Baringer (eds.), *Bulletin of the American Meteorological Society* 90: 44-45.
- Jung M., Verstraete M. M., Gobron N., Reichstein M., Papale D., Bondeau A., Robustelli M., Pinty B. (2008): Diagnostic assessment of European gross primary production. *Global Change Biology* 14: 2349-2364.
- Verstraete M.M., Brink A., Scholes R.J., Beniston M., Stafford Smith M. (2008): Climate change and desertification: Where do we stand, where should we go? *Global and Planetary Change* 64: 105-110.
- Widlowski J.-L., Lavergne T., Pinty T., Gobron N., Verstraete M. M. (2008): Towards a high spatial resolution limit for pixel-based interpretations of optical remote sensing data. *Advances in Space Research* 41 (11): 1724-1732.

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- Institute for Atmospheric Sciences and Climate, Italian National Research Council, Bologna, Italy
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- Institute of Oceanology, Bulgarian Academy of Science, Varna, Bulgaria
- Plymouth Marine Laboratory, Plymouth, United Kingdom
- University of Bristol, QUEST Project, United Kingdom
- University of Sherbrooke, Quebec, Canada

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The JRC Institute for Environment and Sustainability

“Sound science changes hearts and minds. We neglect it at our peril.”

MÁIRE GEOGHEGAN QUINN

European Commissioner for Research, Innovation and Science



STRUCTURE OF THE INSTITUTE FOR ENVIRONMENT AND SUSTAINABILITY

The Institute for Environment and Sustainability is one of the seven scientific institutes that make up the Joint Research Centre. The IES itself is made up of the Directorate, the Management Support Unit, and Research Actions that are grouped into six scientific Units within the Institute.



Units and their Research Actions in the 7th EU Framework Programme for Research and Technological Development (Status 2009)
Director: Leen Hordijk (as of 16 May 2008) – (*Guido Schmuck – acting – until 15 May 2008*)

- 1 **Directorate (Head: Leen Hordijk)**
 - Office of the Director (Head: Pam Kennedy)
 - ENVIHEALTH – Health Impact Assessment of Environmental Risk Factors (Leader: Peter Pärt)
- 2 **Management Support Unit (Unit Head: Neil Hubbard)**
- 3 **Climate Change Unit (Unit Head: Frank Raes)**
 - GAPCC – GLOBAL AIR POLLUTION AND CLIMATE CHANGE (Leader: Rita van Dingenen)
 - GHG-AFOLU – GREENHOUSE GASES IN AGRICULTURE, FORESTRY AND OTHER LAND USES (Leader: Alessandro Cescatti)
 - ICPA-EEI – INTEGRATED CLIMATE POLICY ASSESSMENT: EMISSIONS AND ENVIRONMENTAL IMPACTS (Leader: John van Aardenne)
- 4 **Global Environment Monitoring Unit (Unit Head: Alan Belward)**
 - PROCAS – PROTECTION AND CONSERVATION OF EUROPEAN SEAS (Leader: Nicolas Hoepffner)
 - SOLO – SYSTEMATIC OBSERVATIONS OF LAND AND OCEANS (Leader: Mark Dowell)
 - MONDE – MONITORING NATURAL RESOURCES FOR DEVELOPMENT CO-OPERATION (Leader: Andreas Brink)
 - TREES-3 – GLOBAL FOREST RESOURCE MONITORING (Leader: Frédéric Achard)
 - AU-EU THEMATIC PARTNERSHIP (Leader: Philippe Mayaux) (renamed ‘ACP¹ Observatory’ in 2010)
- 5 **Transport and Air Quality Unit (Acting Unit Head: Alois Krasenbrink)**
 - SusTrans – SUSTAINABLE TRANSPORT (Leader: Adolfo Perujo) (merged with TransTech in 2010)
 - TransTech – TRANSPORT TECHNOLOGIES AND EMISSIONS (Leader: Giorgio Martini)
 - APE – AIR POLLUTION AND EFFECTS (Leader: Annette Borowiak) (renamed ‘APA²’ in 2010)
 - AIRMODE – AIR QUALITY AND TRANSPORT MODELLING (Leader: Panagiota Dilara)
 - REM – RADIOACTIVITY ENVIRONMENTAL MONITORING (Leader: Marc De Cort)
- 6 **Rural, Water and Ecosystem Resources Unit (Unit Head: Giovanni Bidoglio)**
 - AGRI-ENV – INTEGRATION OF ENVIRONMENT CONCERNS INTO AGRICULTURE (Leader: Palle Haastrup)
 - ATEAM – AQUATIC AND TERRESTRIAL ECOSYSTEMS ASSESSMENT AND MONITORING (Leader: Giovanni Bidoglio – acting)*
 - EEWAI – EUROPEAN ECOLOGICAL WATER QUALITY AND INTERCALIBRATION (Leader: Ana Cristina Cardoso)*
 - ENSURE – ENVIRONMENTAL ASSESSMENT OF EUROPEAN WASTE AND THE SUSTAINABLE USE OF RESOURCES (Leader: David Pennington)
- 7 **Spatial Data Infrastructures Unit (Unit Head: Alessandro Annoni)**
 - COSIN-JRC – COMMUNITY SPATIAL INFORMATION NETWORK (Leader: Stephen Peedell) (terminated in December 2009)
 - INSPIRE – INFRASTRUCTURE FOR SPATIAL INFORMATION IN EUROPE (Leader: Paul Smits) (renamed SHAPE³ in 2010)
- 8 **Land Management and Natural Hazards Unit (Unit Head: Guido Schmuck)**
 - FOREST – FOREST DATA AND INFORMATION SYSTEMS (Leader: Jesús San Miguel-Ayanz)
 - SOIL – SOIL DATA AND INFORMATION SYSTEMS (Leader: Luca Montanarella)
 - DESERT – DESERTIFICATION, LAND DEGRADATION, AND DROUGHT (Monitoring, Mitigation and Early Warning) (Leader: Jürgen Vogt)
 - FLOODS – Prediction, MITIGATION, IMPACT ASSESSMENT OF NATURAL HAZARDS (Leader: Ad De Roo)

¹ ACP = Africa-Caribbean-Pacific countries

² APA = Air Pollution Assessment

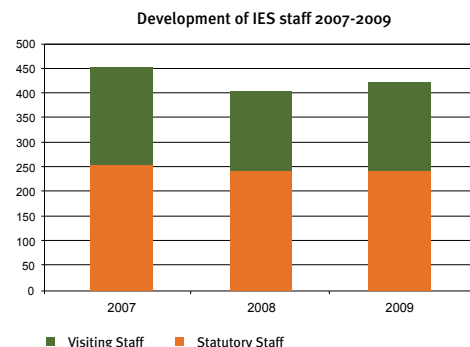
³ SHAPE = SHAring Policies for the Environment

* Reorganised in 2010 with the initiation of two new Actions: MAPLE and BIOMES.

FACTS AND FIGURES

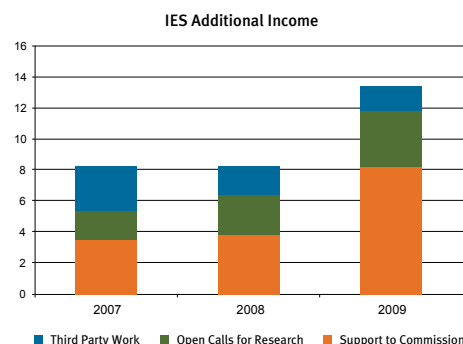
Human Resources

IES staff is made up of statutory staff (EU officials) and visiting staff. Following the transfer of the Renewable Energies Unit from the IES to the Institute for Energy (IE) in February 2008, there was a drop in IES staff numbers. Since then, staff growth has largely been funded by the increase in competitive activities (see 'Funding' below). In December 2009, the Institute had a total of 423 staff members: 57% statutory staff and 43% visiting staff, the latter divided into Contract Agents (18%), Grant Holders (14%), Trainees (8%) and Seconded National Experts (3%). The main staff growth area for 2010 is expected to come in the form of Grant Holders.



Funding of the IES

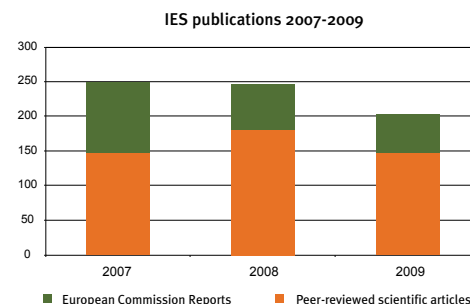
The IES receives its funding from two sources: the EU Research Framework Programme (approximately EUR 50 million in 2009) and additional income obtained directly from customers (also referred to as 'competitive income', approximately EUR 13.5 million in 2009). As can be seen from the chart, this latter income source increased substantially in 2009 compared to previous years. It is split into directly funded support to Commission services, participating with partners in open calls for research projects, and carrying out contract work for third parties. The recent growth in this income source reflects the increasing customer orientation of IES activities.



The IES budget is principally allocated to cover staff costs, research credits (the costs of carrying out research) and contributions to funding the overheads of the Ispra site.

Publications

One measure of the scientific performance of the IES is the number of peer-reviewed manuscripts that are published each year. Over the 2008-09 period greater emphasis was put on publishing in peer-reviewed scientific journals rather than as European Commission reports (blue and yellow respectively in the graph). Over the past three years the number of refereed articles peaked in 2008. In 2009, a high turnover of temporary (visiting) staff whose contracts came to an end resulted in a drop in scientific output. As old contracts ended others began, and new staff members who joined the IES in 2009 are expected to start publishing in the second and third years of their contracts. The number of articles which the IES co-authored with scientists working in other JRC Institutes has also risen over the 2008-09 period.



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<http://www.peer.eu/>



<http://www.alterra.wur.nl>



<http://www.ceh.ac.uk>



<http://www.cemagref.fr>



<http://ies.jrc.ec.europa.eu/>



<http://www.dmu.dk>



<http://www.ymparisto.fi>



<http://www.ufz.de>

COLLABORATING WITH OUR PEERS

Key institutional networks of the IES

The IES has enjoyed eight years as a partner in a strategic alliance of major European environmental research centres in the framework of **PEER (Partnership for European Environmental Research)**. The PEER members are:

ALTEERRA	Wageningen University and Research Centre (The Netherlands)
CEH	Centre for Ecology and Hydrology (United Kingdom)
CEMAGREF	Centre for Agricultural and Environmental Engineering Research (France)
JRC-IES	Institute for Environment and Sustainability (European Commission)
NERI	National Environmental Research Institute (Denmark)
SYKE	Finnish Environment Institute (Finland)
UFZ	Helmholtz Centre for Environmental Research (Germany)

The goal of PEER is to strengthen the environmental sciences' knowledge-base for sustainable development and to foster innovative interdisciplinary research and cross-cutting approaches in support of national and European policy-makers. One of PEER's greatest assets is its unique capacity to address complex environmental questions using its pool of multi-disciplinary competences and activities.

Under the Chair of the CEH, PEER was extremely active in 2008-2009, completing a first common Climate Change initiative to explore novel approaches to mitigation and adaptation, and launching and completing two projects: *Comparative Analysis of European National Adaptation Strategies*, (coordinated by ALTEERRA) and *Policy Integration, Coherence and Governance*, (coordinated by SYKE). More information can be found on http://www.peer.eu/projects/peer_climate_change_projects/.

2009 also saw the final conference of one of PEER's flagship projects 'METIER' (METHODS of Interdisciplinary Environmental Research), which concluded a four-year series of training courses on inter-disciplinary skills for young environmental researchers. The IES and JRC headquarters co-organised the conference with PEER.

Peering into the future...

In 2010, the PEER institutes will give more focus to the exchange of staff between the institutes and to creating training opportunities for young researchers. A common initiative will also be launched in the field of ecosystem services in Europe, which will focus on spatial analysis for policy assessment.



On Chairing PEER

"It's quite an awesome experience being the Chair of PEER. As the figurehead of a partnership involving seven of the most important and influential environmental research organisations in Europe, the role of Chair is both exhilarating and daunting. My first task was to host the PEER workshop on environmental information. Besides contributing to the workshop, the IES ensured the sensitivities of creating a shared information system were respected, which was essential for the workshop's success. During my 'term of office,' one of the exciting tasks handed me by my predecessor, Georg Teutsch, was to ensure the outputs of our two climate change projects (in Adaptation and in Policy Integration) were suitably promoted. With contributions from all PEER partners, we had a joint press release and a presentation event in Brussels. The IES played a central role through Leen Hordjik, ensuring we attracted important influencers in DG Environment and DG Research to the launch event. Being Chair has certainly opened my eyes to how powerful a group PEER can be when it works together, and the value of having the IES of the JRC as a member. I hope my successor, Henrik Sandbeck, enjoys the role as much as I have."

PAT NUTTALL

Director of the Centre for Ecology and Hydrology

AQUILA – AIR QUALITY REFERENCE LABORATORIES

The **AQUILA Network**, founded by the IES in 2001, is made up of 37 National Air Quality Reference Laboratories who are legally responsible for the quality assurance of air pollutant measurements in their respective Member States. The Network aims to:

- Provide expert advice on promoting the harmonisation of EU air quality measurements;
- Coordinate quality control, method development and validation activities.
- Participate in standardisation activities;
- Develop common research projects and pilot studies;
- Provide a forum for information exchange in the form of training courses, workshops and conferences.

The AQUILA chairmanship is elected on a rotating basis, with a permanent co-chair being held by DG Environment and the IES. The secretarial organisation is carried out by the IES.

Highlights of 2008-2009

- In collaboration with the JRC's Institute for Reference Materials and Measurements (IRMM), the IES developed reference material for polycyclic aromatic hydrocarbons and heavy metals in particulate matter.
- A European quality assurance programme for particulate matter (PM_{2.5} and PM₁₀) was carried out in 18 Member States.



<http://ies.jrc.ec.europa.eu/aquila-homepage.html>



Members of AQUILA



From the chairman:

“The AQUILA Network...offers a vivid forum for information exchange and problem solving to all Member States and Candidate Countries, and involves the EEA and other stakeholders. As co-chair and secretariat the IES offers the necessary long-term stability and commitment to continue this successful activity.”

DR ULRICH PFEFFER

Chairman of the AQUILA Network, North Rhine Westphalia Environment Agency, Germany

ESBN - THE EUROPEAN SOIL BUREAU NETWORK

The **European Soil Bureau Network (ESBN)** was created in 1996 as a network of “Centres of Excellence” made up of 56 national soil science institutions and managed by IES staff. Its main tasks are to collect, harmonise, organise and distribute soil information for Europe. The IES hosts the secretariat of the ESBN and provides a central source for soil information relevant to the work of the European Commission.

The scientific quality of ESBN's work is guaranteed by a Steering Committee made up of 11 recognised European soil scientists and an Advisory Committee with delegates from the Member States. Results from studies are stored in the multi-scale European Soil Data Centre (ESDAC), which is designed to be the main source of geo-referenced information on European Soils (*see page 28*).

In 2009, the ESBN Plenary meeting was held in Hungary in conjunction with the “Bridging the centuries” conference which commemorated the 100 years' anniversary of the first ever international soil science meeting. The conference looked at developments in soil science over the past century whilst outlining current and future challenges facing the soil science community. Of particular concern were the pressures of biofuel production versus food security and the increasing recognition by policy makers of the range of ecosystems services provided by soil (*see page 20*).



ESBN in action

ESBN website:

http://eussoils.jrc.ec.europa.eu/esbn/esbn_overview.html



From the chairman:

“Today's environmental problems require new approaches and solutions. Bridging science, practice and politics is necessary. The IES is strongly solution oriented and contributes to a new way of thinking. In cooperation with its partners a synergy effect is realised.”

ARNOLD H. ARNOLDUSSEN

President European Soil Bureau Network (ESBN) 2007 – 2009

Soil-friendly farming

JRC report assesses soil degradation in Europe and identifies opportunities for soil-friendly farming (JRC PR, 14.02.2009)

A joint IES-IPTS report, 'Addressing soil degradation in EU agriculture: relevant processes, practices and policies', identifies the six soil degradation processes most closely linked to agriculture: erosion, organic matter decline, compaction, salinisation or sodification, contamination and decline in soil biodiversity. It found that water and wind erosion can be mitigated through conservation agricultural practices and setting up buffer zones, and organic carbon content can be retained and increased through sustainable farming practices (such as crop rotation and reduced tillage).

See <http://soco.jrc.ec.europa.eu/documents/EUR-23767-web.pdf> and pages 26-27 for more info on sustainable agriculture.



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VELA 7 – testing trucks and busses

Greening buses and trucks! Commission’s research centre opens new CO₂ emissions testing laboratory (JRC PR, 15.03.2009)

On 15 March 2009, the European Commissioner for Science and Research, Janez Potočnik, opened a new facility for testing fuel consumption and emissions of trucks and buses at the IES. The new installation, “VELA 7”, realistically simulates wind drag, tyre/road friction and full drive cycles for real-life articulated lorries of up to 40 tonnes or 12m-long buses. It comes at a crucial time as implementation guidelines for new emission standards, notably the Euro VI standards regarding heavy duty vehicles, must be defined by 1 April 2010. See page 10 for more information on VELA.



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New powerful pattern recognition system

European Commission researcher’s pattern-recognition programme adopted by U.S. services (JRC PR, 15.02.2009)

A powerful pattern recognition programme developed within the IES is being adopted by specialists in US federal agencies, including the Environmental Protection Agency (EPA). Based on Morphological Spatial Pattern Analysis (MSPA), the programme follows a customised sequence of image processing steps to highlight the different geometric features of objects in a given image, e.g. recognising various types of geographical land-cover features. It can be used for a vast range of applications, for example it can spot manufacturing defects on a circuit board, distinguish between healthy and clogged arteries in medical diagnostics and identify polluted downstream waters following environmental incidents. The programme is available for free download from <http://forest.jrc.ec.europa.eu/download/software/guidos>.



MSPA application in environmental monitoring

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Sharp increase in greenhouse gas emissions

Greenhouse gas emissions growing faster since 2000: new data on worldwide emissions 1970-2005 (JRC PR, 25.05.2009)

A joint IES – PBL study, the Emissions Database for Global Atmospheric Research (EDGAR), found that global man-made greenhouse gas (GHG) emissions rose sharply (by 15%) between 2000-2005, compared to earlier increases of 3% (1990-1995) and 6% (1995-2000). GHG emissions were found to be higher in developing than in industrialised countries since 2004, while emissions *per capita* in developing countries were much lower (4 compared to 15 tonnes *per capita* in industrialised countries).

See <http://edgar.jrc.ec.europa.eu/> and pages 56-57 for more information on EDGAR.



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Forest fires

Forest fire damage in 2009 already higher than in 2008 (JRC PR, 10.08.2009)

Estimates from EFFIS (European Forest Fire Information System) (see page 50) show that 200 000 ha of land in the EU had already burned by August in 2009, compared to a total of 180 000 ha in 2008. EFFIS uses satellite images to produce daily updated maps of areas burned by forest fires. Spain and Italy were the most affected in 2009 due to the extreme fire weather conditions in the second half of July, but France, Greece and Portugal also suffered significant damage.

See pages 50-51 for more information on EFFIS.



'08 / '09

COMMUNICATING WITH THE PUBLIC

Websites, publications and visits

A selection of topics covered by IES Scientific and Technical Reports in 2008 and 2009

Morphological spatial pattern of forest ecosystems

Urban aerosols in the Western Mediterranean

Climate change and desertification

Next generation digital Earth

Forest fires in Europe

Pressures on European surface water

High Nature Value farmland

Threats to soil quality in Europe

Future air pollution mitigation strategies

Climate anomalies and human ignition factor on wildfires in Russian Boreal Forest

Supporting EU climate change policy making

Transport sustainability performance

Climate change effects on physical characteristics of European lakes

Measuring elemental and organic carbon in Europe

Environmental radioactivity in the European Community

External costs of maritime transport

Landslide mapping in Austria

Websites

The website of the IES can be found at <http://ies.jrc.ec.europa.eu/>. It contains information on the structure and activities of the IES, its data portals, documentation, job opportunities and contact information, as well as links to separate websites of the different Units within the Institute. Regular updates include the highlight of the month, the IES monthly reports, open positions and JRC press releases regarding IES activities.

Visits and Visitors

Aside from the standard working groups, workshops *etc.*, the IES welcomed many delegations from the European Parliament, national research institutes, Commissioners, Director Generals and general visits from the JRC's and the IES' customers and stakeholders in 2008 and 2009. Over the course of the two years, IES staff organised over 200 presentations, poster sessions, tours and demonstrations in the IES' laboratories and facilities.

The IES also organised laboratory visits and interactive science shows at the JRC's Schools Day (2008) and the JRC's Open Day on the Ispra Site (2009).

Publications

The IES' work is published in a wide variety of reports, articles, books and monographs. Every year between 150 and 200 IES scientific articles are published in peer-reviewed scientific journals. We also give many presentations and poster sessions at scientific conferences and seminars, of which over 60 appear annually in peer-reviewed conference proceedings. In addition, our scientists describe their work in the JRC's dedicated Scientific and Technical Reports which amount to another 50-75 publications every year. These latter reports can be directly downloaded from the online JRC Publications Repository, which also holds bibliographic information about other JRC publications. <http://publications.jrc.ec.europa.eu/repository/>



Scientific events

Over the 2008-09 period the IES organised, co-organised and participated in various scientific events such as conferences, seminars and workshops. This outreach exercise is an opportunity for the IES to share knowledge and strengthen relations with key stakeholders, including research partners, policy makers, governments, governmental agencies, service providers and interested third parties. As a result, the cooperation process becomes smoother and paves the way for advancing the science of environmental protection and sustainability. In addition, each event gives the IES the opportunity to make its scientific work and results known to a wider audience.



UNCCD 1st Scientific Conference - Bio-physical and Socio-economic Monitoring and Assessment of Desertification and Land Degradation to Support Decision Making in Land and Water Management (September 2009, Buenos Aires, Argentina).



3rd INSPIRE Conference, "GSDI/INSPIRE: Building SDI Bridges to Address Global Challenges" (June 2009, Rotterdam, The Netherlands)



American Association for the Advancement of Science (AAAS), "Earth Observation for Africa, with Africa" (February 2008, Boston, USA)

Major scientific events in which the IES has had an active role include:

- American Association for the Advancement of Science (AAAS), "Earth Observation for Africa, with Africa" (February 2008, Boston, USA).
- The ninth meeting of the Conference of the Parties (COP9) of the Convention on Biological Diversity (May 2008, Bonn, Germany).
- 2nd INSPIRE Conference, "INSPIRE: Implementation and Beyond" (June 2008, Maribor, Slovenia).
- "Climate 2008" – The first global, virtual climate conference (November 2008).
- American Association for the Advancement of Science (AAAS), "Our Planet and Its Life: Origins and Futures" (February 2009, Chicago, USA).
- "GMES and Africa" (March 2009, Ispra, Italy).
- ISRSE 2009: The 33rd International Symposium on Remote Sensing of Environment, "Sustaining the Millennium Development Goals" (May 2009, Stresa, Italy).
- 3rd INSPIRE Conference, "GSDI/INSPIRE: Building SDI Bridges to Address Global Challenges" (June 2009, Rotterdam, The Netherlands).
- UNECE's 148th session of the World forum for harmonization of vehicle regulations (WP.29) (June 2009, Geneva, Switzerland).
- 1st Joint DMCSEE-JRC Workshop on Drought Monitoring (September 2009, Ljubljana, Slovenia).
- UNCCD 1st Scientific Conference, "Bio-physical and Socio-economic Monitoring and Assessment of Desertification and Land Degradation to Support Decision Making in Land and Water Management" (September 2009, Buenos Aires, Argentina).
- Ocean Colour 2009 Africa, "Methods and Applications of Ocean Colour Remote Sensing in African Coastal and Regional Seas" (October 2009, Zanzibar, Tanzania).
- 2nd European Conference on Public Health (November 2009, Lodz, Poland).



The first global, virtual climate conference "Climate 2008" (November 2008)



Erica Roggio
Bari, Italy



Harald Scholz
Düsseldorf, Germany

EXPLORATORY RESEARCH

Exploring the future

The IES makes a conscious effort to invest in anticipatory research which may not necessarily have a customer in mind but which is designed to support complex future policy issues. In 2008 and 2009, the Institute ran more than ten Exploratory Research (ER) projects.

Following the JRC's external review and the subsequent 'King Report' in 2008, the JRC was asked to increase the role and visibility of its ER. It was also recommended that foresight studies or anticipatory research be promoted.

In 2009, the IES drafted new guidelines for ER which introduced greater competition and also liberated more personnel resources to undertake ER. The Director invited IES staff members to submit ER proposals in line with the IES' Annual Work Programme and strongly encouraged collaboration between IES Units and with other JRC Institutes. Twenty-nine proposals were originally submitted, out of which four projects were selected for funding in 2010:

- Next Generation Digital Earth (IES, Google Earth©)
- Land-Use Modelling – A systems-based approach (IES, IPTS, IPSC)
- Environmental toxicity and fate of nano-particles (IES, IHCP)
- Effects of eco-innovations on CO₂ emission reduction from light duty vehicles (IES, IE).

“The most exciting phrase to hear in science, the one that heralds the most discoveries, is not ‘Eureka!’, but ‘That’s funny...’”

ISAAC ASIMOV, *Russian novelist*



“Exploratory research is really like working in a fog. You don’t know where you’re going. You’re just groping. Then people learn about it afterwards and think how straightforward it was.”

FRANCIS CRICK

British Nobel Prize Laureate for discovering the structure of DNA together with James D. Watson

“The important thing is not to stop questioning”

ALBERT EINSTEIN, *German Nobel Prize Laureate (Physics)*



As part of the corporate strategy, ER projects from each Institute are presented to the Director General and all other Institutes at an annual ER symposium. The two IES projects selected for the 2008 and 2009 symposiums are briefly described below:

2008: MODELLING OF DIESEL-ENGINE EXHAUST NANO-PARTICLE DYNAMICS

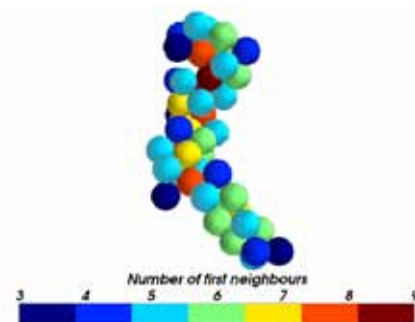
By Lorenzo Isella, Yannis Drossinos and Barouch Giechaskiel



L. Isella, Y. Drossinos and B. Giechaskiel

This project involved the development of a set of computational tools to model the dynamics of combustion-generated nano-particles in vehicle-emission systems. It demonstrated that a proper understanding of the dynamics of soot particles could have repercussions for the currently legislated vehicle-emission systems, especially those that measure non-volatile particle number emissions (as required by Euro V and Euro VI legislation).

The results were published in “Diesel-exhaust aerosol dynamics from the tail-pipe to the dilution tunnel”, *Journal of Aerosol Science* 39 (2008): 737-758.



A computer-generated soot aggregate composed of 50 monomers. The color code denotes the number of first monomer neighbors.

2009: MULTI-MODEL ENSEMBLE MODELLING

By Stefano Galmarini and Slawomir Potemski

Multi-model ensemble modelling is a relatively new technique consisting of statistically combining multiple model simulations to improve individual model performance. This research project aimed at improving the ensemble technique in the context of atmospheric dispersion and air quality.

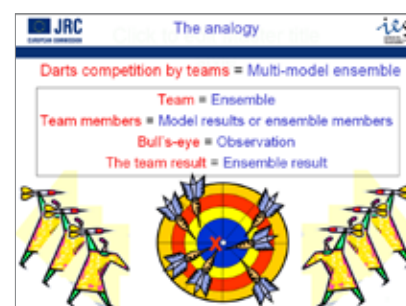
The results show the importance of variance of the individual model results used for the ensemble treatment, and how useful this information can be in defining the ensemble characteristics and in guaranteeing that the behaviour of the latter will fulfil expectations. The results show that an appropriate model characterisation would greatly help in the selection of those models which really bring added value to the ensemble result (see page 39).



S. Galmarini



S. Potemski



Multi-model Ensemble Modelling analogy

“Many of the inventions we now take for granted are the result of research that had no apparent commercial purpose. The internet is the outstanding example. So, excellence in frontier research is a must.”

MÁIRE GEOGHEGAN QUINN
EU Commissioner for European Research,
Innovation and Science Policy, 2010

STRIVING FOR EXCELLENCE

JRC and IES Excellence Awards 2008-2009

Each year, excellent scientific and administrative performance is recognised and acclaimed at the levels of both the JRC and the Institute.

Over the past two years, the work of IES staff members has been highly acclaimed at the JRC-level under the award categories for 'Best Young Scientist', 'Peer-Reviewed Scientific Paper', 'Support to EU Policy', 'Technical Assistance' and 'Administrative and Site Support'. At the Institute level, 15 IES staff members were awarded for their excellent achievements in 2008 and a further 18 in 2009 across all categories of awards. A flavour of their work is given below. IES staff members are indicated in 'bold'.



JRC EXCELLENCE AWARDS 2008



Category 'Best Peer-reviewed Scientific Paper'

MARIJN VAN DER VELDE¹ and **FAYÇAL BOURAOUI**² (2009): Pan-European regional-scale modelling of water and N efficiencies of rapeseed cultivation for bio-diesel production. *Global Change Biology Journal*, 15 (1): 24-37.



Category 'Support to EU Policies'

FRÉDÉRIC ACHARD¹, **GIACOMO GRASSI**², **HUGH EVA**³, **PHILIPPE MAYAUX**⁴, **SUVI MONNI**⁵, **HANS-JÜRGEN STIBIG**⁶ – Supporting the development of the European climate change policy in two issues currently debated within the UNFCCC climate negotiations: REDD (reducing emissions from deforestation and degradation in developing countries) and LULUCF (Land Use, Land Use Change and Forestry).



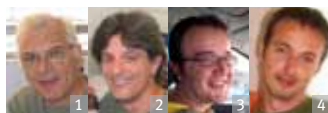
Robert Edwards, **VINCENT MAHIEU**, Szabolcs Szekeres and Frederik Neuwahl – Support for the EU biofuels policy and involvement in the formulation of the Commission proposal for a directive on promotion of the use of renewable resources.

JRC EXCELLENCE AWARDS 2009



Category 'Support to EU Policies'

Antonio Soria, Juan Carlos Císcar Martínez, László Szabó, Denise van Regemorter, Guillaume Leduc, Françoise Némry Catharina Bamps, **LUC FEYEN**¹, **RUTGER DANKERS**², **KATALIN BÓDIS**³, **JOSÉ BARREDO**⁴, **AD DE ROO**⁵, **CARLO LAVALLE** (JRC-IPTS and IES) – Project on the Impacts of Climate Change in Europe (PESETA).



Category 'Technical Assistance'

VALERIO PAGLIARI¹, **DAVID ROUX**², **FULGENCIO SAN MARTIN**³, **LORENZO ORLANDINI**⁴ – Development and setup of EDGAR, the Emissions Database for Global Atmospheric Research.

<http://edgar.jrc.ec.europa.eu/index.php>



Category 'Administrative and Site Support'

LUIGI ROGORA¹ and **RAINER SCHUBERT**² – Creation of a new modern and effective IES documentation archive and innovative use of a refurbished building to meet the requirements of storing over 22 000 soil samples in a new European Soil Archive.

IES EXCELLENCE AWARDS 2008

Category 'Best Peer-reviewed Scientific Paper'

ADRIAN LEIP¹, GIULIO MARCHI², R. Koeble, M. Kempen, W. Britz and C. Li. (2008): Linking an economic model for European agriculture with a mechanistic model to estimate nitrogen and carbon losses from arable soils in Europe. *Biogeosciences* 5: 73-94.



STEFANO GALMARINI, J.F. Vinuesa and A. Martilli (2008):

Modelling the impact of sub-grid scale emission variability on upper-air concentration. *Atmospheric Chemistry and Physics* 8: 141-158.



ALBERTO PISTOCCHI (2008): A GIS-based approach for modelling the fate and transport of pollutants in Europe. *Environmental Science and Technology*, 42: 3640-3647.



Category 'Technical Assistance'

TANIA HUBER¹, GIOVANNI LOCORO², GIULIO MARIANI³, JAN WOLLGAST⁴, HELLE SKEJO⁵, ANNE MUELLER⁶, BRUNO PARACCHINI⁷, MICHELA GHIANI⁸, SERAFINO CONTINI⁹, JOAQUIN PINTO GRANDE¹⁰ – Contribution to the 2nd Joint Danube Survey.



IES EXCELLENCE AWARDS 2009

Category 'Best Young Scientist'

MARIJN VAN DER VELDE – Outstanding publication record and ability to work in a multi-disciplinary setting. Marijn's research made a major contribution to the IES' activities in integrated agri-environmental assessments, particularly in the areas of food production, climate change, water resources and biofuels.



Category 'Best Peer-reviewed Scientific Paper'

MICHEL M. VERSTRAETE, Robert J. Scholes, and Mark Stafford Smith (2009): Climate and desertification: Looking at an old problem through new lenses. *Frontiers in Ecology and the Environment*, doi:10.1890/o80119.



RITA VAN DINGENEN¹, FRANK DENTENER², FRANK RAES³, Maarten C. Krol, Lisa Emberson, Janusz Cofala (2009):



The global impact of ozone on agricultural crop yields under current and future air quality legislation. *Atmospheric Environment*, 43 (3): 605-618.

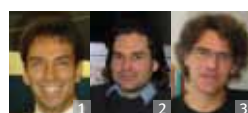
SLAWOMIR POTEMPSKI¹ and STEFANO GALMARINI²



(2009): *Est modus in rebus*: Analytical properties of multi-model ensembles. *Atmospheric Chemistry and Physics*, 9: 9471-9489.

M. Cassiani, J. F. Vinuesa, STEFANO GALMARINI and B. Denby (2009): Stochastic fields method for sub-gridscale emission heterogeneity in mesoscale atmospheric dispersion models. *Atmospheric Chemistry and Physics Discussions*, 9: 15215-15245.

BAROUCH GIECHASKIEL¹, BALINT ALFÖLDY², YANNIS



DROSSINOS³ (2009): A metric for health effects studies of diesel exhaust particles. *Journal of Aerosol Science* 40: 639-651.

Category 'Support to EU Policy'

JEAN-MICHEL TERRES, FABIEN RAMOS, ÅSE MARI ELIASSON AND KRISTIN BÖTTCHER: Support to Common Agricultural



Policy: new delimitation of the Less Favoured Areas (LFA) in Europe.

MICHEL MILLOT: Technical coordination of INSPIRE.



RUDOLF HUMMEL: Worldwide harmonised technical regulation for the non-road transient test cycle.

Category 'Knowledge Transfer'



BRUNO COMBAL: Implementation of the e-station in Africa.

FEEDBACK FROM OUR PARTNERS

Many of today's environmental challenges are global. Partnerships in the EU and global scientific communities have never been more important in tackling these global issues and finding sustainable solutions. The statements below provide an insight into how our partners and customers see the IES' role as a scientific hub and catalyst to bring people together from different disciplines across the globe in order to better address the challenges facing Europe and the world.



“The Department for Human Resource Science and Technology appreciates the cooperative spirit demonstrated by the JRC’s Institute for Environment and Sustainability in the framework of the preparation phase of the Pan-African University and of the EU-Africa Partnership on Science, Space and Information Technology, and in particular for the preparation of the GMES and Africa action plan.”

JEAN-PIERRE ONVEHOUN EZIN
*Commissioner for Human Resources, Science and Technology
African Union Commission*

“The JRC’s Institute for Environment and Sustainability (IES) is an excellent partner of the European Environment Agency (EEA). It is a key source of high quality information and knowledge, contributing significantly to the EEA’s work. By cooperating closely, the IES and the EEA make sure that there is a solid basis for Europe’s decision-makers to take informed decisions on environmental issues.”

JACQUELINE MCGLADE
Executive Director, European Environment Agency



“There is a long-term partnership between the JRC’s Institute for Environment and Sustainability and the International Commission for the Protection of the Danube River and we appreciate the outstanding expert support from the IES in the areas of flood protection, water quality assessment and GIS that is helping to achieve the goals of sustainable river basin management on the Danube.”

PHILIP WELLER
ICPDR Secretary-General (Danube Commission)



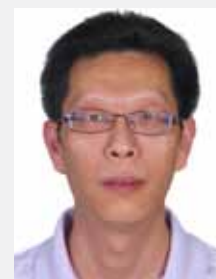
“The time and expense of securing quality data is often used to excuse taking a holistic, life-cycle, evidence-based approach to managing environmental impacts. ACE and its member companies therefore welcome and support the Institute for Environment and Sustainability’s efforts to overcome this obstacle by working in partnership with industry to ensure availability of representative data. We see this as an important step enabling better measurement – and therefore management – of the environmental performance of products through the value chain.”

CHRISTIAN VERSCHUEREN
Director General, ACE – the Alliance for Beverage Cartons and the Environment



“The collaboration of the Chinese Standards Organization (CNIS) and the JRC’s Institute for Environment and Sustainability (IES) in the development of the ILCD Handbook has proven to be a very great opportunity for both China and the JRC to compare Chinese and European LCA inventory data. CNIS will benefit from the experiences of the IES in dealing with data format and data quality control according to the ILCD Handbook, and hopes to further cooperate with the IES in the future development of the ILCD.”

JIN HUANG
Senior Professor CNIS



“The JRC’s Institute for Environment and Sustainability provides recognized leadership in bringing together the technical community to meet the challenges of our changing environment. Through its world-class staff and its comprehensive understanding of technical and environmental challenges, the IES is addressing some of the most important and complex issues facing Europe and the world.”

JAY PEARLMAN
Chair of the Institute of Electrical and Electronics Engineers (IEEE)

Research activities provided by JRC have given an important contribution to the work of Civil Protection and other disaster management institutions with the emphasis on improving our knowledge and capacity related to preparedness and prevention of hazards, forecasting and early warning of emerging risks and a necessary component to mitigate damage and human losses, especially in the field of forest fires and floods. The importance of JRC research is also increasing regarding the impact of climate change on natural and technological hazards.

PIA BUCELLA
*Director of Communication, Governance, and Civil Protection
Directorate General for the Environment*



“Accounting rules for forests and land uses can have an important impact on the overall level of ambition of emission reduction commitments. Getting an accurate description and quantification of greenhouse gas emissions and removals from forestry and land use activities, both happening now and expected to happen in the future, is critical to promote sustainable land use systems in the context of successful international climate policy. Operating at the interface of science and policy, the JRC’s Institute for Environment and Sustainability provided invaluable support, not only as part of the Commission’s negotiating team but to all international negotiators in this field, in the run up and during the Copenhagen Climate Change Summit. The need for such targeted support is likely to further increase in the future.”

ARTUR RUNGE-METZGER
*Director of Directorate “International and Climate Strategy”
Directorate General for Climate Action*



A LOOK TO THE FUTURE

Just as we have recently turned a page into the second decade of the 21st Century, the JRC has also turned a page with the preparation of a 10-year Corporate Strategy – “Integrating Robust Science for Policy-Making”. I am now looking forward to the implementation of this strategy which will involve enhanced collaboration with colleagues across the JRC in order to better tackle the global and increasingly complex environmental challenges facing us today.

At the heart of the Institute’s research activities will be the ‘sustainable management of natural resources’, which is one of seven Thematic Areas that make up the JRC’s portfolio for the period 2010-20. As the JRC strives to provide science-based policy options, the IES will expand on its socio-economic skills and further develop its policy analysis and integrated assessment of interrelated research areas, for example, climate change and biofuels.

I will also invest in reinforcing the Institute’s foundations in exploratory research and encourage a more forward-looking, pro-active approach to our research. I’m acutely aware that tackling global issues requires teamwork, and I consider our partnerships within the EU and the global scientific community to be of paramount importance in maintaining internationally-recognised research. The IES is committed to improving its organisational performance and to increasing the satisfaction of its customers and staff in the future, as is evident in our efforts to achieve ISO 9001 certification for quality management by Spring 2010.

All of these developments will take the IES and the JRC further along the path towards better addressing the European Commission’s priorities which will guide EU policy-making in the years to come, *i.e.* creating a competitive, connected and greener economy, empowering people in inclusive societies, and creating value by basing growth on knowledge.

As a closing note, I very much hope you have enjoyed reading about the activities of the IES and that you are now inspired to join the efforts to safeguard an environment which our children and grandchildren will be proud to inherit.

LEEN HORDIJK

Director, Institute for Environment and Sustainability

“To achieve a sustainable future, we must already look beyond the short term. Europe needs to get back on track. Then it must stay on track. That is the purpose of Europe 2020.”

JOSÉ MANUEL BARROSO
European Commission President



GLOSSARY OF ABBREVIATIONS

°C	<i>Degrees Celsius</i>	CEHIS	Connectivity between Environment and Health Information Systems	Dr	Doctor
²²² Rn	<i>Radon</i>	CEMA-GREF	Centre for Agricultural and Environmental Engineering Research (France)	DSD Consortium	Dryland Science for Development Consortium
3-D	<i>Three-dimensional</i>	CEN	European Committee for Standardisation	E955	<i>European Union food additive code for Sucralose</i>
AAAS	American Association for the Advancement of Science	CEOS	Committee on Earth Observation Satellites	EASA	European Aviation Safety Agency
ACCENT	Atmospheric Composition Change – the European Network of Excellence	CH ₄	<i>Methane</i>	EAWAG	Swiss Federal Institute of Aquatic Science and Technology
ACE	Alliance for Beverage Cartons and the Environment	CICOS	Commission Internationale du bassin Congo-Oubangui-Sangha, Democratic Republic of Congo (DRC)	EC	European Commission
ACEA	European Automobile Manufacturers' Association	CIFOR	Centre for International Forestry Research, Indonesia	EC	<i>elemental carbon</i>
ACP	African-Caribbean-Pacific countries	CIHEAM	Centre International de Hautes études Agronomiques Méditerranéennes (International Centre for Advanced Mediterranean Agronomic Studies), Italy	ECHAM5-HAM	Aerosol Climate Model
ACSAD	Arab Center for the Studies of Arid Zones and Dry Lands, Syria	CIRAD	Centre de coopération internationale en recherche agronomique pour le développement (Centre for international cooperation in agronomic research for development)	ECMWF	European Centre for Medium-Range Weather Forecasts, UK
AE	<i>Air pollutant emissions</i>	CITY-DELTA	European Modelling Exercise – An Inter-comparison of long-term model responses to urban-scale emission-reduction scenarios	ECN	Energy Research Centre of The Netherlands
AERONET	AERosol ROBOTIC NETwork	CLRTAP	UNECE Convention on Long-range Transboundary Air Pollution	ECOWAS	Economic Community Of West African States
AG-RHYMET	Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle	CM	<i>carbonaceous matter</i>	ECURIE	European Community Urgent Radiological Information Exchange
AGRI-ENV	Integration of Environment Concerns into Agriculture (IES Action)	CNIS	China National Institute for Standardization	ECV	Essential Climate Variables
AIRMODE	Air Quality and Transport Modelling (IES Action)	CNR	Italian Research Council (Consiglio Nazionale delle Ricerche)	ECVAM	European Centre for the Validation of Alternative Methods
AIST	Advanced Industrial Science and Technology	CO	<i>Carbon Monoxide</i>	EDGAR	Emissions Database for Global Atmospheric Research
ALOS	Advanced Land Observing Satellite	CO ₂	<i>Carbon Dioxide</i>	EDO	European Drought Observatory (IES map server)
ALTERRA	Dutch environmental research institute – part of Wageningen University and Research Centre	COM	Communication	Eds	Editors
AMESD	African Monitoring of the Environment for Sustainable Development	COMIFAC	Commission des Forêts d'Afrique Centrale	EEA	European Environment Agency
AMIS	African Marine Information System	CONCAWE	Conservation of Clean Air and Water in Europe – The oil companies' European association for environment, health and safety in refining and distribution	EEC	European Economic Community
APA	Air Pollution Assessment	COP	Conference of the Parties	EEWAI	European Ecological Water Quality and Intercalibration (IES Action)
APE	Air Pollution and Effects (IES Action, renamed APA in 2010)	COP9	Ninth meeting of the Conference of the Parties	EFAS	European Flood Alert System
AQMEII	Air Quality Model Evaluation International Initiative	CORINE	Coordination of information on the environment, a European programme initiated in 1985 by the European Commission	EFDAC	European Forest Data Centre
AQUILA	Air Quality Reference Laboratories	COSIN-JRC	Community Spatial Information Infrastructure (IES Action, renamed ENABLE in 2010)	EFFIS	European Forest Fire Information System
<i>asl</i>	<i>above sea level</i>	CRC Press	Chemical Rubber Company Press	EFIMED	Mediterranean Regional Office for the European Forest Institute
ATEAM	Aquatic and Terrestrial Ecosystems Assessment and Monitoring (IES Action, renamed MAPLE as of 2010)	CSIRO	Australian Commonwealth Science and Research Organisation	EFSA	European Food Safety Authority
AUC	African Union Commission	<i>ctrl</i>	<i>Control</i>	EIONET	European Environmental Information and Observation Network
AU-EU	African Union – European Union	Do/D1/D2...	Deliverable 0, 1, 2,....	ELCD	European Reference Life Cycle Database
AU-EU Thematic Partnership	African Union – European Union Thematic Partnership (IES Action)	DESERT	Desertification, Land Degradation and Drought - Monitoring, Mitigation and Early Warning (IES Action)	EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Agency)
AVHRR	Advanced Very High Resolution Radiometer	DG	Directorate-General	EMEP	European Monitoring and Evaluation Programme
BAFU	Bundesamt für Umwelt (Swiss Federal Office for the Environment)	DG ENV	Directorate-General for the Environment, also known as DG Environment	EMIS	Environmental Marine Information System
BAP	Biomass Action Plan (COM(2005) 628)	DG RELEX	Directorate-General for External Relations	EMPA	Swiss Federal Laboratories for Materials Testing and Research
BAU	Business-as-usual	DLDD	Desertification, Land Degradation and Drought	ENABLE	Environmental Information Systems Implementation and Evolution (IES 2010 Action, replaces COSIN-JRC Action)
BFG	German Federal Institute for Hydrology	DMCSEE	Drought Management Centre for Southeastern Europe	ENSEMBLE	A system which reconciles disparate national forecasts of medium and long-range atmospheric dispersion
BIOMES	Biodiversity, Water and Ecosystem Services (IES 2010 Action, replaces EEWAI Action)	DNA	<i>Deoxyribonucleic acid</i>	ENSO	El Niño Southern Oscillation
BIOSOIL	The Biosoil project is a study that monitors forest condition for the protection of forests against atmospheric pollution and against forest fires	doi	digital object identifier	ENSURE	Environmental Assessment of European Wastes and the Sustainable Management of Resources (IES Action)
Bq/m ³	<i>Becquerel per cubic metre (the unit for radioactive activity)</i>			ENVIHEALTH	Environment and Health (IES Action)
CAFE	Clean Air For Europe			ENVISAT	European Environment Research Satellite
CAP	Common Agricultural Policy			EPA	United States Environmental Protection Agency
CARB	California Air Resource Board			ER	Exploratory Research
CBD	Convention on Biological Diversity			ERLAP	European Reference Laboratory for Air Pollution
CEEAC	Communauté Économique des États de l'Afrique Centrale, Gabon			ERMES	European Research on Mobile Emission Sources
CEH	Centre for Ecology and Hydrology, United Kingdom				

ESA	European Space Agency	GHG-AFOLU	Greenhouse Gases in Agriculture, Forestry and Other Land Uses (IES Action)	IOCCG	International Ocean Colour Coordinating Group
ESBN	European Soil Bureau Network	GIS	Geographic Information Systems	IPCC	Intergovernmental Panel on Climate Change
ESDAC	European Soil Data Centre	GLOSIS	Global Soil Information System	IPCC A2	A2 scenario family of the IPCC Special Report on Emissions Scenarios
ESDB	European Soil Database	GMES	Global Monitoring for Environment and Security	IPSC	Institute for the Protection and Security of the Citizen (JRC Institute)
ETEX-2	European Tracer Experiment – 2	GMP	Global Monitoring Plan	IPTS	Institute for Prospective Technological Studies (JRC Institute)
EU	European Union	GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics	IRD	L'Institut de recherche pour le développement
EU27	27 Member-State European Union (as of 2007)	GRPE	UN Working Party on Pollution and Energy	IRIX	International Radiation Information Exchange
EUCAR	European Council for Automotive Research and Development	GSDI	Global Spatial Data Infrastructure Association	IRMM	Institute for Reference Materials and Measurements (JRC Institute)
EUGLOREH	EU Public Health Project – Global Report on the Health Status in the European Union	<i>Gt</i>	<i>Gigatonnes</i>	ISBN	International Standard Book Number
EUMET-Cast	EUMETSAT's Broadcast System for Environmental Data	GTOS	Global Terrestrial Observing System	ISO	International Organization for Standardization
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites	GTR	Global Technical Regulation	ISPRS	International Society for Photogrammetry and Remote Sensing
EURATOM	European Atomic Energy Community	<i>ha</i>	<i>hectares</i>	ISRIC	World Data Centre for Soils (International Soil Reference and Information Centre, NL)
EURDEP	European Radiological Data Exchange Platform	HNV	High Nature Value	ISRSE	International Symposium on Remote Sensing of Environment
Euro 6	European Emission Standard 6 for light duty vehicles. It will be binding for the type approval of vehicles as of 1 September 2014 and for the registration and sale of new types of cars and vans as of 1 September 2015	IADIZA-CONICET	Unidad de Ecología Animal, Instituto Argentino de Investigaciones de Zonas Áridas, Argentina	ITC	International Institute for Geo-Information Science and Earth Observation (NL)
Euro V	European Emission Standard V relating to the emissions from engines for use in heavy duty vehicles, which applies to new registrations as of October 2009	IAEA	International Atomic Energy Agency	IUPAC	International Union of Pure and Applied Chemistry
Euro VI	European Emission Standard VI for heavy duty vehicles, aimed at reducing emissions of nitrogen oxides and particulate matter from trucks and buses as of 2013	IBICT	Brazilian Institute for Informatics in Science and Technology	IUTA	Institute of Energy and Environmental Technology
EURO-DELTA	European Co-ordination on Mediterranean and Black Sea Deltas	ICES	International Council for Exploration of the Seas	IWW	Rheinisch-Westfälisches Institut für Wasser, Germany
EuroSDR	European Spatial Data Research Network	ICOS	Integrated Carbon Observation System	JEMAI	Japan Environmental Management Association for Industry
EUSAAR	European Supersites for Atmospheric Aerosol Research	ICPAC	IGAD Climate Prediction and Applications Centre	JRC	Joint Research Centre
EUSF	European Union Social Fund	ICPA-EEI	Integrated Climate Policy Assessment: Emissions and Environmental Impacts (IES Action)	JRC-IES	Official abbreviation of the Joint Research Centre – Institute for Environment and Sustainability
EUWI	European Union Water Initiative	ICPDR	International Commission for the Protection of the Danube River	<i>km</i>	<i>Kilometre</i>
<i>exp ann dam</i>	<i>Expected annual damages</i>	IE	Institute for Energy (JRC Institute)	KNNV	Royal Dutch Society for the Study of Wildlife
FAIR-MODE	Forum for Air Quality Modelling in Europe	IEA	International Energy Agency	Landsat	Land Remote-Sensing Satellite
FAO	Food and Agriculture Organization of the United Nations	IEEE	Institute for Electrical and Electronic Engineers	LCA	Life Cycle Assessment
FAO-SWALIM	FAO – Somalia Water and Land Information Management	IES	Institute for Environment and Sustainability (JRC Institute)	LCT	Life Cycle Thinking
fAPAR	fraction of Absorbed Photosynthetically Active Radiation	IFEU	Institute for Energy and Environmental Research	LSCE	Laboratoire des Sciences du Climat et de l'Environnement
FCHV	Fuel Cell Hydrogen Vehicle	IFT	Institute for Tropospheric Research	LULUCF	Land Use, Land Use Change and Forestry
FLEGT	Forest Law Enforcement of Governance and Trade	IGAD	Intergovernmental Authority on Development, Republic of Djibouti	MAN	Global Maritime Aerosol Network
FLOODS	Prediction, Mitigation, Impact Assessment of Natural Hazards (IES Action)	IGB	Leibniz-Institute of Freshwater Ecology and Inland Fisheries	MAPLE	Monitoring Across Policies and Environmental Media (IES 2010 Action, replaces ATEAM Action)
FOREST	Forest Data and Information Systems (IES Action)	IHCP	Institute for Health and Consumer Protection (JRC Institute)	MERIS	Medium Resolution Imaging Spectrometer
FP	Framework Programme	IIASA	International Institute for Applied Systems Analysis	METIER	METHODS of Interdisciplinary Environmental Research (PEER project)
FRA-2010	Forest Resources Assessment 2010	IICT	Instituto de Investigação Científica Tropical (Tropical Research Institute of Portugal)	MIC	Monitoring and Information Centre of DG Environment
FSI	Forest Survey of India	IKSD/ICPDR	International Commission for the Protection of the Danube River	<i>min.dust</i>	<i>mineral dust</i>
FWI	Forest fire weather index (indice forêt météo – IFM)	IKSE/ICPER	International Commission for the Protection of the Elbe River	MODIS	Moderate Resolution Imaging Spectrometer
GAPCC	Global Air Pollution and Climate Change (IES Action)	IKSO/ICPOR	International Commission for the Protection of the Oder River	MOLAND	Monitoring Land Use / Cover Dynamics
GAW	Global Atmospheric Watch	ILCD	International Reference Life Cycle Data System	MONDE	Monitoring Natural Resources for Development Cooperation (IES Action)
GCOS	Global Climate Observing System	IMAU	Institute for Marine and Atmospheric Research, Utrecht University	MPI	Max Planck Institute
GDP	Gross Domestic Product	INERIS	Institut National de l'Environnement Industriel et des Risques	MPI-M	Max Planck Institute for Meteorology
GENNESYS	Grand European Initiative on Nanoscience and Nanotechnology using Neutron- and Synchrotron radiation sources	INRA	French National Institute for Agricultural Research	MSFD	Marine Strategy Framework Directive
GEO	Group on Earth Observations	INRETS	French National Institute for Transport and Safety Research	MTEC	National Metal and Materials Technology Center, Thailand
GEOSS	Global Earth Observation System of the Systems	INSPIRE	Infrastructure for Spatial Information in the European Community (EU Directive)	<i>N</i>	<i>Nitrogen</i>
GHG	Greenhouse Gas	INSPIRE	Infrastructure for Spatial Information in Europe (IES Action, renamed SHAPE in 2010)	<i>N₂O</i>	<i>Nitrous oxide</i>
		InVS	Institut de Veille Sanitaire, Paris, France	NAGREF	National Agricultural Research Foundation, Greece
				NASA	National Aeronautics and Space Administration, US government agency

NATO	North Atlantic Treaty Organisation
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Water Index
NEPAD	New Partnership for Africa's Development
NERI	National Environmental Research Institute, Denmark
NILU	Norwegian Institute for Air Research
NIVA	Norwegian Institute for Water Research
NO_3	<i>Nitrate</i>
NO_4	<i>Ammonium</i>
NOAA-AVHRR	National Oceanic and Atmospheric Administration – Advanced Very High Resolution Radiometer
NORMAN network	Network of reference laboratories for monitoring of emerging environmental pollutants
NO_x	<i>Nitrogen Oxides</i>
NRMM	Non-Road Mobile Machinery
NTSEL	National Traffic Safety and Environment Laboratory
O.J.	Official Journal (of the European Communities)
OECD	Organisation for Economic Cooperation and Development
OM	<i>Organic Matter</i>
ORCHESTRA project	Open Architecture and Spatial Data Infrastructure for Risk Management – Integrated Project funded by the European Commission's 6 th Framework Program
OSS	Observatoire du Sahara et du Sahel (Sahara and Sahel Observatory), Tunisia
PAH	<i>Polycyclic Aromatic Hydrocarbons</i>
PALSAR	Phased Array type L-band Synthetic Aperture Radar
PBL	Netherlands Environmental Assessment Agency
PEBLDS	United Nations Pan-European Biodiversity and Landscape Strategy
PEER	Partnership for European Environmental Research
PEMS	Portable Emissions Measurement Systems
PESETA	Projection of Economic impacts of climate change in Sectors of the European Union based on bottom-up Analysis – a joint project led by the IPTS that focuses on the impacts of climate change on certain sectors
PM	<i>Particulate Matter</i>
PM_{10}	<i>Particles of 10 micrometers or less</i>
$PM_{2.5}$	<i>Particles of less than 2.5 micrometers</i>
POLES	Prospective Outlook on Long-term Energy Systems (simulation model)
POMI	Po Valley Modelling Intercomparison exercise
POP	<i>Persistent Organic Pollutants</i>
PPP	Purchasing Power Parities
PR	Press Release
PROCAS	Protection and Conservation of European Seas (IES Action)
QA/QC	Quality Assurance/Quality Control
QUEST	Quantifying and Understanding the Earth System (University of Bristol)
R&D	Research and Development
RAMI	Radiation Transfer Model Intercomparison
RAPAC	Réseau des Aires Protégées d'Afrique Centrale, Gabon
RCMRD	Regional Center for Mapping of Resources for Development, Kenya
REDD	Reducing Emissions from Deforestation and Degradation
REM	Radioactivity Environmental Monitoring (IES Action)
RIVM	Dutch National Institute for Public Health and the Environment
RNA	<i>Ribonucleic acid</i>
<i>rp</i>	<i>return periods</i>
RSS	Remote Sensing Survey
RTD	Research and Technological Development
SADC	Southern African Development Community
SADCRSU	Southern African Development Community – Regional Remote Sensing Unit, Botswana
SAR	Synthetic Aperture Radar
SCIAMA-CHY	SCanning Imaging Absorption SpectroMeter for Atmospheric Cartography
SCP	Sustainable Consumption and Production
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SEC	Internal Commission Working Document
SEIS	Shared Environmental Information System
SF_6	<i>Sulfur hexafluoride</i>
SHAPE	SHaring Policies for the Environment (IES 2010 Action, replaces INSPIRE Action)
SIRIM-Berhad	New name of the Standards and Industrial Research Institute of Malaysia (SIRIM)
SO_2	<i>Sulphur dioxide</i>
SO_4	<i>Sulfate</i>
SoCo Project	Sustainable Agriculture and Soil Conservation Project
SOIL	Soil Data and Information Systems (IES Action)
SOLO	Systematic Observations of Land and Ocean (IES Action)
SPI	Standardised Precipitation Index
SPS	Science for Peace and Security (NATO Programme)
SusTrans	Sustainable Transport (IES Action)
SYKE	Finnish Environment Institute
<i>T</i>	<i>Temperature</i>
TEEB	The Economics of Ecosystems and Biodiversity
TFEIP	Task Force on Emission Inventories and Projections
TM5-4DVAR	Inverse modelling system developed by the IES
TNO	Dutch Organisation for Applied Scientific Research
TransTech	Transport Technologies and Emissions (IES Action)
TREES-3	Third phase of the 'TREES' project (Tropical Ecosystem Environment observations by Satellites) carried out by the 'Global Forest Resource Monitoring' Action (IES Action)
UCL	University College London
UCL	Université Catholique de Louvain
UFZ	Helmholtz Centre for Environmental Research (Germany)
UN	United Nations
<i>unacc.</i>	<i>unaccounted mass</i>
UNCCD	United Nations Convention to Combat Desertification
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNEP/GEF	United Nations Environment Programme / Division of Global Environment Facility Coordination
UNFCCC	United Nations Framework Convention on Climate Change
UNFCCC/SBSTA	Subsidiary Body for Scientific and Technological Advice
USA	United States of America
US-EPA	US Environmental Protection Agency
VELA	Vehicle Emissions Laboratories (IES Facility)
VITO	Vision on Technology – Flemish institute for technological research
WAD	World Atlas of Desertification
WBCSD	World Business Council for Sustainable Development
WFD	Water Framework Directive
WG	Working Group
WHDC	Worldwide harmonized emissions certification procedure
WHO	World Health Organization
WMO	World Meteorological Organization
WOCAT	World Overview of Conservation Approaches and Technologies
WP.29	The World Forum for Harmonization of Vehicle Regulations – a permanent UNECE working party
WTW	Well-to-Wheels
<i> yrs</i>	<i> years</i>
ZAUM	Centre for Allergy and Environment Laboratory of Toxicology and Exposure Research, Germany
ΔT	<i>Change in temperature</i>
μg	<i>microgramme</i>
μm	<i>micrometre (one millionth of a metre)</i>

STRAIGHTFORWARD SCIENCE

Some scientific terms explained

In these pages we try to give clear explanations of some of the scientific terms used in this brochure. We hope this helps readers to unlock the messages behind the science, to embark on discussions of the key issues, to dispel the myth that science is only for scientists and to generally make our work and achievements more accessible and digestible to all branches of society.

“We also need to address the increasing disconnect between science and society. Society must be familiar and at ease with the science underpinning its progress, functioning and survival. Science must belong in Society.”

MÁIRE GEOGHEGAN QUINN
EU Commissioner for Research, Innovation and Science

“You do not really understand something unless you can explain it to your grandmother.”

ALBERT EINSTEIN
German Nobel Prize Laureate
(Physics)

Abatement strategies	Methods for reducing or eliminating something.	Biomass	The mass (in kg) of living or recently living organic material that can be used as fuel, such as wood, plants, <i>etc.</i>
Absorption spectrometry	A technique for measuring the absorption of radiation by a sample exposed to a radiating field (such as sunlight). The sample absorbs a certain amount of the energy (photons), the amount of which depends on the frequency of the radiating field. The variation of the intensity of absorption is called the absorption spectrum.	Biophysical criteria	Biological and physical parameters of an entity or process.
Aerosols	Atmospheric particles – fine solid particles or liquid droplets suspended in a gas, <i>e.g.</i> dust, air pollution, mist, smoke.	Biosphere	Greek biosz “life”, sphaira “sphere”: the part of the Earth and its atmosphere where life can exist, including soil, water and air.
Agroforestry	Incorporating forestry into agriculture; combining agriculture and forestry practices to create an integrated and sustainable system of food and fibre production.	Boreal	Related to or concerning either sub-Arctic or sub-Antarctic regions.
Agronomic	Relating to the application of soil and plant sciences to the management of land and crops.	Buffer strips	Strips of land kept permanently in vegetation (<i>e.g.</i> grass) to reduce the drift of fluids such as water runoff from one place to another or to help protect biodiversity.
Ambient	Existing or present on all sides, surrounding.	Carbon fixation	The process whereby gaseous carbon (in the form of carbon dioxide) is removed from the air by photosynthesis thereby converting it into solid form, thus ‘fixing’ it in sugars for instance.
Angiosperm	A class of plant with seeds enclosed in an ovary. These are also generally referred to as ‘flowering plants’.	Carbonaceous aerosol	A suspension of fine solid carbon-rich particles or liquid droplets in a gas.
Anthropogenic	Caused by human beings.	Chlorophyll <i>a</i>	Chlorophyll is a photosynthetic pigment found in all green plants on land and in algae in the sea. This molecule exists in different forms named ‘a’, ‘b’, ‘c’, <i>etc.</i> A key substance in the process of photosynthesis, its name comes from the Greek chloros (green) and phyllon (leaf). The concentration of chlorophyll <i>a</i> is used to quantify the amount of algae (phytoplankton) in surface water and soils, for instance.
Atmospheric dispersion	The diffusion of gases, droplets or particulate matter in the atmosphere due to physical processes.	Climate-carbon feedbacks	A system or a process includes a feedback when its current output affects its future output. A positive feedback amplifies the original response of the system to its input, while a negative feedback damps it. For example, a warmer climate (stimulated by fossil fuel burning) can lead to enhanced fires and biomass burning, which will result in further emissions of carbon dioxide (CO ₂) and make the situation even worse (positive feedback). On the other hand, if an atmosphere richer in CO ₂ can lead to a higher assimilation of this greenhouse gas by plants, and this enhanced productivity would contribute to reducing the atmospheric CO ₂ concentration (negative feedback).
Atmospheric forcing	A measure of how the atmosphere is affected by internal or external events, such as natural climate hazards (hurricanes, volcanoes) or manmade effects such as increased greenhouse gas emissions.	Cloud albedo	Albedo, typically expressed in percentages, refers to the proportion of incoming radiation that is reflected by a surface. Clouds are generally fairly bright, especially when they are deep: they have a high albedo (viewed from above).
Atmospheric transport model	Computer model of the atmosphere, which uses meteorological parameters (such as wind speed, wind direction, precipitation) to calculate the transport of atmospheric tracers during their lifetime in the atmosphere. When coupled with atmospheric chemistry models they can model the behaviour of reactive atmospheric constituents.	Compaction	Compression, an increase in the density of something. Soil compaction occurs by compressing the soil particles closer together, thus increasing the bulk density and reducing the pore space available for air and water.
Background air pollution	Pollution that is to be found at various distances from its sources. ‘Regional background’ refers to countryside/rural areas outside urban areas and removed from industrial pollution sources.	Contour farming	Farming practices such as planting crops, ploughing, <i>etc.</i> which follow the natural contours of the land.
Benthic	The bottom of a water body (lake, sea, <i>etc.</i>) and/or organisms which are attached to the bottom of the water body.		
Biodiversity	The number, range and variety of animal, plant, fungal and bacterial life and species to be found within a specific area.		
Biofuels	Fuels made from renewable biological resources, such as plant biomass.		
Biogeochemical model	A model that simulates the chemical, physical, geological and biological processes that occur in the environment.		

Cyanobacterial blooms	Cyanobacteria are aquatic bacteria that manufacture their own food through photosynthesis. Various referred to as red slime algae, blue-green algae, blue-green bacteria or Cyanophyta, their name comes from their blue-green colour ('cyan' comes from the Greek 'kyanós' for blue). They are also known to be the oldest (as old as 3.5 billion years) fossils ever found. Aquatic cyanobacteria are probably best known for the extensive and highly visible blooms that can form in both freshwater and the marine environment and can have the appearance of blue-green paint or scum. Such blooms can be toxic.	Inverse modelling	Direct modelling generates outputs on the basis of given inputs. Inverse modelling aims at retrieving the inputs of the model on the basis of its outputs. In the context of the greenhouse gas problem, a direct model would predict the concentration of these gases knowing the distribution and strength of the sources. An inverse modelling approach would start from information (typically measured) about the concentrations of greenhouse gases in space and time and generate likely distributions of sources and their strengths. Inverse modelling is typically used to check the consistency of 'bottom-up' models and to trace the source of observed data, such as greenhouse gas emissions for example.
Diatoms	From the Greek 'dia' which means "through" and 'temnein' which means "to cut", diatoms are microscopic, single celled algae which are encased in two asymmetrical silica cell walls.	Macroalgae	Large plant-like free floating algae, visible to the naked eye and commonly referred to as seaweed.
DNA Microarray technology	The study of large numbers of different DNA sequences simultaneously by using advanced computer technology connected to a scanning microscope. It is used mainly in biology and medicine.	Mapping Unit	The relationship between one unit on a map and the number of ground units that one unit represents. For example 1:100 000 means that 1 cm on the map shows 100 000 cm on the ground (1 km).
Ecosystem	The sum of all living organisms and their interactions with each other and with their physical environment.	Mesoscale	Medium spatial scale (5 - 100 km).
Ensemble modelling	In the context of numerical weather forecasting, 'ensemble modelling' refers to the practice of running the same forecast model many times, starting from slightly different initial conditions, to estimate the likely evolution of the weather as well as to quantify the reliability of such a forecast.	Micrometer	One millionth of a metre.
Environmental indicators	Measurable features that provide information as to what is happening in the environment.	Mid-oceanic gyres	Large-scale ocean current systems which occur in the sub tropics, particularly those involved with large wind movements.
Epidemiological studies	The study of the distribution, control, and prevention of disease in a population.	Molecular biology	The study of life at the level of the simplest structural unit of an element or compound, particularly the study of DNA and RNA.
Eutrophication	The process whereby waters become hyper-enriched by nutrients (usually phosphorus and nitrogen), resulting in excessive plant growth, a build-up of algae and oxygen depletion.	Monomers	A monomer is a molecule that can become chemically bonded to other monomers to form a polymer. It comes from the Greek mono "one" and meros "part".
fAPAR	The fraction of Absorbed Photosynthetically Active Radiation (fAPAR) is the fraction of solar radiation in the Photosynthetically Active Radiation spectral region (the wave band of radiation used in photosynthesis) that is absorbed by a photosynthesising organism, such as leaves. It is directly related to primary production and can be used to estimate how much carbon dioxide is absorbed by vegetation. fAPAR is recognised as an Essential Climate Variable in characterising the Earth's climate.	MSPA	MSPA (Morphological Spatial Pattern Analysis) is a customised sequence of mathematical morphological operators (<i>i.e.</i> theories and techniques which analyse and process geometrical structures) targeted at the description of the geometry and connectivity of the components of an image. Based on geometric concepts only, this methodology can be applied to any scale and to any type of digital image in any field of application.
Food web integrity	A food web is the balance of who eats what in the ecosystem, also known as the food cycle. Food web integrity refers to how robust a food web is, <i>i.e.</i> how stable, whether there are risks of extinctions leading to changes in the overall food web, <i>etc.</i>	Nanoparticle	A particle that is a maximum of 100 nanometers (100 millionth of a millimetre) in size.
Forest fragmentation/ Forest connectivity	Fragmentation and connectivity are often used as spatial indicators of the integrity of an ecosystem or landscape. They provide information about the potential spatial arrangement of forest patches, for example, which may reduce opportunities for organisms to disperse as their ecological needs are affected (<i>e.g.</i> access to specific habitats, sufficient area for food and breeding).	Nanotechnology	The science (study and invention) of things that are measured by a nanometre (one billionth of a metre).
Fuel cell	An electrochemical cell that combines a fuel (often hydrogen) with oxygen to produce electrical energy.	Nocturnal inversion layer	The planetary boundary layer is the lowest part of the atmosphere. Its behavior is directly influenced by its contact with the Earth's surface. At night, the drop in temperature causes the build-up of the nocturnal inversion layer, resulting in the accumulation of trace gases beneath it.
Georeferenced maps	Maps on which the coordinates of certain data locations are displayed.	Normalized Difference Water Index	The Normalized Difference Water Index (NDWI) is an index for determining the water content of vegetation based on physical principles. It combines satellite imagery of the Short Wave Infrared (SWIR) and Near-Infrared (NIR) radiation channels to give an accurate picture of the water content of vegetation.
Good environmental status	Defined by the Marine Strategy Framework Directive (MSFD) as the environmental status of marine waters (oceans and seas) which are intrinsically clean, healthy, productive, ecologically diverse and dynamic, and are used in a sustainable manner.	Nutrient load	The nutrient load refers to the total amount of nutrients, <i>e.g.</i> nitrogen or phosphorus, entering water bodies in a given period. These nutrient loads can come from soil (through runoff or groundwater) or air (rain, snow, wind).
Groundwater	Water that occurs naturally beneath the Earth's surface. It is formed by water soaking into the ground and flowing down until it collects above hard rock.	Nutrient losses	Nutrient losses refer to the nutrients that pass from the soil or air into water bodies. The soil or air loses the nutrients to the water.
Hindcast	A hindcast is a weather forecast in the past. Since we already know how the weather actually evolved, this can be used to evaluate the performance of the predictive model. Also known as backtesting.	Particulate Matter (PM)	Fine atmospheric particles (see aerosols). PM ₁₀ : particulate matter not more than 10 micrometres in diameter (thoracic fraction). PM _{2.5} : particulate matter not more than 2.5 micrometres in diameter (respirable fraction).
Hydrodynamic model	A system that models the motion of water and other liquids.	Permafrost	Soil that has remained frozen for at least two consecutive years.
Integrated Assessment Modelling	Integrating numerical models from two or more disciplines, <i>e.g.</i> science and economics, into a single framework in order to generate useful information for policy making.	Phenological metrics	Measurements of periodic plant life-cycle events that can be affected by climate and human activity.
Intercropping	Growing two or more crops together on the same piece of land.	Phytobenthos	Plant organisms which live at the bottom of a water body (sea, lake, <i>etc.</i>).
		Phytoplankton	Tiny photosynthetic plant plankton, that drift in water bodies and survive through photosynthesis.
		Polycyclic aromatic hydrocarbons (PAHs)	Air pollutants which arise from fossil fuel combustion, such as the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances. The less efficient the burning process, the more PAHs are given off. Forest fires and volcanoes can produce PAHs naturally. Some PAH compounds have been identified as carcinogenic and teratogenic.

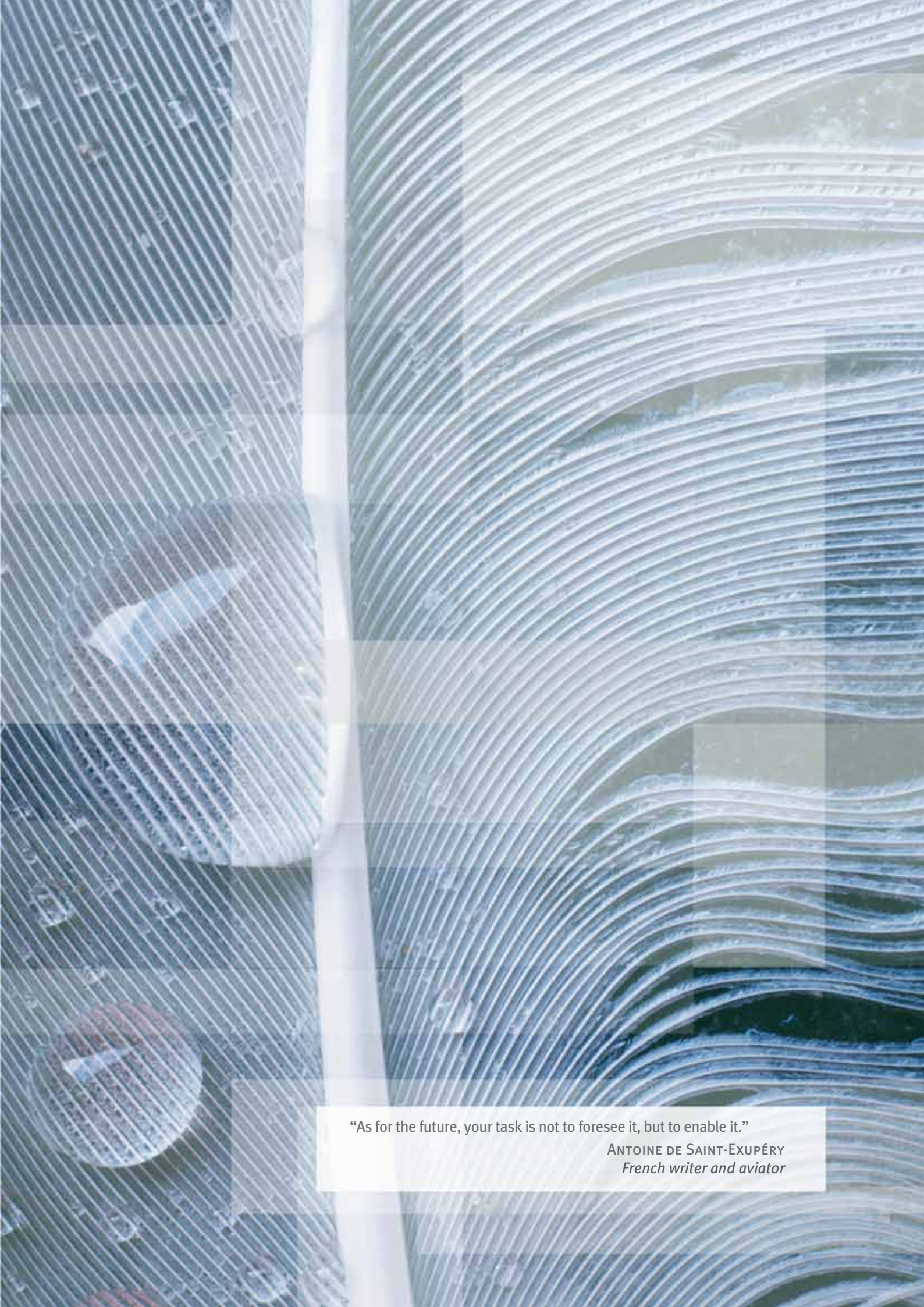
Powertrain	A powertrain in a motor vehicle is the series of components that generates and delivers power, including the engine, transmission, drive-shafts, differentials, and the final drive (wheels, propeller, etc.).	Salinisation	The process by which soluble salts are accumulated in soils.
Pressure-state-response system	The Pressure-State-Response (PSR) model, developed by the OECD, is a mechanism for monitoring environmental and sustainable development indicators. Pressures are introduced due to human interaction with the environment, which then have an effect on the state or condition of that environment, leading to a response, for example a government policy, to address the pressure and redress the imbalance caused in the environment.	Sodification	The process by which the sodium content of soils is increased.
Primary producers	Autotroph organisms (such as plants, algae, etc.) which convert carbon dioxide and other inorganic compounds into organic materials through photosynthesis. Primary producers constitute the first step in the global food chain: they feed all heterotroph organisms that survive only by eating organic materials.	Soil moisture anomalies	Levels of soil moisture as compared to the long-term average soil moisture for a given period in time (e.g. day, week, month). Expressed in standard deviations above or below the average value.
Primary production	The conversion of inorganic material and sunlight into organic compounds, primarily through photosynthesis.	Soot particles	Soot particles are nanosized particles composed of black carbon and emitted by diesel engines, among other causes. Their size is approximately 100 nanometers. Recently, concerns have been raised about their possible adverse effect on human health.
REDD	REDD – reducing emissions from deforestation and forest degradation in developing countries – is a mechanism designed to help slow climate change by providing incentives to reduce the rates at which forests are cleared and/or selectively logged.	Space-time heterogeneity	Diversity/variability over area and time.
Remote sensing	The acquisition of information about an object, area, or phenomenon through the analysis of data acquired without physical contact with the object, area, or phenomenon under investigation.	Standardized Precipitation Index (SPI)	The SPI was formulated in the United States in 1993 to quantify precipitation, and hence to measure drought, for multiple time scales. It is based on the long-term precipitation record for a given period. A separate SPI value is calculated for a selection of time scales, covering a given number of past months. This index is normalised (with 0 being the average), so negative figures represent drought, and positive figures represent wet conditions.
Return periods	The average length of time between natural hazards, such as a flood, of a certain magnitude. For example, a flood with a return period of 100 years (a 100-year flood), will occur on average once in every 100 years.	Stochastic	Random.
		The Human-Ecosystem model	The Human-Ecosystem model addresses the dynamic interactions and feedbacks between the biophysical ecosystem and human activities. Ecosystem services (such as the provision of clean and steady water supplies, food, firewood, clean air and biodiversity) can be influenced by human activities, and <i>vice versa</i> .
		Toxicity (Environmental toxicity)	The degree to which a substance is poisonous.
		Vertical mixing	An upward and downward movement of air or water that occurs as a result of the temperature differences between layers at different heights/depths.
		Water bodies	Oceans, seas, lakes, reservoirs, rivers, streams, ponds, wetlands, etc.

COMING TO TERMS WITH TERMS

Some other terms explained

AERONET	The AERONET (AErosol RObotic NETWORK) program is an international network of ground-based remote sensing aerosol networks established by NASA and PHOTONS (Univ. of Lille 1, CNES, and CNRS-INSU) and expanded on by international collaborators, including the IES. The network measures systematic cloud-screened sun and sky radiances, and provides a long-term, continuous and readily accessible public domain database of aerosol optical, microphysical and radiative properties.	BioSoil project	The BioSoil project (2006-09) is the largest forest soil and biodiversity monitoring exercise ever implemented at the EU scale. It is a joint effort of the European Commission (DG Environment and the IES) and EU Member States to demonstrate the feasibility of systematic forest soil monitoring at the European scale for the protection of forests against atmospheric pollution and against forest fires.
Africa-EU Partnership	The Africa-EU Partnership is based on the Joint Africa-EU Strategy, adopted in 2007, which defines the long-term policy orientations between Africa and Europe. It aims to build a bridge between the two continents in a partnership based on a shared vision and common principles, fostering a mature and political partnership between equals through dialogue, common approach and joint decisions.	Capacity building	A set of processes and activities aiming at supporting or promoting development, in particular through teaching or training, transferring technologies, etc.
AMESD project	AMESD (African Monitoring of the Environment for Sustainable Development) is an international cooperation project of the African Union and the European Union, which is partly funded by the European Development Fund. It aims to provide Africa with an efficient system for monitoring the environment and how the land is being developed, in order to improve the management of agricultural, marine and river resources. All African countries of the ACP are involved. The AMESD Head Office is based in the African Union Commission in Addis Ababa, Ethiopia.	Corine/CORINE	Corine stands for Coordination of Information on the Environment. The EU established the Corine programme in 1985, aiming to create pan-European databases on land cover, biotopes (habitats), soil maps, coastal erosion and acid rain. It was integrated into the European Environment Agency's work programme in 1994.
Aquaknow	AQUAKNOW is a dynamic interactive website designed specifically for the water sector. It is managed and developed by DG EuropeAid and the IES. Its main objective is to advance knowledge sharing by encouraging experts and practitioners in the water sector to engage in fruitful interaction through a virtual space for collaboration, discussion and information sharing.	ECHAM5-HAM	An aerosol-climate modelling system, designed in 2005 by a panel of scientists including the IES, which can be applied in a wide range of climate scenarios. ECHAM5-HAM predicts the evolution of an ensemble of microphysically interacting aerosol populations as well as their size-distribution and composition.
		Eco-innovation	The development of new ecological solutions for the environment; new processes or products that are designed to promote ecological health.
		EDGAR	The Emissions Database for Global Atmospheric Research (EDGAR) is a joint project of the IES and the Netherlands Environmental Assessment Agency (PBL). EDGAR provides global anthropogenic emission inventories of greenhouse gases and air pollutants by country and on spatial grids. The IES, which joined the project in 2004, developed a new database structure which allows for emissions to be calculated by country and sector, and includes specific technologies for combustion/processing and emission abatement measures. In order to facilitate the use of EDGAR data in both air pollution and climate modelling on different scales, the country emissions are plotted on a 0.1 x 0.1 grid for a large variety of emission sources.

EMEP	EMEP (the European Monitoring and Evaluation Programme) is a scientifically based and policy driven programme under the Convention on Long-range Transboundary Air Pollution (CLRTAP) for international cooperation to solve transboundary air pollution problems. EMEP's main objective is to regularly provide governments and subsidiary bodies under the CLRTAP with qualified scientific information to support the development and further evaluation of international protocols on emission reductions negotiated within the Convention. Initially, the EMEP programme focused on assessing the transboundary transport of acidification and eutrophication. Later, the scope of the programme has widened to address the formation of ground level ozone and, more recently, of persistent organic pollutants (POPs), heavy metals and particulate matter. At present, about 100 monitoring stations in 24 countries participate in the programme.	IPCC A2 scenario	The Intergovernmental Panel on Climate Change (IPCC)'s 2001 Special Report on Emissions Scenarios outlines 40 different emissions scenarios, each making different assumptions about future driving forces of climate change such as greenhouse gas pollution and land-use. These scenarios are organised into six scenario families: A1FI, A1B, A1T, A2, B1, and B2. The A2 scenario family represents the 'worst case scenario', a divided world of independent nations, rising population growth, regional economic development, and slow technological and income growth.
ENSEMBLE	A technique developed within the IES that combines the results of different atmospheric dispersion and air quality models in order to obtain a better prediction and an estimation of their uncertainty.	IRIX	IRIX stands for International Radiation Information eX-change. IES staff played a key role in defining the draft IRIX standards, which were developed under the IAEA Action Plan. These standards include 1) a well-defined set of information items that are relevant during radiation accidents, 2) an appropriate XML schema and 3) related web-service methods. These standards will be used by the EC, the IAEA and other international and national organizations for the exchange of information and data during radiological accidents.
EUMETCast	EUMETCast is the telecommunications system used for disseminating the meteorological data collected mainly by EUMETSAT, the European Organisation for the Exploitation of Meteorological Satellites. The technology used, based on Digital Video Broadcast (DVB) technology, makes it possible for a wide user community to receive the data with standard satellite TV equipment and a personal computer.	King Report	An ex-post evaluation of the Joint Research Centre (JRC) Direct Actions of the 6 th Framework Programme for the period 2002-2006 by a panel of international experts from different disciplines, led by Sir David King, the former chief scientific adviser to the UK government. The final report was issued in September 2008.
EUMETSAT	EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites) is an independent (non-EU) inter-governmental organisation established in 1986 to obtain continuous satellite data for weather forecasting and climate applications. It is made up of 26 Member States and five Cooperating States. EUMETSAT is responsible for the operation and exploitation of its satellites, delivering satellite data to end-users and contributing to the operational monitoring of climate and climate change.	Landsat	The Landsat Remote Sensing Satellite Program is the longest running civilian series of Earth-observing satellites. These provide detailed images of the Earth's surface at a variety of wavelengths. The first satellite was launched in 1972, and the programme is currently managed by NASA and the U.S. Geological Survey.
GCOS	The Global Climate Observing System (GCOS) is an international institution set up in 1992 to monitor and provide comprehensive information on the climate system, detect and attribute climate change, assess the impacts of climate variability and change, and support research toward improved understanding, modelling and prediction of the climate system. GCOS is sponsored by the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of the UN Educational, Scientific and Cultural Organization (UNESCO), the UN Environment Programme (UNEP) and the International Council for Science (ICSU). It addresses the entire climate system including physical, chemical and biological properties, and atmospheric, oceanic, hydrologic, cryospheric and terrestrial processes.	MERIS	The MEdium Resolution Imaging Spectrometer (MERIS) instrument is one of the main sensors on board the European Space Agency (ESA)'s Envisat platform. It acquires measurements in 15 spectral bands within the solar spectral domain that are useful to characterise some of the properties of ocean surfaces as well as the overlying atmosphere and land areas.
GlobCover project	The GlobCover project was a two-year initiative of the European Space Agency (ESA), that was launched in 2005. It was led by an international network of partners including the United Nations Environment Programme (UNEP), the Food and Agriculture Organisation (FAO), the European Commission's Joint Research Centre (JRC), the International Geosphere-Biosphere Programme (IGBP) and the Global Observations of Forest Cover and Global Observations of Land Dynamics (GOCF-GOLD) Implementation Team Project Office. The project aimed to produce a global land cover map for the year 2005 to a resolution three times sharper than any previous satellite map, broken down into more than 20 separate land cover classes. The GlobCover global land-cover map was released at the end of 2008.	MODIS	MODIS (Moderate-resolution Imaging Spectroradiometer) is a space-based scientific instrument which can be found aboard two satellites in Earth's orbit – the Terra (EOS AM) and the Aqua (EOS PM) satellites. Together, the instruments image the entire Earth every 1 to 2 days capturing data in 36 spectral bands at varying spatial resolutions. They are designed to improve our understanding of global dynamics and processes occurring on the land, in the oceans, and in the lower atmosphere.
GOCF-GOLD	Global Observation for Forest and Land Cover Dynamics (GOCF/GOLD) is a coordinated international effort working to provide ongoing space-based and <i>in-situ</i> observations of forests and land cover for the sustainable management of resources, and to obtain an accurate understanding of carbon and its fluxes.	Open Geospatial Consortium	International voluntary standards organisation which designs and implements standards of geospatial content and services. Established in 1994, the consortium includes over 370 organisations worldwide.
Gothenburg protocol	A protocol designed to reduce acidification, eutrophication and ground-level ozone by setting emissions ceilings for four pollutants (sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia), to be met by 2010. It was adopted by the Executive Body of the UNECE in 1999.	PALSAR sensor	PALSAR, the Phased Array type L-band Synthetic Aperture Radar, is an active high-performance microwave sensor which uses the L-band frequency on board the Japanese ALOS satellite. It allows for land observations to be carried out day and night in all weathers.
The ICOS Project	ICOS (the 'Integrated carbon observation system') is a new European Research Infrastructure for quantifying and understanding the European greenhouse gas balance, helping policy makers evaluate the effectiveness of legislation designed to tackle climate change. ICOS aims to build a network of monitoring stations comprising state-of-the-art instrumentation across Europe and neighbouring regions. The ICOS infrastructure will measure both surface fluxes and atmospheric concentrations to monitor changes in the levels of CO ₂ and other greenhouse gases such as methane. ICOS is scheduled to enter its operational phase in 2012 and is expected to run for around 20 years.	POLES model	The POLES (Prospective Outlook on Long-term Energy Systems) model is a world energy simulation model which forecasts global energy supply, demand and prices by country over time. It is managed by CNRS, Enerdata and the JRC-IPTS.
		Radiation Transfer Model Intercomparison (RAMI)	RAMI is an IES initiative that aims to benchmark models that simulate the transfer of radiation in the Earth's vegetation-soil layer. It assesses the capability, performance and conformity of the latest generation of radiation transfer (RT) models and promotes further model enhancements and developments.
		SeaWiFS	The Sea-viewing Wide Field-of-view Sensor (SeaWiFS) is an ocean colour sensor on the SeaStar satellite which orbits the Earth. It provides quantitative data on global ocean bio-optical properties to the Earth science community.
		The Syndromes model	The Syndromes Model addresses complex interactions within the Earth system. Syndromes are typical cause-effect patterns of global change, with impacts on both the environment and human development. Syndrome analysis makes it possible to assess which regions of the world are particularly susceptible to specific syndromes. There are some 16 identified syndromes of global change.



“As for the future, your task is not to foresee it, but to enable it.”

ANTOINE DE SAINT-EXUPÉRY
French writer and aviator

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Abstract

“Science for the environment” presents the Institute for Environment and Sustainability of the European Commission’s Joint Research Centre. The brochure gives an insight into the Institute’s achievements for the years 2008-09, and provides an outlook on the challenges ahead.



“You must be the change you wish to see in the world.”

MAHATMA GANDHI, INDIAN POLITICAL AND SPIRITUAL LEADER (1869-1948)



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