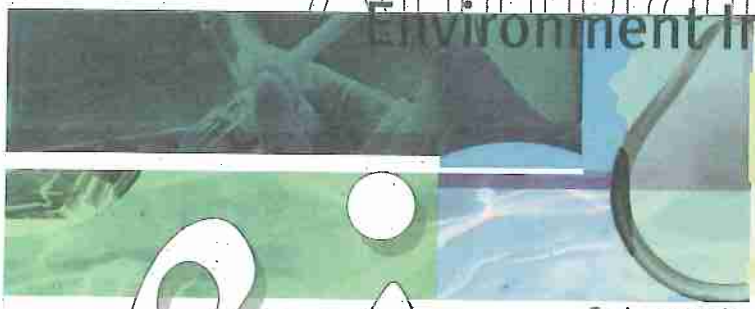
joint research centre
EUROPEAN COMMISSION

Annual Report

Environment Institute

1999



Environment Institute Annual Report 1999

EUROPEAN COMMISSION
JOINT RESEARCH CENTRE

Report EUR 19520 EN

The mission of EI is to carry out research in support of EU policy for the protection of the environment and the citizen.

Prime objectives of EI are to investigate the level and fate of contaminants in the air, water and soil, to assess the effects of those contaminants upon the environment and individuals and to promote a sustainable energy supply.

www.ei.jrc.it

The EI Communication Task Force

From left to right:

Emanuela Rossi (Management Support)
José M. Jiménez (Directorate)
An Lievens (Directorate)
Annette Borowiak (Air Quality)
Niels Jensen (Atmospheric Processes in Global Change)
Eddo Hoekstra (Water Research and Monitoring)
Arwyn Jones (Soil and Waste)
Jennifer Rundle (Renewable Energies)
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In the field of environmental toxicology and human health:

Animal House: Allows to keep small animals (mice, rats, rabbits, etc.) and to carry out *in vivo* short-term toxicological experiments in full respect with EC DIrectives (in particular, EC 86/609), as well as to perform cell isolation and primary cells culture.

Aquarium Facilities: Allows to keep aquatic animals (fish) and to carry out *in vivo* toxicological experiments, as well as to perform cell isolation and primary cells culture.

Cell Culture Laboratory: Allows to culture primary cells and established cell lines and is equipped with suitable apparata (cytofluorimeter with cell sorter built-in capabilities, microplates technology in chemiluminiscence and fluorescence, etc.) for the study of relevant endpoints (e.g. apoptosis, intracellular signalling) by means of cellular toxicology and cytotoxicity methodologies.

Molecular Biology and Biochemical Laboratory: This facility is designed to set up and hold standard and refined methodologies for the study of relevant molecular end-points of interest in environmental toxicology studies. In particular:

- the study of selected gene activities has been set up a first priority, including electrophoretic detection of polymerase chain reaction (PCR) amplified sequences (such as randomly-amplified polymorphic DNA, RAPD, and arbitrary fragment length polymorphism, AFLP);
- equipment for protein chemistry and enzymological studies is available, such as chromatography (including a versatile Fast Performance Liquid Chromatography, FPLC, apparatus), spectrophotometry and 1D and 2D electrophoresis.

In the field of radioactivity environmental monitoring:

Centre of Excellence for Collection, Exchange and Handling of Environmental Radioactivity Data. In this context REM has a large experience in data banking and data transmission in routine and emergency conditions, as well as in the use of geographic information systems and spatial data handling. It provides services by making, as far as possible, this information available to external services and the general public by means of reports and internet (on-line access).

Mesoscale Flow Models allow the reconstruction of the wind and temperature field in the hypothesis of separation between general circulation and local effects. Mesoscale flow models are used in terrain-dependent co-ordinates.

Atmospheric Dispersion Models range from long-distance dispersion, in which some of the features of the turbulent transport of the material in the atmosphere are simplified, to the local-mesoscale lagrangian particle models that take into account the complexity of the ground.

Statistical Model Evaluation Packages are used to quantify in statistical and graphical terms the level of agreement between model results and observations. New tools have been developed for dispersion model inter-comparison and evaluation and for three-dimensional circulation models.

Reconstruction of the Turbulent Field within the atmospheric boundary layer for dispersion model applications.

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not only models were compared with models but also experiment evidence was used. The modellers that participated to the activity showed a great interest and intention to continue in the future since the real-time character of RTMOD allows them to test model performances but also emergency response procedures.

For this reason the ENSEMBLE project (SCA) was prepared and submitted to DG RTD. During this three-year project, the same modelling community will be asked to perform periodic testing of their systems and tools intended as support to decision making will be developed.

The prediction of near-source circulation is fundamental for the simulation of long range dispersion. In order to test the state of the art of this modelling, the MESOCOM pilot project was launched in the frame of EUROTRAC/SATURN. MESOCOM gathers a community of 11 research institutes using mesoscale models, which are requested to simulate specific and well-controlled cases. The comparison of the model results, performed at JRC-ISPRA, allows an estimate of the variability in dependence to the modelling system used. The final scope of the project is an attempt to reduce to the minimum the diversity of the model results.

The model inter-comparison activity continues with the participation of some activities in the frame of the Air Quality program. They consist of:

- the participation to the EUROTRAC/SATURN project PIPAPO (Pianura Padana Production of Ozone), where several types of mesoscale three-dimensional models are currently used for air quality assessment;
- the 3PW activity conducted for the 3D wind simulation and model validation during summer and winter pollution episodes at the Bolzano province; and
- the SCA NOASAMERCAS, where models will be applied to the description of the sea-breeze formation and development in Sardinia.

SELECTED PUBLICATIONS

Bellasio, R., Bianconi, R., Graziani, G., Mosca, S. "RTMOD: An Internet Based System to Analyse the Predictions of Long-Range Atmospheric Dispersion Models", *Computers and Geosciences*, 25 (7) (1999), 819-833.

Galmarini, S., Thunis, P. "On the Validity of Reynolds Assumptions for Running-Mean Filters in the Absence of a Spectral Gap", *Journal of Atmospheric Sciences*, 56(12) (1999), 1785-1796.

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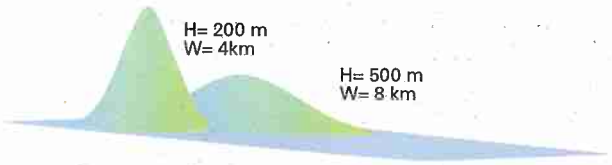

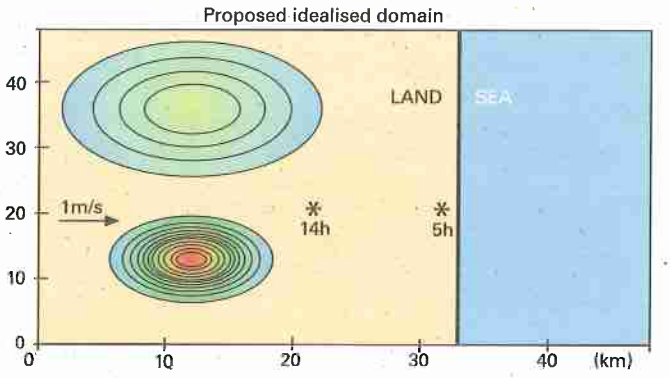

2-dimensional (right panel) and three dimensional representation of the ideal domain used for mesoscale flow model intercomparison, MESOCOM. Land-sea interface with two gaussian hills generate sea-breeze circulation.

Data Banking, Handling and Reporting

The Radioactivity Environmental Monitoring (REM) data bank contains more than 1,300,000 measurements on radioactivity levels in the environment from 1984 onwards for almost all European countries. It is freely accessible via the Internet (http://java.ei.jrc.it/).

Most of the information was provided by the EU Member States in the framework of the Euratom Treaty, with a view to preparing EU environmental monitoring reports. For this purpose, a new version of the data input software (Easy-Proteo) and additional conversion processors developed by us is being used by the majority of the EU Member States. In this way improved data quality check and a standardised data exchange format is ensured, leading to accelerated reporting. The draft reports describing the radioactivity in the environment of the EU in 1994 and 1995 have been (re)distributed to the MSs for official comments. The final reports are expected to be published in the first half of 2000.

Under the SCA called "Centre for Information and Valorisation of European Radioactive contaminated Territories" (CIVERT), a valorisation support system (VSS) is being developed which will provide temporal and spatial statistical tools to valorise data and to interface the results to a geographic information system (GIS).

International Nuclear Emergency Data Exchange Systems

In case of a nuclear emergency with transboundary effects, it is essential that relevant information be quickly and accurately exchanged at an international level. In the REM project two systems have been developed:

- European Community Urgent Radiological Information Exchange (ECURIE) system, by which coded messages are exchanged between national contact points in the EU Member States and the Commission (DG ENV C.1: Radiation Protection) in case of nuclear emergency. During 1999 work was focused on:
  - further development and user training of CoDecS, a PC encoding-decoding software;
  - development of an automatic interface to the Real-time On-line DecisiOn Support system (RODOS) under a SCA with DG RTD DII-3.
- The European Union Radiological Data Exchange Platform (EURDEP), a system by which automatic monitoring data are continuously exchanged, currently on a daily basis with 21 countries. The work in 1999 includes:
  - automation of the data-aggregation, analysis of the incoming radioactivity data, possibility to switch between routine and emergency data-exchange;
  - the development of an automatic interface to RODOS (SCA with DG RTD DII-3).

Modelling Activities

In the Real-Time MODelling evaluation study (RTMOD), twenty-two participants were demanded to forecast the pollutant cloud tracer plume evolution every 3 h at the approximately 5,000 intersections of parallels and meridians (with an interval of 0.5 degrees) over Europe using forecasted and analysed meteorological fields as input. Four fictitious releases were considered. The characteristics of the releases and their locations were supplied to the models by an alert message. During the project, the Algeciras radioactive release took place. The case was also analysed as an additional RTMOD exercise. This time

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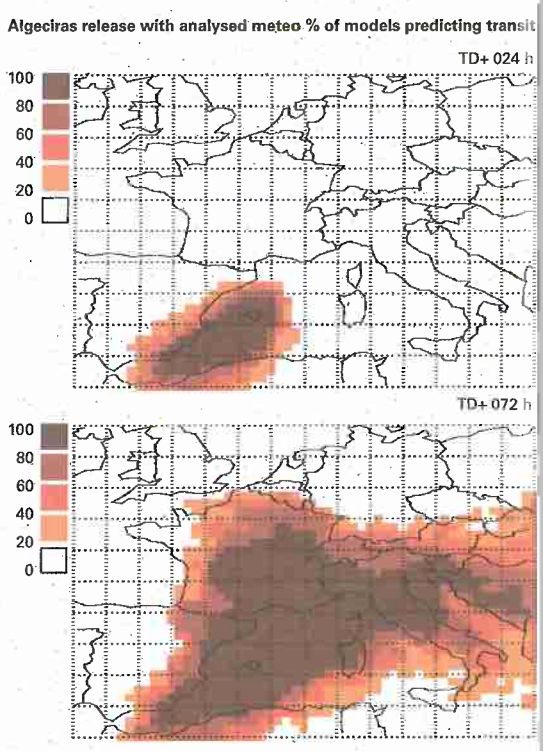
Colombo, I., Monteggia, E., Moretti, S., Mangiarini, L., Sacco, M.G., Villa, A., Rapelli, S., Clerici, L., Berra, B. "Oncogene Transgenic Mice: An Useful Model to Study *in vivo* the Relationships between Gangliosides and Oncogenes", *Cancer Biochemistry and Biophysics*, 16 (1998), 229-242.

Pessina, A., Piccirillo, M., Mineo, E., Catalani, P., Gribaldo, L., Marafante, E., Neri, M.G., Raimondi, A. "Role of SR-4987 Stromal Cells in the Modulation of Doxorubicin Toxicity to *in vitro* Granulocyte-Macrophage Progenitors (CFU-GM)", *Life Sciences*, 65 (1999), 513-523.

Mosesso, P., Marafante, E., Cinelli, S., Penna, S., Seidel, R., Palitti, F. "Evidence That Estrogen Is Clastogenic in a Metabolically Competent Chinese Hamster Cell Line. New Insights for Understanding the Role of Estrogen in Cancer", *Mutagenesis*, in press (2000).



Evolution of the Cs-137 cloud after the Algeciras accidental release in1998. The figure shows the space distribution of agreement among a community of 11 model simulations. The images relate to 24 and 72 hours after the release occurrence.

Cell Toxicology: Culture of several cell types is currently applied addressing several toxicological end-points (i.e. viability tests by MTT and CFE, apoptosis, identification of intermediates in intracellular signalling, cellular receptors), as listed below:

Cell lines	Application
Stem cells (ES-D3)	Estrogenic effects
Adrenocortical (Y1)	Estrogenic effects
Epithelial (MCF-7)	Estrogenic effects
Keratinocytes (HaCaT)	Epidermal toxicity
Embryonic fibroblasts (NIH-3T3)	Metabolic effects
Pulmonary fibroblasts (L929)	Particulate toxicity
Primary cells	
Uterine epithelial	Estrogenic effects
Cerebellar neurons (CGC)	Neurotoxicity and stress response
Mammalian and fish hepatocytes	Metabolic effects and stress response
Embryonic fibroblasts	Metabolic effects and genotoxicity
Haematopoietic cells (bone marrow)	Metabolic effects
Fish gill epithelial	Biological transport

Post-electrophoretic analyses are carried out by means of sophisticated computerized video-documentation systems, which allow identification of specific nucleic acid sequences or proteins as biomarkers of toxic exposure and/or effects.

Molecular Biology and Biochemical Testing Methods are used as analytical tools for the description of harmful effects associated to the exposure to environmental chemicals and chemical mixtures, by:

- DNA fingerprinting analyses by means of randomly-amplified polymorphic DNA (RAPD), and arbitrary fragment length polymorphism (AFLP) as well as mRNAs expresion measurements coupled with polymerase chain reaction (RAP-PCR), which allows us to identify differential patterns for real experimental situations.
- Detection of stress proteins and of nucleic acid fragments (hsp 23-27 and/or hsp68-70) as biomarkers of toxic effects following esposure of cells to actual experimental situations.
- Engineerisation of cell lines (established or derived from transgenic mice) to study specific gene activities, such as steroidogenic factor 1 (SF-1), cytochrome P450, hsp 23-27 and/or hsp68-70, as relevant endpoints or biomarkers of exposure and/or effects of environmental chemicals and in complex mixtures of environmental interest (in particular, EDCs).
- Application of established transgenic mouse (embryo and adult) models (i.e. hsp70/hGH, hsp70/GFP) for the evaluation of stress response to environmental chemicals and mixtures and for testing suspected EDCs.
- Vitellogenin and *zona radiata* protein detection as biomarkers for ED effects in aquatic organisms.

Co-ordination Activities: in collaboration with EU and international bodies we carry out:

- Support to EU regulatory actions and policy in the field of EDCs by participation and organisation of experts meetings, establishment of and participation in networks of international co-operation (EU-US Transatlantic co-operation, DG ENV, DG HEALTH, IPCS-WHO, US-EPA, CEFIC), as well as writing and reviewing scientific reports concerning methodological tools and integrated risk assessment procedures for EDCs (i.e. contributing to the IPCS Global Assessment of EDCs).
- Handling and implemention of the *endocrine* database, which is available to universities, research centres and regulatory authorities.
- Development of models and strategy for complex situations of exposure (complex mixtures of environmental chemicals and situations of combined exposure, i.e. air, food, water), as well as evaluation of the total toxicity charge of environmental mixtures.
- Co-ordination of the Hormone and Endocrine Disruptors JRC cluster.

  - the study of sensitive molecular endpoints in selected experimental models for suspected EDCs;
  - the development of biochemical assays for rapid screening of specific biomarkers in aquatic wildlife;
  - he development of hormonal equivalent factors (HEF), which may be a tool in an unified approach to assess their hormonal effect in situations of continuous, low-level and complex exposure (environmental pollutants, hormone- and food residues and natural products) in humans and wildlife;
  - the first report for the IPCS Global Assessment of EDCs.
- To establish molecular biology-based methods for the identification and detection of pathogens in water.
- To assess the toxicological impact of (micro)-particulate of actual environmental emissions.

This project will have links with other JRC projects:

- On water quality (LEPE) and air emission (ERLIVE).
- On environmental chemicals and health effects, and on risk assessment.

Radioactivity Environmental Monitoring (REM) Project

The Commission has the obligation to provide information to the European Parliament and to the Member States on the levels of radioactivity in the environment. This obligation has lead to the creation of the REM project in order to exchange monitoring data and to evaluate model predictions (e.g., ATMES, ETEX, REMdb, ECURIE, EURDEP). Based on this experience a consistent operational support system for exchanging radioactivity information (data and model results) in normal and in emergency conditions will be established. Moreover, tools will be developed for analysing the significance of this information, in order to assist the Commission in defining:

- the nature of information needed to meet its requirements in routine and emergency conditions;
- environmental pressure indicators.

There are relationships with other JRC projects in two main programmes:

- Projects on air quality (ERLAP), modelling (DAIMS).
- Competitive support programme (DG RTD DII-3–DG INFO, Co-operation with the "Real-time On-line DecisiOn Support" system, "Centre for Information and Valorisation of European Radioactive contaminated Territories" (CIVERT).

These projects will share common interests with DG AGRI, DG ENV, DG RTD and DG HEALTH, and foresee collaborations with IPCS-WHO, CEFIC, USEPA, University and Research Institutes from different EU Member States (EIHH), as well as more than 80 competent authorities and scientific institutes on world-wide basis for data provision, information exchange and model development (REM).

ACTIVITIES AND PROJECTS

Environmental Toxicology and Human Health

Animal Toxicology: An efficient rationalisation and standardisation of the animal-holding facilities are guaranteeing maintenance conditions for *in vivo* toxicological experiments in mice, rats and fish. *In vivo* testing methodologies currently applied for the evaluation of EDCs are the uterotrophic assay in rats and vitellogenin induction in fish. Moreover, *in vitro* culture of pre-implantation mouse embryos is carried out for the evaluation of the toxicity of environmental chemicals and mixtures.

In vitro *testing on responding MCF-7 cells is used for establishing the potential endocrine disrupting ability of environmental chemicals and mixtures.*

- The development of the VSS (Valorisation Support System) of the CIVERT (Centre for Information and Valorisation of European Radioactive contaminated Territories: SCA with DG RTD DII-3) has been finalised. This GIS interface provides several procedures to interpret and represent environmental contamination by making use of the available measurements (Bayesian kriging, multivariate analysis...).
- The CoDecS (Coding Decoding software for ECURIE) approached its final status and a preliminary release was sent to the Member States. A first of a series of 3 user training sessions was kept at the JRC in the beginning of December 1999.
- Conclusion of the RTMOD project. During 1999 the project reached its conclusion with a meeting organized at Ispra and the preparation of the final report. The project demonstrated the necessity of a constant activity of long-range dispersion model inter-comparison. During the two years of the exercise, model results have shown a neat improvement, therefore underlining the usefulness of the activity. A follow up of the project that includes also links with decision making has been submitted in the form of a Shared-Cost Action accepted for funding by DG RTD.
- The MESOCOM pilot-project, which stems from the final recommendation of the ETEX exercise that underlined the necessity of better simulation of near-source flow, was launched at the end of 1998 and proceeded successfully through out 1999. The project intends to compare and evaluate the results of three-dimensional predictive flow models. A large number of modelling groups from the major European research institutes accepted to participate to this preliminary pilot phase on voluntary basis and are willing to take part to the future evolution of the project as stated during the first meeting held at Ispra at the end of 1999.

http://www.ei.jrc.it/ie/projects/REM/
http://www.ei.jrc.it/ie/projects/ETEX/
http://www.ei.jrc.it/ie/projects/Rtmod/
http://www.ei.jrc.it/ie/projects/eurdep/

FUTURE ACTIVITIES

The focus of future activities, framed within the 5th Framework Programme (5 FWP), are organised in two Institutional Research projects, one for each field of activity.

Environmental Integrity and Human Health (EIHH) Project

The project is being implemented along the following lines:

- To improve mechanistic-based methodologies for integrated risk assessment of chemicals suspected to be harmful to human health and wildlife, including chemical mixtures and situations of mixed exposure (e.g. water and air pollutants, pesticides and hormone residues, materials and goods). In particular, it is envisaged:
  - the establishment of internationally expert-agreed models and strategies;
  - the development of biomarker-oriented cellular and molecular biology-based techniques.
- To identify critical end-points in establishing potential endocrine disrupting (ED) effects in different situations of environmental exposure in strict collaboration with international organisations. In particular through:
  - the expansion of the endocrine web site located at the JRC-Ispra (http://endocrine.ei.jrc.it), which is intended to offer information and links about EDCs in the Commission;
  - an active role within the EU-US Transatlantic Cooperation in the field of EDCs;
  - the application and validation of a QSAR approach, integrated by *in vivo/in vitro* assays;

The visualization of specific fluorescent probes by fluorescence microscopes allows the identification of responding cells after challenge to suspected endocrine disrupting chemicals (EDCs).

results) will be established over the next few years. In this context, tools (e.g. environmental pressure indicators) will be developed for analysing the significance of this information, in order to assist the Commission in defining the nature of information needed to meet its requirements.

MAJOR ACHIEVEMENTS IN 1999

In the field of **Environmental Toxicology and Human Health:**

- Reports on candidate biomarkers for risk assessment in metal contact dermatitis and neurotoxicity. Manuscripts for publication in scientific journals are in preparation.
- Our patented (No. PCT/IP98/00231) transgenic mice model (hsp70/hGH) on chemical stress response was succesfully applied in toxicological experiments with environmental chemicals and drugs.
- A JRC web site on endocrine research has been activated within the Environmental Impact Unit (http://endocrine.ei.jrc.it), which includes the International Program in Chemical Safety (IPCS) database named Global Endocrine Disruptors Research Inventory (GEDRI).
- Actions have been undertaken, including the organization of an experts meeting at the JRC-Ispra (18-21 April 1999, draft report available), for the implementation of the EU-US co-operation in the field of EDCs, following the indications from the Washington Conference (June 1998) New Vistas in Transatlantic Science & Technology Cooperation.
- A kick-off meeting of the Hormone and Endocrine Disruptors JRC cluster was held at the JRC-Ispra (6 April 1999).
- Research contributing also to the SCA project entitled Endocrine Disrupting Activity of Environmental Pollutants (EDAEP) is in progress, with a successful development of *in vivo/in vitro* tests for suspected EDCs.
- The development of molecular biology-based testing methods for EDCs by a simplified analysis of differentially expressed mRNAs from human and murine cells and by construction of transgenic cell line model via insertion of a SF-1/GFP (promotor/reporter gene) DNA construct in Y1 adrenocortical cells is in progress.
- Reports on Strategies for Integrated Risk Assessment and on Identification of biomarkers for stress response induced by environmental pollutants are also in progress.
- A draft report on EDCs research on aquatic wildlife literature critical review is available.

http://www.ei.jrc.it/ie/projects/GIRED/
http://www.ei.jrc.it/ie/projects/EDAEP/
http://www.ei.jrc.it/ie/projects/Neurotoxicity/

In the field of **Radioactivity Environmental Monitoring:**

- The data input processing software for REM (EasyProteo) was extended with the possibility to read tabular ASCII data and was made Y2K compliant. The REM query interface was further improved and the REM database contents were updated.
- The software to aggregate the incoming EURDEP (European Union Radiological Data Exchange Platform) data has been largely automated, extended with an analysis of the incoming data, the possibility to switch between routine (daily) and alert (two-hourly) data-exchange and with an interface towards a mail-distribution system. The information platform for automatic exchange of data between national real-time monitoring systems in routine and emergency conditions, has been extended. It comprehends now the daily exchange of gamma dose rate measurements with 21 European countries. In the context of a DG RTD DII-3 SCA project, called Real-time On-line DecisiOn Support (RODOS), an interface between EURDEP and RODOS was developed.

The use of the polymerase chain reaction (PCR) permits the study of selected gene aotivities and the identification of differential expression patterns of specific genes as triggered by different environmental chemicals.

SELECTED PUBLICATIONS

Gilmour, K.M., Pärt, P., Prunet, P., Pisam, M., Mc Donald, D., Wood, C.M. "Permeability and Morphology of a Cultured Branchial Epithelium from the Rainbow Trout During Prolonged Apical Exposure to Freshwater", *Journal of Experimental Zoology*, 281 (1998), 531-545.

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Sandbacka, M., Pärt, P., Isomaa, B. "Gill Epithelial Cells as Tools for Toxicity Screening–Comparison between Primary Cultures, Cells in Suspension and Epithelia on Filters", *Aquatic Toxicology*, 46 (1999), 23-32.

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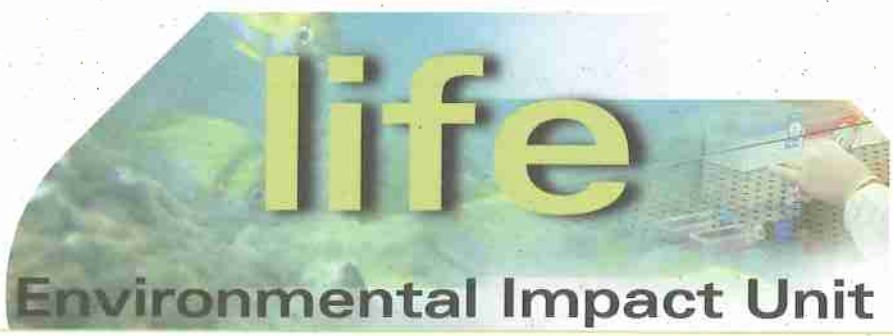
Pärt, P., Wood, C.M., Gilmour, K.M., Perry, S.F., Laurent, P., Zadunaisky, J., Walsh, P.J. "Urea and Water Permeability in the Ureotelic Gulf Toadfish (Opsanus Beta)", *Journal of Experimental Zoology*, 283 (1999), 1-12.



Environmental Impact Unit

THE UNIT'S MISSION

Environmental and human health issues have a high priority on the political agenda. In this respect, the Commission of the European Union (EU) has a responsibility to protect both the European citizen and the environment by providing transparent information and guidelines. Of particular concern is the impact of chemicals on human health, the effect of environmental pollution on wild species as well as the presence and spreading of radioactivity in the environment. The projects described below are designed to develop tools and strategies to assess population hazards and the risk of environmental contamination in order to provide high-quality scientific support to the Commission in defining its policy.

Homepage: http://www.ei.jrc.it/ie/intro/

FIELDS OF ACTIVITY

The work is organized under two main headings:

Environmental Toxicology and Human Health

The work foresees the development of new methodologies for integrated toxicological evaluation of environmental pollutants, as well as to better contribute in accurate risk assessment exercises. In support to EU regulatory activities, different situations of exposure are considered (air and water quality) to evaluate the impact of environmental risk factors on the health of the environment and human well-being. A particular attention is given to on-going EU environmental policies (e.g. Strategy Paper on Endocrine Disrupting Chemicals, EDCs) to assess combined risks derived from complex situations of exposure. A bio-marker-oriented approach based on the identification of critical end-points representing cumulative molecular and cellular effects is being developed and will be incorporated into testing paradigm. Hereby a more realistic evaluation of human health risks in support of new orientations in risk assessment procedures is proposed (e.g. hormonal equivalent factors in water quality criteria).

Radioactivity Environmental Monitoring (REM)

REM supports the Commission in its responsibilities to provide qualified information on the levels of radioactive contamination of the various compartments of the environment (air, water, soil) via exchange of monitoring data and modelling results. REM collects, assembles, analyses and provides this information both for normal and emergency situations and ensures the availability of tools for the inter-communication and access of users from Member States and other European countries. Underpinning research consists of the development and inter-comparison of atmospheric dispersion models as well as the development and implementation of advanced statistical tools for data valorisation. Based on these activities a consistent operational support system for exchanging radioactivity information (data and model

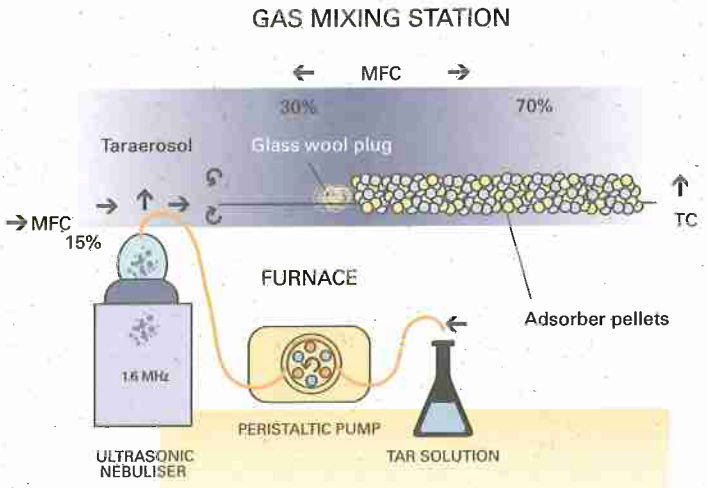
INTRODUCTION

Many environmental pollutants pose risks to wildlife and human health, as they find their way into water supplies, the atmosphere and the food chain. Particular concern is caused by situations of long-term exposure to chemicals at low concentrations and to complex mixtures, as well as to the dispersion of radioactive elements. The role of the Environmental Impact Unit is to provide scientific assessment to regulatory authorities in these fields.

life

Environmental Impact

Unit Head: P. Pärt



Unique rig for studying tar removal from biogas (MFC = Mass Flow Controller, TC = Thermocouple).

SELECTED PUBLICATIONS

Malara, C., Ricapito, I., Edwards, R.A.H., Toci, F. "Evaluation and Mitigation of Tritium Memory in Detritiation", *The Journal of Nuclear Materials*, Vol. 273, Issue 2 (1999), 203-212.

age, whole-crop fermentation and pyrolysis. These produce methane, ethanol vapour or biogas, which are all converted to hydrogen by steam reforming.

The obstacles to the widespread use of steam reformers are the amount of platinum metal catalysts required, and catalyst deactivation at the high temperatures needed for optimum hydrogen yield. After only one year, HYDRA has found two solutions to the problem. One is a base metal catalyst with activity as good as platinum-group catalysts. The other is a radically different form of catalytic reactor, which is being patented. This eliminates deactivation and poisoning, allows high temperature operation and suppresses unwanted side reactions.

In 1999 HYDRA staff also completed a project on upgrading of biodiesel. A microwave reactor took less than a quarter the time of the conventional process. Microwaves excite only the reacting polar molecules, instead of the whole bio-oil.

KNOW-HOW, INSTRUMENTS AND LABORATORIES

The European Solar Test Installation (ESTI) is a calibration and testing laboratory for photovoltaic solar-energy components. It assists the manufacturing industry and consumer in assessing the performance and reliability of photovoltaic systems. With independence of judgement and neutrality, ESTI is committed to quality in the execution of its calibration and testing procedures so as to give its clients the highest degree of confidence in its measurement results. The Quality Assurance Programme of ESTI is one of the keys to the successful global implementation of photovoltaic solar energy. In line with the mission of the JRC, ESTI provides the scientific and technical basis for the harmonisation of standards within the single market of the European Union. ESTI also acts as the technology centre supporting the European Commission's research, development, demonstration and dissemination policy in the field of clean and efficient energy technologies. Its strategy is to maintain and expand its leading position as a laboratory for renewable energy technologies and to continually develop its excellence. ESTI was awarded Accredited Laboratory Status in September 1996 by COFRAC Essais, France. The Quality Assurance Programme implemented by the ESTI Laboratory conforms to EN 45001/ISO/Guide 25.

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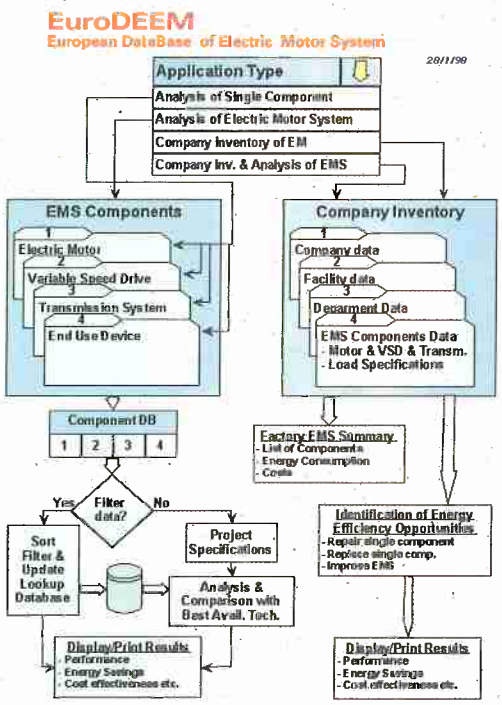


The complex architecture of the EuroDEEM data base.

being a promising new approach for achieving major energy savings in the European non-residential sector. The JRC has played a key role in its preparation: it has collected and reviewed the information to be given to the GreenLight Participants and acted as the Commission's scientific and technical interlocutors in the GreenLight feasibility studies. In particular, a market enquiry was successfully co-ordinated in four European Member States to check the viability and acceptance of the programme. The GreenLight concept was the leading contribution at all major European conferences and workshops. With the massive feedback we have gained, we assisted DG Energy in defining a sound structure for the programme, plus all the necessary materials (registration form, logo, brochures, etc., as well as the GreenLight web site at http:// www.eu-greenlight.org). Finally, by intensive contacts with all the European Energy Agencies, the Unit has succeeded in setting up a powerful network of GreenLight Promoters in 13 Member States. The JRC has gathered them into a timely SAVE kick-off project aimed at strengthening and catalysing GreenLight.

Rational Use of Energy in Buildings: For the Energy Application of Information Technologies (IT) during 1999 a workshop has been organised involving leading telecommunication producers, interested universities and likely users (municipal and central utilities, Energy Saving Providers). A collaborative network for setting up and submitting new projects to the European competition in this field has been established. Investigations have started on the possibility of carrying out Energy Certification of buildings by means of new Information Technologies as a service offered by new Energy Service Providers. Regarding Measurements and Verification Protocols for Performance-Based Contracts, the on-going Research, Development and Demonstration efforts carried out in all countries by the scientific community have made available a large number of innovative technologies for energy efficiency. Nonetheless, the transfer of advanced technologies and sustainable building concepts to the market takes place at a very slow pace. Builders treat building energy retrofit work much the same way as normal building work, without accepting responsibilities or giving guarantees for the overall building energy performance. Specific Measurements and Verification (M&V) Protocols applicable to many energy retrofit measures have still to be developed and adopted. An international action aimed at the development of such M&V protocols at world level, promoted by the US Department of Energy, is now evolving also at the European Commission, through the JRC.

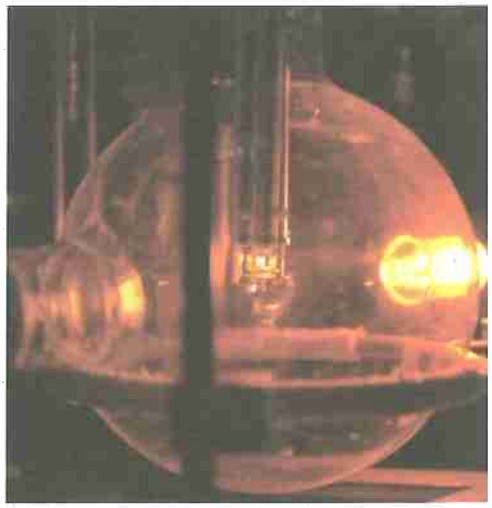
Development of the THEBIS Database: The lack of a quick tool for retrieving European Demonstration Projects, and of their availability according to standard reporting formats, considerably reduces their dissemination and replication potential. For this reason, the development of a database, named THEBIS, containing very detailed technical descriptions of THERMIE and other national demonstration projects was started a few years ago and has continued during 1999. The most important lesson learned from the development of a database of this kind is that the detailed and consistent data and performance indicators from many projects, which have ended, can be obtained only by means of contractual pressure. This important outcome will be transmitted to the European Commission (DG Energy) and to EU public administration, with the recommendation to include in future contracts a request for contractors to submit their final reports according to THEBIS Standard Data Entry. THEBIS is foreseen to be operating as an interactive database in a JRC web site.

HYDRA

The future use of hydrogen as a fuel will do nothing to reduce carbon dioxide emissions, unless hydrogen is made from renewable sources. The HYDRA project targets research on critical steps in the most economic processes for making renewable hydrogen. With no surplus hydroelectricity in Europe, the cheapest renewable hydrogen is made from biomass: the best processes are based on fermentation of sew-

ADELS

The main drawback for hydrogen use in renewable energy systems is its difficult storage. Therefore, we study carbon nano-structures as they have been reported to have the potential for storing large amounts of hydrogen. In collaboration with the University of Montpellier an evaluation of the recently discovered SWNTs for energy storage applications, particularly for hydrogen storage, has been undertaken. Facilities were set up (a thermobalance and a high-pressure Sievert's apparatus) to allow measurements of hydrogen adsorption at temperatures from -93°C to 600°C). We measured surprisingly low adsorption, which implies that hydrogen is adsorbed only on the outside of nanotubes, and probably the H_2 molecules do not penetrate the tubes themselves, which are thought to be closed at the ends. Therefore we investigated procedures for cutting the nanotubes to allow access to the interiors. Acidic oxidation procedures reported in the literature were not effective at increasing the adsorption. Therefore, a mechanical procedure has been devised that could offer a more promising solution. In collaboration with Salford University, a new method for producing carbon nanotubes has been invented. It has the potential for continuous production with much lower energy costs than the current energy-intensive batch processes.



The released quantity of Hydrogen stored in nanotubes is measured by a mass-spectrometer.

Preliminary Results of Hydrogen in C-Nanostructures

Pressure	>70 mbar	50 bar
Temperature	-140°C	-193°C
Adsorption of H_2 (weight %)	2.4 (3.4)	0.1

Advanced Battery Energy Storage Systems: Together with the Institute for Systems, Informatics and Safety (JRC) in-house development of a centrifugal electrochemical power source was started. The objective is to develop and test a novel idea on enhancing the performance of fuel cells and other electrochemical power devices by using strong centrifugal forces. This activity is based on a pending European patent held by EC-JRC. By taking up this activity as part of ADELS, the project meets its objective (i.e. advanced battery energy storage systems) and at the same time provides a frame for know-how development and protection of IPR. The development is under way of an appropriate electrode for the power source.

BATEEE

Data Base on Electric Motor Systems: The EuroDEEM database was officially launched on 8 October 1998. Since then it has attracted the interest of the motor industry (more than 40 manufacturers are supplying data), the national authorities and energy agencies and the specialised press. At the beginning of 1999, the Joint Research Centre released a completely new version (EuroDEEM98 V.1.1.) with many enhancements. The new software was designed to consider and treat the whole electric motor drive system and its components, and also to identify the most promising energy conservation opportunities.

The GreenLight Programme: In 1999, the Unit has provided DG Energy with diligent scientific and technical support for the conception, development, implementation and monitoring of the European GreenLight Programme. GreenLight is a voluntary programme where private and public organisations commit towards the European Commission to upgrade their existing lighting and to design new installations, using energy efficient lighting systems wherever and whenever (1) the energy savings justify the investment and (2) the lighting quality is maintained or improved. Participants are invited to sign a registration form stating that they will undertake all the relevant lighting upgrades within a given time period. In return for their commitment, they benefit from comprehensive technical support as well as broad public recognition. The GreenLight programme has been heralded as

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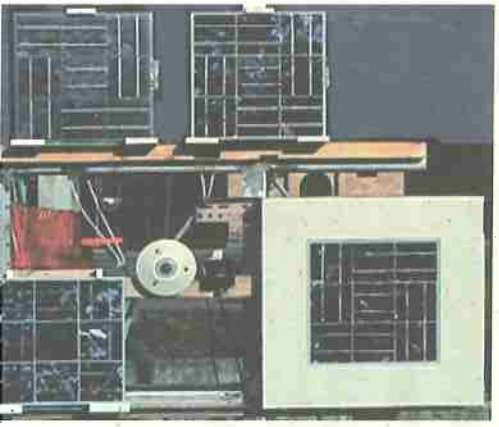
files can be applied to the systems being tested. Performing the defined test cycles under reproducible conditions (controlled climatic chamber with steady-state solar simulator) ensures the best reproducibility of the results. In autumn 1999, six complete solar home systems were installed within the chamber. For the first time ever in the world, complete photovoltaic systems have been exposed to predefined and controlled test cycles following procedures developed at ESTI. In the meantime the ESTI procedures were finalised in collaboration with leading laboratories from Europe and the US and have now been accepted by the PV GAP Standards Committee and are under consideration by the relevant IEC TC82 Working Group 3. The results obtained by these tests allow the assessment of matching and sizing of the components; total system efficiency; the ability of the system to work during bad-weather periods and the recovery period.

Renewable Energies in Desalination: This field is attracting considerable and growing interest and is included in one of the priority action lines of the European Commission's Task Force on Environment and Water. The project addresses the strategic topic of providing drinking/irrigation water through seawater desalination in a very energy-efficient and cost competitive technology. The aim is to validate an innovative approach towards seawater desalination with a broad application potential (e.g. for isolated villages in coastal areas). A new patent for a seawater desalination system, by condensing air moisture, was obtained during 1999, and a collaboration agreement was formulated with the Almeria region, Spain, for the realisation of a plant for agricultural irrigation. The Reverse Osmosis Deep-Sea System (RODSS) was designed by the JRC-Ispra in collaboration with ENEL (I), ETA (I) and WIP (D) and a patent obtained in 1998. This system uses a reverse osmosis desalinating unit, sited offshore at a suitable operative depth, and achieves a remarkable energy efficiency through the free exploitation of the hydrostatic pressure of seawater. A desalination plant will be built on the island of Pantelleria, Sicily (I) and the preparation for construction started in 1999.

Building Integrated Photovoltaic Applications: The development of applications of solar photovoltaics in the built environment has been enhanced by the realisation of several demonstration installations, integrating solar photovoltiac systems into building structures and developing methods to assess and quantify the associated benefits from these installations. Within a Joule project we investigated and developed, in the first place, effective methods of increasing the heat transfer from PV modules to the surrounding air in building integrated situations and, in the second place, the development of a PV module with improved heat transfer characteristics. We have developed specific reference modules that include sensors to provide the required input for energy balance modelling work and a test reference environment to study the effect of thermal exchanges between the PV module and its direct boundaries. The construction of an outdoor plant has started and will become fully operational in 2000. This will be an extension to the Unit's test facilities for the monitoring and long-term testing of building integrated PV-roof and -façade systems.

Monitoring: The analytical monitoring of PV-installations, supporting the demonstration of European photovoltaic systems, has continued. Detailed monthly reports on performance and availability have been provided to help eliminate malfunction and to improve supply quality and economy. On an hourly basis, the whole conversion chain from in-plane irradiation to supplied electricity, respectively to end use (e.g. drinking water supply) has been analysed and when necessary, technical visits made for on-site measurements. This technical support, mainly for DG Energy, included pre-normative work with the IEC on PV systems. The guidelines for monitoring and evaluation have been widely adopted both inside and outside of Europe. The methods used and the results from selected projects are available at http:// iamest.jrc.it/projects/moni/index.htm.



Purpose-made reference elements serve to establish new standards to applying photovoltaic modules as future building elements.

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quences for two Indian and one South African manufacturer which started in 1998, but were delayed by failures. There is a demand from manufacturers for long-term testing (e.g. tests to failure) to provide a technical basis for their warranty policies.

In fact, repeated test sequences provided the most interesting results (see the Joule MENHIR Project and the TISO collaboration), as the progressive action of degradation mechanisms provoked by different tests could be observed. In particular, the degradation observed in different types of EVA material against high temperature/high humidity (damp heat–DAH) accelerated tests suggest that the fast curing EVA formulations are inferior to the standard cure EVA since the early 1980s. On the other hand, the lifetime of modules manufactured with standard cure EVA may be significantly longer than 15-20 years. The results of repeated tests on modules manufactured by Arco Solar (now Simmons Solar) in 1982, and since exposed at TISO, were remarkable. No electrical performance degradation was observed in these modules after 1020 thermal cycles, or 4000 hours of damp heat.

Reference Measurements and Activities, Calibration Campaign
The purpose of the Pyroheliometer Intercomparison, Golden, Colorado exercise (NPC-99) was to provide the 25 participants with current World Radiometric Reference (WRR) reduction factors for their absolute cavity radiometers. As many as five absolute-cavity radiometers with direct WRR traceability were used to form the reference group for these comparisons. These reference cavities participated in at least one of the International Pyrheliometer Comparisons (IPCs) which are conducted every five years by the World Meteorological Organisation's (WMO) World Radiation Centre (WRC) in Davos Switzerland. The absolute cavity comparisons held at NREL (Golden, CO, USA) from 4-15 October had eighteen participants representing Canada, Indonesia, Saudi Arabia, the European Commission and the United States. These radiometers are used to support the calibration of pyranometers and pyrheliometers deployed by researchers in climate change, renewable energy, materials science and instrumentation development. The weather conditions were ideal for carrying out the comparisons and 1500 measurement intervals, during the days with very clear skies, were available to compute results for 1999.

Clean, solar electricity for everybody, everywhere.

Device Physics
Considerable effort was devoted to the identification of alternative materials for solar cell production, as the demand for photovoltaic electricity cannot be satisfied by silicon alone. Among others, polycrystalline thin films, CIS and the more common amorphous silicon materials were evaluated in terms of their stability and performance. The European Solar Test Installation organised the European Silicon Photovoltaic Co-ordination Meeting at Ispra on 19 March 1999 to co-ordinate research efforts in silicon materials and cell research. The invited participants from industry, research centres and universities presented and discussed their ideas on the future trends and a research and development road-map to achieve the goals of the Fifth Framework Programme, in terms of cost reduction and efficiency improvement. The project has organised co-ordination meetings between manufacturers of the raw materials for conventional silicon solar cells and the manufacturers of finished photovoltaic solar modules, together with researchers, in order to define a consistent and direct approach to meeting the environmentally oriented energy challenge of the new century.

Solar Systems
Solar Home Systems: In early 1999, the European Solar Test Installation started to design and implement an indoor facility for the reliable and reproducible testing of stand-alone photovoltaic power systems. The goal was to provide a test facility for small PV systems, and to ensure the comparability of the results gathered. The facility consists basically of a large climatic chamber with an incorporated solar simulator. With this facility any combination of irradiance/temperature pro-

Photovoltaic Device Physics: The application of our new Light Beam Induced Current Measurement Set-Up, developed during 1999, will focus on the understanding of CdTe and CIS thin film materials. In combination with a unique Cell Spectral Response Facility, electronic properties and material limits will be investigated.

Photovoltaic Modules and Components: The Project plans to develop over the next year a Lamination Facility within the JRC in order to study in detail lifetime limits and accelerated ageing effects. The work serves to verify the severity and suitability of international testing standards for developing Photovoltaic products. Work will begin in the year 2000 on developing a standard for the measurement and type approval testing of Concentrator Systems. The results and verification of the new concept in Energy Rating of the ESTI Laboratory will be brought to a wider audience during 2000 and 2001 in order to promote the interest of manufacturers in energy rating, rather than peak power, as is the case at the present time. Analogies will be drawn from the automobile industry.

Applications of Photovoltaic Systems: In the field of Applications of Renewables, the year 2000 and beyond will see: (1) The completion of an extension of the Unit's test facilities for the monitoring and long-term testing of building integrated Photovoltaic and hybrid thermal Photovoltaic roof and façade systems; (2) The realisation of a desalination demonstration plant and definition of the site for a second alternative process demonstration; (3) The application of the Solar Home System Testing to an outdoor site; (4) The application of a new innovative PV shading element to the existing Solar House project.

ADELS

During the coming years, work will continue on carbon nanostructures, its production and characterisation (morphological, its behaviour as hydrogen storage media and its electrochemical activity for its application in advanced batteries concepts) and on the development of a centrifugal electrochemical power source. A research line on a low temperature molten salt battery will start. The idea is to substitute Al for Li in a molten salt cell.

The responsibility of new precision reference solar cells is determined by using a spectrally selective light source.

ACTIVITIES AND PROJECTS

SOLAREC

The Photovoltaic Solar and Thermal Electricity Project SOLAREC has defined three main objectives to develop, demonstrate and promote the use of solar electricity on a wide scale for the benefit of the European Citizen.

Photovoltaic Module Test Operation

During 1999, the NOCT measurement facility on the ESTI outdoor field was greatly improved, bringing it into conformity with the IEC 61215 standard. The new measurement systems were used during the partial eclipse of 11 August 1999 to gather data on the linearity of the PV modules installed at that time. Facilities for measuring the performance of AC-modules were also added, and used for the Joule ARIA Project. The basements of the thermal test field were cleared out, leaving four test stands for solar collector measurements (two without storage, two with). These may be used for energy rating measurements on hybrid thermal-PV devices, prototypes of which were received for type approval testing from a German manufacturer, Solarwatt. Collaboration contracts were established with TISO-LEEE, Canton Ticino, for the study of the end-of-life of the first grid-connected array in Europe, and with Eurosolare, for the development of reference devices for building integration and the study of new encapsulant systems. A methacrylate resin module was subjected to the UV exposure test. Type approval testing work was limited to the completion of test se-

veloping nanostructures for storage of hydrogen and as electrode material for metal-hydride accumulators.

HYDRA–Hydrogen from Biomass
Demonstrating hydrogen production from bio-ethanol in terms of production-rates, costs and efficiency.

BATEEE–Technologies for Efficient and Environmental Energies
Transferring knowledge of energy efficiency through information technology–Preparing for the deregulated electricity market and energy-service providers–Assessing strategies for smart, zero-energy buildings.

MAJOR ACHIEVEMENTS IN 1999

SOLAREC: In the field of solar Photovoltaic electricity generation the Solarec Project has made some noticeable steps forward in the measurement, characterisation, understanding and application of Solar Photovoltaic Electricity during 1999. This regards in particular the Laser Scan Technique to identify and diagnose production inhomogenieties in thin film solar cells and concepts for the measurement and quantification of Photovoltaic Module Energy Rating.

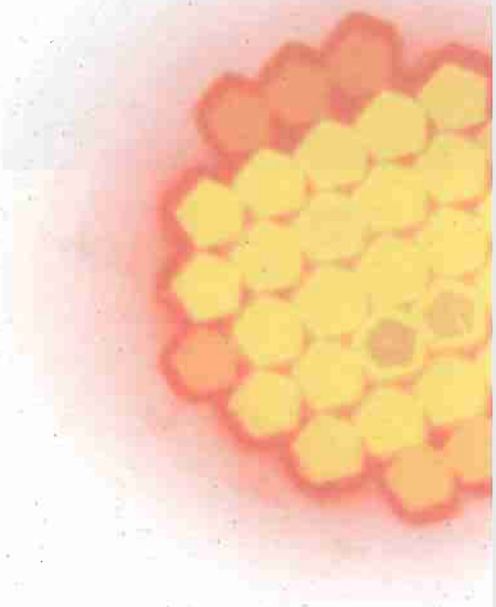
With the establishment and execution of the first controlled indoor test programme for Solar Home Systems, ESTI again sets a world first for standards and quality for Photovoltaic products and deployment of Photovoltaic electricity.

Complementary use of Solar renewables in the newly granted patents for two independent processes of water desalination has demonstrated the ability of the group to take laboratory research one step further.

ADELS: In the field of storage, facilities were set up to allow measurements of hydrogen adsorption in carbon nanostructures at temperatures from 80 to 873K (-193 to 600°C). Initial measurements were also performed as a function of pressure and temperature. They showed that the as-received samples adsorbed between 0.1 to 2.4 weight % hydrogen depending on the experimental conditions.

BATEEE: During 1999 the JRC, on behalf of DG Energy, further developed the idea of a GreenLight programme. A demonstration project, approved by the SAVE Committee, has been set up and the JRC will ensure the technical co-ordination. The technical knowledge on lighting has been gathered and loaded into a JRC web-site (http://www.greenlight.eu.org/).

HYDRA: Hydra made four important advances in its first year: (1) A catalyst for making hydrogen from ethanol, which does not use precious metals, but works just as well; (2) A novel catalytic reactor for hydrogen production, which is immune to deactivation even at high temperatures; (3) A system for removing tar from bio-gas without cooling it; (4) A microwave reactor which dramatically reduces the cost of upgrading biodiesel.



Light-guiding optics of the large area solar simulator at ESTI.

FUTURE ACTIVITIES

SOLAREC

Reference Measurements: The project will continue to develop and expand its calibration facilities for solar irradiance measurements and improving the traceability of measurements for precision calibrations in the field of Photovoltaic devices. Field Tests and verification will be undertaken on the first series of a new Absolute Primary Silicon Reference Sensor (ASPIRE).

energy

Renewable Energies Unit

THE UNIT'S MISSION

By giving advice on relevant technological issues, the mission of the Renewable Energies Unit is to support European policies on the introduction of renewable energies into the energy-supply system. The Unit undertakes in-house research in carefully selected fields requiring further European effort, so as to increase the renewable-energy share of the competitive energy market. The post-Kyoto Protocol and the European Commission's White Paper on Renewable Energies call for increased penetration of renewable energy supply, in particular of photovoltaic solar energy and biomass.

Homepage: http://iamest.jrc.it/

FIELDS OF ACTIVITY

SOLAREC–Solar Electricity
Establishing quality standards in production, supply, deployment and use of solar electricity:

- Assessing options solving the materials supply problem of solar cells.
- Significantly reducing costs in PV module production.
- Contributing to system integration issues in the built environment and for water production.

Reference Measurements
Increasing precision of measurements in order to meet requirements of the market.

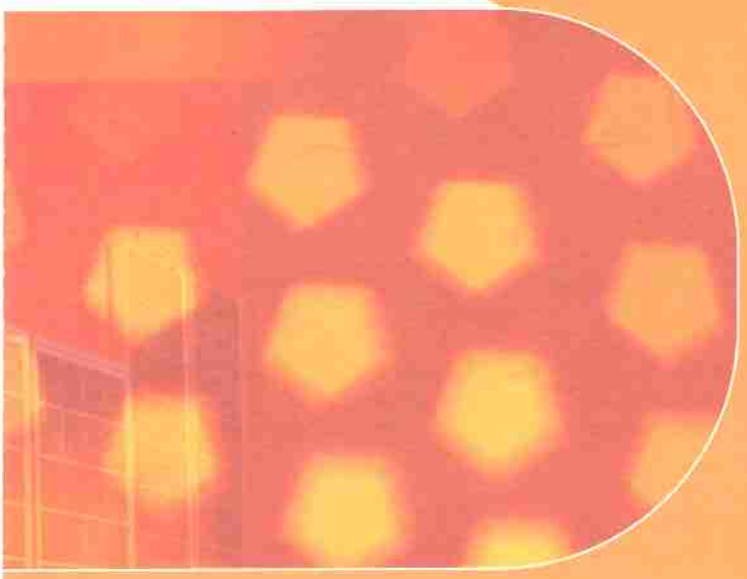
Materials and Device Technology
Resolving problems of materials availability of current technology–Investigations of cadmium-telluride and copper-indium-DiSelenide thin film structures–Investigating emerging technologies of organic and highly molecular materials.

Module Improvement
Developing concepts which will substantially decrease production cost of modules–Harmonising power and energy rating of flat-plate and concentrating devices–New initiative for concentrators (PV and thermal).

Solar Systems
Demonstrating cost-effective solutions for integration in the built environment–Evaluating thermal solar electricity concepts for large centralised plants–Harmonising quality standards for small, decentralised systems: quality, reliability, user satisfaction, integration of PV in the IEC Quality System.

New application focus: water production and purification.

ADELS–Advanced Electricity Storage
Assessing the suitability and lifetime of advanced battery concepts for renewable electricity, in particular Lithium-Ion technologies–De-



INTRODUCTION

Since burning or processing of fossil fuels causes air pollution, it is increasingly necessary to seek alternative, "cleaner" and renewable energy sources. Solar-energy conversion by photovoltaic panels and the production of hydrogen from biomass (via bio-ethanol) will increasingly contribute to renewable energies in future. There is a great need to improve the associated technology in terms of efficiency, life time and cost. It is the task of the Renewable Energies Unit to develop, test and apply more advanced techniques of energy conversion, transfer, storage and use, and to promote the practical application of all potentially efficient forms of renewable energy.

energy

Renewable Energies

Unit Head: H. Ossenbrink

The Unit organised inter-laboratory tests with custom laboratories in different Member States to investigate the applicability of different types of markers and the corresponding analytical methods to different types of oil. One marker was selected for a testing period of five years.

KNOW-HOW, INSTRUMENTS AND LABORATORIES

The Unit has considerable expertise to undertake comprehensive collection of field data at contaminated sites while the Unit's laboratories have at their disposal a wide variety of analytical instruments to study organic, inorganic and radioactive compounds.

Organic, Inorganic and Mobile Laboratories.
The Unit is particularly well equipped to study organic compounds, especially dioxins. The instrumentation for these studies include gas and liquid chromatographs coupled to low- and high-resolution mass spectrometers. Automated devices for fast sample extraction and purification of various environmental matrices (vegetal, animal or mineral) and waste material are available. Sampling equipment is also available to collect organic contaminants in the environment and in industrial installations. Analysis of major and trace elements in a variety of matrices can be done by atomic absorption, x-ray fluorescence and diffraction.

The Unit can draw on the considerable resources of the Institute's Advanced Mobile Analytical Laboratories (AMAL) to carry out on-site inorganic and organic analyses of soil and water samples from contaminated sites.

Experimental Facilities and Field Studies
To support the development of physical models, the Unit has excellent experimental facilities. These include:

- A soil monolith facility for 3-D migration studies of organic compounds (CUBE) and a geochemical laboratory equipped with anoxic chambers for the simulation of variable redox conditions.
- Access to a waste incinerator. The Unit's high-resolution mass-spectrometry facilities have been involved in "horizontal" activities within the Institute, notably through the European Reference Laboratory on Waste Incineration and Vehicle Emission Measurements (ERLIVE).
- A Tuneable Diode Laser (TDL) working at high repetition rates is available for point measurement of greenhouse gases in the atmosphere (CH_4 and N_2O). The TDL can be coupled with micrometeorological instrumentation (see Air Quality Unit) to estimate fluxes and open-path measurements. Applications also include the measurement of atmospheric emissions of methane from landfill sites.

Informatics and Modelling
The Unit possesses considerable experience in the use of GIS, data base, spatial analysis and WWW technology for developing knowledge-management solutions for a range of environmental applications. The Unit is active in the development of hydrological models.

High-Resolution Mass Spectrometer Clean Up System.

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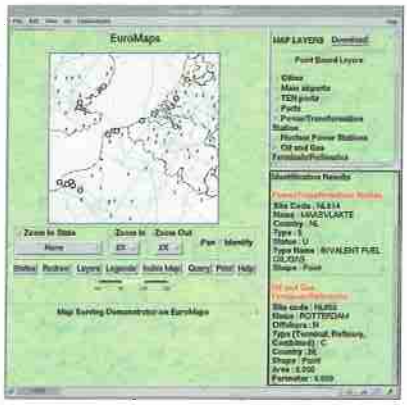

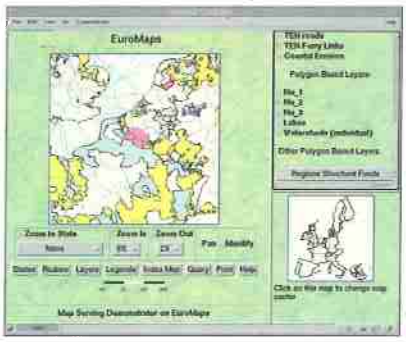

Dissemination of Geographical Data through the Web

Of particular importance to the development of an integrated information system has been the EuroMaps project. This activity has been undertaken jointly with ISIS as a Competitive Support Activity for the European Statistical Agency (EUROSTAT). EuroMaps is a Web based application that allows users to interactively create high quality maps from EUROSTAT statistical data and provides a means for disseminating geo-referenced data. A user can select areas of interest and data-layers to be displayed interactively through a standard web-browser. The application is based on the integration of ESRI's ArcView GIS and ArcView Internet Map Server (IMS) together with customised Avenue scripts and JavaScript programmes for controlling the user interface.

A parallel project being managed by the Unit as a Competitive Support Activity for DG Enterprise is investigating the coupling of a groundwater model developed by WASY Gmbh (Berlin) within an ArcInfo GIS to a WWW based interface. The system is being developed using a prototype version of the new ArcIMS and innovative software developed within the Unit. The aim of the project is to provide planners and the public with real time information on the state of groundwater levels in a coal mining areas in the Rhine valley.

Both these projects have provided the Unit with the means of testing and evaluating various procedures to enable the display and processing of spatial data through a WWW browser. In addition, the EuroMaps project has participated in the JRC Web Mapping Test Bed project that aims to develop a global protocol that links geographic information systems around the world (OpenGIS).

Support to Other Activities

During 1999, the Unit continued to provide support to a number of other EI activities in the domain of information management. Of particular interest was the completion and population of the On-line Archive System for the Aerosol Characterization Experiment (ACE)-2 field campaign (see Atmospheric Processes and Global Change Unit).

A study of the requirements for an information system on water-resource management and a thematic atlas of water resources were completed for the Regione Lombardia (see Water Unit).

As part of the inaugural World GIS Day (November 19th, 1999), the Unit organised a workshop of all GIS related activities with the JRC. The workshop was supported by EI, SAI and ISIS and was attended by over 80 people.

As part of a Competitive Support Activity to EUROSTAT, the Unit developed an ArcInfo GIS application called ARTNAT (ArcInfo TraNsport Accessibility Tool). This programme calculated an index to estimate the degree of access to European transport infrastructure. Outputs from this study were used in a series of spatial analysis studies.

The Unit contributed to the JRC's ongoing activity in humanitarian demining. A series of presentation were made to both the US State Department and the Western European Union that resulted in the release of many digital maps of the Kosovo area.

OTHER ACTIVITIES

During 1999, staff from the Unit participated in a number of Working Groups of the Comité Européen des Normes (CEN), which aims to standardise analytical methods within the EU.

The Unit's Organic Laboratory successfully completed the EUROMARKER project (competitive support to Directorate-General Customs and Indirect Taxation) which aimed at selecting a uniform marker for rebated gas oils and kerosene, and validating analytical detection methods.

pletely removed the contaminated muds and the most critical phase of the disaster seems to be over. During June 1999, a joint field campaign with JRC Space Applications Institute was organised in collaboration with the Consejo Superior de Investigaciones Cientifícas (CSIC) to characterise the residual contamination and establish a relationship between measurements of soil contamination and the spectral response of airborne imaging spectrometry. Different physical and geo-chemical investigations were carried out at 23 representatives sites in the affected area (gradient of heavy metal concentrations in soils, water and vegetation, soil texture and mineralogy, spectral reflectance of different natural surfaces, radiometric calibration) with observations using airborne advanced radiometric sensors. The Guadiamar area represents an ideal opportunity to demonstrate the development of a common approach at EU level to support preventive and remediation policies for contaminated lands.

The Unit's organic laboratory is continuing to study dioxins from the Seveso area (Italy) in order to check whether legislative thresholds are still exceeded in the affected area. The project is monitoring dioxin levels throughout the affected zones and since the areas are densely populated, these studies are being conducted in close co-operation with epidemiologists and the local authorities.

Two activities carried out in close co-operation with the EI-Unit Water Research and Monitoring investigated the impact of a contaminated site on groundwater quality and the environmental impact of the possible enlargement of a landfill (in collaboration with the JRC Institute for Systems, Informatics and Safety). These activities included sampling and analysis of soil, soil gas and groundwater, and also measurements of aerial depositions on soils using mosses (e.g. Hypnum cupressiforme) as biomonitors.

Emission of Greenhouse Gases from Soils

An increasing consideration is given to the role of soils as sinks or sources of nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2), greenhouse gases of the Kyoto protocol that, however, regulates so far only activities related to forestry. As a support to post-Kyoto negotiations on future mitigation measures, soil research needs to strengthen the role of management practices of agricultural ecosystems as a way of minimising the net GWP of the greenhouse gases exchanged between agricultural land and the atmosphere.

In this context, the RICEOTOPES shared-cost action, co-funded by DG Research, aims to improve the understanding of the relationships between observed temporal variations in the 13C/12C and D/H isotopic ratios of methane emitted from rice paddies by improving the modelling of regional and global fluxes of methane. The Unit focused on the measurements of CH_4 fluxes using Tuneable Diode Laser Absorption Spectroscopy coupled with eddy-correlation (collaboration with the EI Unit Air Quality) and on the isotopic analyses of CH_4 by GC-IRMS (collaboration with IHCP) for the comparison of mixing ratio and 13C content of atmospheric methane down- and upwind of the rice growing area. Additionally, measurements of N_2O fluxes during the drainage period using the closed-chamber technique were carried out. Comparisons of the emission of carbon equivalents as N_2O and CH_4 from early and late flooding fields in 1998 and 1999 showed that a substantial reduction in GWP occurs as a result of the adoption of the late-flooding practice.

Development of Environmental Information Systems

The Unit is actively developing a range of information management solutions to integrate results from a number of diverse activities that address data management, analysis and dissemination. These solutions involve merging database management systems, GIS and Internet/WWW technologies.

Aznalcollar river accident.

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Aznalcollar river accident.

und Rohstoffe (BGR, Hannover). This study will be followed by a survey of available data from competent national authorities for the production of maps of heavy metals and organic matter in European soils and supported by a programme of *in-situ* analysis where data are not available or of poor quality. A questionnaire has been sent to soil experts and institutions in Europe. The results of the Feasibility Study based on the responses to the questionnaire was presented at the European Soil Forum in Berlin in November 1999 and used as a basis to define the future work programme. As part of the above study, the Unit organised a workshop on "Problems around Sewage Sludge" that was attended by policy makers from the Commission, NGOs, technical experts and representatives from a range of associated industries (e.g. water, food, and farmers).

Flow of Dangerous Substances in Waste Streams

This activity supports waste-related EU Directives, taking into account the cross-media nature of waste emissions. A study has been launched to estimate the flow of dangerous substances associated to waste streams in selected economical sectors, tracking them from the source of generation to the consumption as a basis for environmental impact studies of waste management strategies. A specific initiative analyses the role of waste recycling in the contamination of animal feeding products by Dioxins and other POPs. This relatively unknown pathway of Dioxins and POPs to humans has been highlighted recently by the concerns over Belgian chickens. The initiative aims to quantify the contribution of this pathway to the human daily intake and will comprise the testing of standard reference materials in collaboration with IRMM and IHCP.

Development of Indicators for Contaminated Sites

In collaboration with the EEA and the Austrian partners of the Topic Centre Soils (UBA, Vienna), a project was undertaken to develop a methodology to identify regional indicators for contaminated sites in Europe. The background to these indicators is the EEA's Driving Forces-Pressures-State-Impact-Response model (DPSIR) and the Multifunction/Multi-Impact approaches that are used to characterise contaminated sites. More than 100 indicators were proposed for the Northwest Salzburg region of Austria. Five classes of indicators were used as judgement parameters in a multi-criteria analysis that attempted to select areas within the study area that most urgently required remediation. Although the developed indicators require further validation, initial results indicate that such information can play a significant role in the planning process by reducing the complexity of the information that has to be considered by policy makers.

An activity was started to investigate the potential of micro-organisms to degrade contaminants *in situ* under natural conditions. Known as "natural attenuation", this method has gained widespread attention as a potentially efficient and cost effective remediation strategy than more engineered technologies. For some substances (e.g. chlorinated volatile organic compounds–cVOC), biodegradation results in a net change in the 12C/13C ratio in the compound being degraded. Since the current way of proving the occurrence of biodegradation in the field relies mainly on indirect indications involving a variety of chemical and biological measurements and experiments, the analysis of carbon isotope fractionation provides a more direct evidence of intrinsic bio-remediation. In this project, carbon isotope ratios of cVOC in groundwater will be determined to describe the status of biodegradation. In collaboration with the University of Tübingen, this task will be combined with new approaches in groundwater investigation and sample preparation that enable the characterisation of degradation status of an entire contaminant plume. From this data degradation rates for the cVOC can be computed and implemented in groundwater flow models.

Assessing Contamination from Industrial Accidents and Sites

The failure of a dam at the Aznalcollar mine (Andalucía, Spain) in the spring of 1998 caused a wave of toxic pyritic slurry to be discharged along 30 km of the Guadiamar River and threatened to destroy the Doñana National Park. The subsequent remediation has almost com-

connection with a regional network in the Baltic area has also been established.

http://www.ei.jrc.it/sw/projects/watershed/

The Climate, Hydrochemistry and Economics of Surface-Water Systems (CHESS)

The general objective of the CHESS project is to study how climatic changes could affect the quality of freshwater resources in Europe. Within CHESS, the Unit focuses on the development and validation of a model of watershed processes and the transfer of diffuse sources of pollutants to river systems using a watershed-scale, continuous-time, distributed-parameter model linked to an in-stream water quality model. In 1999 applications concerned river basins in Finland and the UK (>2000 Km^2). Scenario analyses evaluated the sustainability of agricultural practices under changing climate conditions and the impact of alternative management scenarios. Initial results showed that the expected extension of the cropping season in Finland would not lead to additional nutrient loading to surface waters. Sensitivity analysis was carried out in collaboration with the Universidad Politécnica de Madrid using two different methods. The first was based on linear regression models within a Montecarlo procedure using both raw and ranked values while the second makes use of the FAST procedure, based on the Fourier coefficients of the output variables and a sinusoidal sampling of the input parameters. CHESS is being undertaken in collaboration with the Institute of Hydrology (UK), the Finnish Environment Institute, the Technical University of Athens, the Vrije Universiteit Brussel and the Istituto di Ricerca sulle Acque of Bari. CHESS is a shared-cost action funded by DG Research.

http://www.ei.jrc.it/sw/projects/CHESS/

Assessing the Vulnerability of European Soils to Chemical Contamination

In collaboration with the European Chemicals Bureau and the University of Aberdeen, an activity has been started to develop models to assess chemical contamination in soils and groundwaters. The system will model the predicted environmental concentration (PEC) of a number of substances (e.g. pesticides) in the soil compartment on a regional basis. The model will be implemented within a GIS and draws on a number of digital datasets from individual test areas and on a pan-European level. This work will lead to a significant improvement in the risk assessment procedures currently being used and propose effective strategies to reduce the uncertainty in the various scenarios that are currently used to estimate the environmental risks and health effects associated with the use of chemicals in the environment.

Environmental Compatibility of Waste Management Strategies

Statistics on waste generation trends in the EU show that the use of cleaner technologies alone is not sufficient to decrease waste production. To solve the problem waste generation should be de-coupled from economic growth by enforcing the concepts of prevention, reuse and recycling, ensuring at the same time a safer disposal. However, the heritage of past waste management activities remains and its remediation will represent a challenge in the next decades, possibly representing a limiting factor for investment in pre-accession countries. The Unit has launched a number of strategies to understand these problems.

Problems around Sewage Sludge

An activity has been started to support DG Environment in the upcoming revision of the Directive on Sewage Sludge. As part of this revision, the JRC has been given the responsibility of collecting information on the levels of heavy metals and organic matter in European soils. With the European Soils Bureau, the Unit hosted a meeting of experts from Member States to discuss and endorse a proposal for a Feasibility Study then carried out by the Bundesanstalt für Geowissenschaften

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An example of poor waste management procedures.

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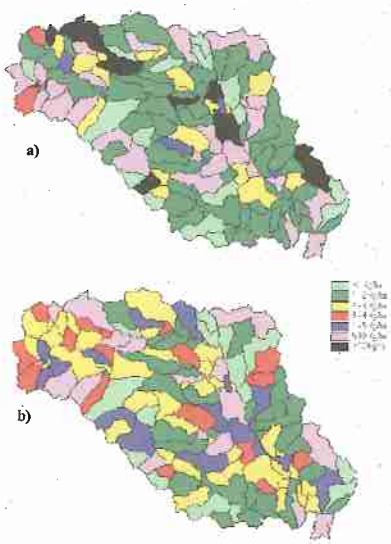
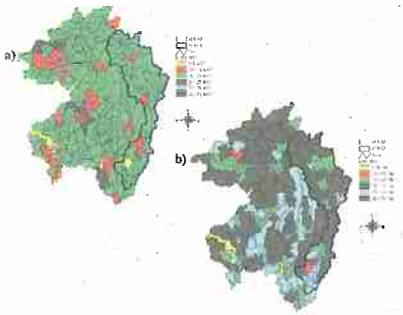


Impact of land application of organic waste on nitrate loading to river for the Ouse watershed, UK, considering: a) application of 210 kg/ha year on pasture only, and b) application of 100 kg/ha year both for winter wheat and pasture.



Impact of climate change scenarios on water quantity for the Vantaa watershed, Finland. Comparison is made between: a) baseline scenario (1960-1990); b) expected total runoff to the river for a possible scenario (years 2020-2050) considering an increase in rainfall and temperature.

ACTIVITIES AND PROJECTS

Impact of Waste Emissions on Soils

Assessing the Impact of Legislation on Soil and Water Quality

There is a number of procedural EU instruments that affect soil protection through measures directed at the protection of air and water or within sector policies. Implications can be found in the new agri-environmental policy, throughout the existing water-related Directives, and in the forthcoming Water Framework Directive, requiring Member States to manage water at watershed scale, particularly in relation to reverse pollution trends. This activity consists of various approaches to assess the consequence of changes in land use, climate and EU policy on soil and water quality. Many of these approaches are based on field work and use models and GIS software to process data sets for soils, hydrology, pollutant sources, crops and basin topography.

European Watershed Observation Network on Soil and Water Pollution

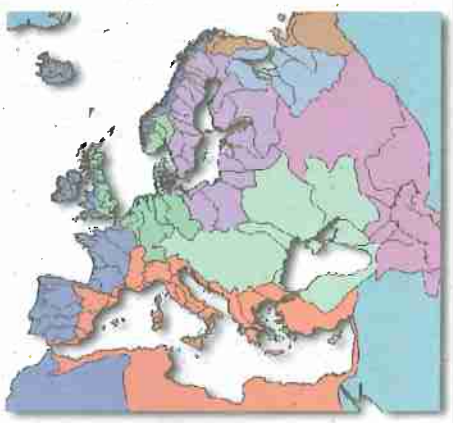
The EuWASP activity investigates how soil and water resources are affected by changes in land use and management decisions as a result of EU policies and legislation. This knowledge is obtained by testing a number of EU guidelines at selected watersheds that are linked in a network of existing national and regional initiatives. A meeting involving a number of Member State institutions was held to investigate the feasibility of setting up the network, discuss research priorities, and make a preliminary selection of possible river basins taking advantage of already existing national or regional initiatives.

A key task being carried out in co-operation with DG Environment and the European Environment Agency is the establishment of a catalogue of existing study areas containing a harmonised description of their characteristics, monitoring capacities and historical data collection. Such a catalogue will provide fundamental background information on sites being studied in Europe. The catalogue will be a useful tool for selecting sites to assess the impact of environmental policies (e.g. Urban Waste Water Directive, Nitrate Directive or Water Framework Directive implementation) or for assessing harmonised criteria or standards for the effects of pollution. The first stage in the compilation of this catalogue is a questionnaire that has been sent to academic bodies and research institutions in Europe covering a range of climatic and ecosystem characteristics and multiple soil and water pollution problems. Activities at the EuWASP watershed network are closely integrated with a parallel network of coastal sites in Europe (ESCON) that is being developed within the EI Unit Water Research and Monitoring. These two activities contribute to the European Watershed Coastal Zone Integrated Study that is assessing the interrelated nature of coastal water quality in relation to dominant human activities in the upland drainage basin.

Research has focused on two watersheds in the Mediterranean area. In collaboration with local authorities, field campaigns for data acquisition (soil and water sampling and analysis) continued at a coastal agricultural watershed in Italy. This collaborative project focused on the application of an integrated modelling system to describe nitrogen and water cycling. A nested approach, ranging from the field to the catchment scale, was adopted. The spatial range and pace of the nitrogen turn-over has been combined with information on land use through models accounting for hydraulic and hydrological changes. Models of processes such as volatilisation, soil production and emission of gases with greenhouse properties have been coupled with hydrological models to account for the whole nitrogen cycle. Discussions have started with Spanish institutions to establish collaboration on a second watershed (Guadiamar River) to obtain time series data for both river basin and coastal zone sites. In order to compare the effects associated with different climatic and ecosystem conditions, a

soil-water continuum, and the impact of different management decisions at watershed scale.

- Following the accident that occurred at the Aznalcollar mine (Andalucía, Spain) in 1998 and the discharge of toxic slurry along the Guadiamar River, a field campaign was organised in collaboration with the JRC-SAI. The campaign characterised the residual contamination, establishing a relationship between measurements of soil contamination and the spectral response of airborne imaging spectrometry.
- With the European Environment Agency and the Austrian partners (UBA, Vienna) of the Topic Centre Soils, a series of region-based indicators were developed for contaminated sites in Europe.
- Support DG Environment policy on the application of Sewage Sludge on agricultural lands by launching an activity to gather information on concentrations of heavy metals and organic matter in European soils.
- A new High-Resolution Gas Chromatography/Mass Spectrometry (HRMS) laboratory to measure dioxins and Persistent Organic Pollutants was initiated.
- Significant progress was made in the integration of GIS and WWW technologies. The Unit was responsible for organising the 1st JRC Global GIS Day Workshop.

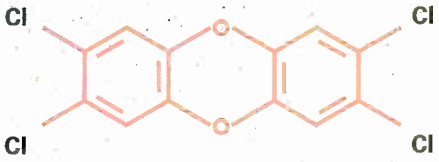


European river catchments (source GISCO).

FUTURE ACTIVITIES

During the reminder of the 5th Framework Programme (1999-2002), the Soil and Waste Unit will continue to provide support for the preparation of European Community legislation in the fields of soil and water protection and waste management.

Specific focus will be placed on developing the EuWASP observational network of research watersheds and on the validation of the HARP (Harmonized Quantification and Reporting Procedures for Nutrients) guidelines on well-instrumented watersheds in Finland and in France. The HARP guidelines provide grounds to estimate normalized values of nitrogen and phosphorus losses from both point and non-point sources and help assess the effectiveness of the pollution reduction strategy.



Dioxine molecule.

Development and validation of waste characterisation and modelling methods to estimate the flux of dangerous substances associated with selected waste streams. Investigation of the role of waste recycling in the contamination of animal feed by Dioxins and other Persistent Organic Pollutants (POPs).

Activities on contaminated lands will be organised around an Observatory on Assessment and Remediation of Contaminated Lands. A research action on the environmental impact of mining waste will be launched in collaboration with DG Environment and EEA and with the involvement of Pre-Accession countries.

The Unit will develop a tool to assess biodegradation processes at contaminated sites. This tool will lead to a more reliable assessment of natural attenuation (the ability of microorganisms to degrade contaminants *in situ*).

The Unit will start a modelling activity on the potential regional concentrations of chemicals in European soils. This activity is being carried out in collaboration with the IHCP and the University of Aberdeen and is expected to significantly improve the spatial component of current risk assessment methodologies.

The development of GIS based models to assess the regional component of greenhouse gas emissions from European soils. This project will build on experimental work carried out in the Unit and draws from a variety of ground observations and remotely sensed data sets.

soil

Soil and Waste Unit

THE UNIT'S MISSION

The mission of the Soil and Waste Unit is to carry out research in support of EU policies regulating the environmental impacts of waste management strategies and protecting soil resources. The primary objectives of the Unit are to establish relationships between pressures arising from industrial, urban and agricultural waste producing activities and soil and groundwater pollution, and to understand better the role of soils in the production of greenhouse gases.

Homepage: http://www.ei.jrc.it/sw/intro/

FIELDS OF ACTIVITY

The major activity of the Soil and Waste Unit is the project on Impacts of Waste Emissions on Soils (IWES, JRC Project No. 42). Particular emphasis is placed on the following themes:

- investigating the implications of EU legislation and policy on soil and water quality through the establishment of a network of inland and coastal case-study watersheds throughout Europe (in the frame of LEPE),
- assessment of the contribution by industrial and agricultural sectors to pollutants found in waste streams as a basis for environmental impact studies of alternative waste management strategies (waste minimisation, recycling and toxicity prevention),
- definition of appropriate criteria to establish a balance between affordable restoration and risks, including on-site validation studies for the characterisation of soil and groundwater pollution,
- development of spatial data banks and generation of pan-European indices for an assessment of soil toxification and vulnerability,
- assessing the spatial and temporal distribution of greenhouse-gas emissions from agricultural ecosystems.

These activities are supported by the development of integrated information systems using models, databases, geographic information systems (GIS) and Internet technology.

The Soil and Waste Unit collaborates closely with the European Commission's Directorate-General Environment, the European Soil Bureau (ESB), the European Chemical Bureau (ECB) and the European Environment Agency (EEA).

MAJOR ACHIEVEMENTS IN 1999

These were:

- The establishment of the EuWASP (European Watershed Observational Network on Soil and Water Pollution) network to improve the understanding of relationships between pressures on soil and water quality arising from emissions of pollutants, their transfer in the

INTRODUCTION

The correct and controlled disposal of substances from urban, industrial and agricultural activities is fundamental to the preservation of environmental resources. It is important to recognise that the contamination of soils by waste dumping, air pollution, industrial accidents and farming practices has a direct bearing on the quality of groundwater and on the plants growing in them. In addition, many European soils have the potential to emit various "greenhouse gasses" that have a bearing on global climate issues.

The increased generation of waste in the EU is such that waste management has become both an environmental problem and an independent economic sector. Projections of increase for the next decades are directly related to the expected economic growth. In Central and Eastern European Accession countries, total amounts of waste generated are reported to be three times the EU average.

It is the task of the Soil and Waste Unit to understand these processes, their interactions and their consequences. This knowledge will lead to an improvement in the sustainable management of soil resources and in the reduction of waste production.

soil

Soil and Waste

Unit Head: G. Bidoglio

European Land-Ocean Interaction Studies Project Office

The European Land-Ocean Interaction Studies (ELOISE) Project Office is very closely related to ESCON. ELOISE is a Thematic Network of the EU in which coastal-zone research projects in the Commission are focused on the important question of how land-ocean interactions operate and on how these are influenced by human activities. It is an initiative of the Research DG. In October 1997, an ELOISE Project Office was established at the Environment Institute in support of Research DG. Its work comprises in supporting the ELOISE thematic network through the promotion of workshops and meetings, and the preparation and circulation of information, so as to favour collaboration on coastal-zone research within Europe and between ELOISE and other international communities such as Land-Ocean Interaction in the Coastal Zone (LOICZ).

During 1999 Research DG and the Environment Institute of the JRC developed the ELOISE Phase II Implementation Report. This report summarises the current state-of-play of the Thematic Network ELOISE. It describes the planning and execution of ELOISE from its inception in 1994 up to the present and outlines the objectives, management, organisation and project content. Currently ELOISE comprises 27 shared-cost and 2 concerted action projects involving 230 partners in 24 countries. About half of the projects of Phase I ended in 1998 or 1999. The Phase II projects continue into the year 2000.

The Third ELOISE Open Science Conference was held in Noordwijkerhout, the Netherlands from 1-4 December 1999. Some 180 participants took part in the meeting and results from 29 projects where presented and discussed over the three-day period. The papers will be peer reviewed and published in two special issues of Nearshore and Coastal Oceanography (NCO) series of Continental Shelf Research, and Atmospheric Environment.

KNOW-HOW, INSTRUMENTS AND LABORATORIES

The Unit's laboratories can perform analyses of organic and inorganic compounds at trace levels in all environmental matrices, including isotopic analysis of stable isotopes. The specialized laboratories of the Unit include:

- a clean room (class 100) for sample handling, preparation and measurement of contaminants at very low concentrations (less than a nanogram per kilogram),
- a laboratory for the production of reference materials for the analysis of various environmental matrices, such as water, soils, sediments, biota and waste materials,
- a limnological laboratory for the performance of aquatic ecology research and biological monitoring (phytoplankton biomass and density) of inland and marine waters; an axenic algal culture room is also available,
- a laboratory equipped for studying wastewater treatment,
- a sub-surface flow reed-bed wastewater treatment system,
- a micro-calorimetric laboratory for investigating (an)aerobic biological processes.

Advanced Mobile Analytical Laboratories (AMAL)

Among the analytical facilities available in the Unit is the modular mobile laboratory for sampling and on-site analysis. It comprises of an off-road vehicle plus vans and trucks with trailers. The laboratory is equipped with analytical instrumentation ranging from portable detectors to gaschromatography/mass spectrometry, depending on actual needs. The structure allows efficient fieldwork for environmental characterisation of water, soil and waste in applications where measurements require immediate sample preparation, interactive sampling based on previous results or fast results are needed.

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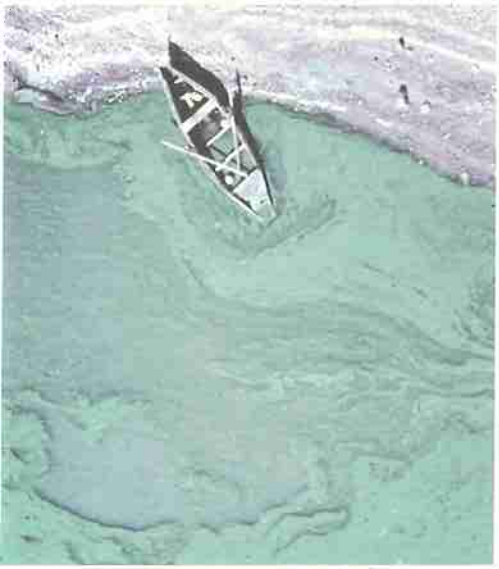

Eutrophication.

European Scientific Coastal Observational Network

The activity European Scientific Coastal Observational Network (ESCON), which is an entirely new project for the Unit, is the contribution to the project "European Watershed-Coastal Zone Pollution Exchange" (EW-CZPE) that is being carried in collaboration with the Soil and Waste Unit as well as in close co-operation with Environment DG. It is becoming increasingly accepted at the scientific, industrial and political level that the uses made of all European watersheds have long-term and wide ranging impacts not only on soil and freshwater resources but also on the quality and quantity of water run-off to coastal areas. In order to develop adequate political and technical measures to allow sustainable development of both fresh and marine coastal waters integrated assessment needs to be undertaken.

By selecting a limited number of basins over a range of European conditions characteristic of the pollution problems encountered by Member States, the development of comprehensive, inter-comparable data will be facilitated that more closely corresponds to the needs of such a study. The selection of key basins will also contribute to the development of a wide range of information needed to investigate the effect of EU Water Policy Directives on reducing different types of pollution sources. It will justify the long-term investment of Community and national resources in the development of methodologies and monitoring techniques that will be needed to estimate the efficiency of the application of EU Water Directives in terms of water quality and socio-economic cost-benefit.

At selected European watershed-coastal zone sites, the EW-CZPE project studies processes that lead to eutrophication or other selected pollution events in European waters. Specific objectives of the EW-CZPE project are to:

- determine the long-term changes of selected European river basin-coastal zones at local, regional and continental scale and identify and quantify the effect of current anthropogenic activities on these linked ecosystem in the context of their natural variation,
- determine the natural capacity of coastal ecosystems to assimilate nutrients originating from land-based sources,
- estimate the level of nutrient reduction required to protect water quality and living resources from human induced nutrient changes.

A minimum of 5 years will be necessary to implement a programme on European coastal waters in an operational way and assess first results, followed by a period of long-term surveillance for a further 5 years.

In 1999 an integrated approach with the Soil and Waste Unit has been agreed. Initial discussions with the Space Applications Institute on the possibility of identifying common test sites where *in situ* studies and space observation techniques can be employed were started. The main efforts have been focused on setting up the network. This has consisted of holding an experts meeting in Ispra where both river basin and coastal zone scientists were invited to provide input to the project, to discuss objectives, to identify possible test sites and to agree on a strategy to develop a European network. A number of potential test sites have been identified and contacts were made with local authorities and institutes to discuss data access and collaboration. A problem that has been encountered is that so far it has been difficult to convince some national programmes to contribute in a practical manner to the exercise. Therefore, in collaboration with Environment DG and the EEA, a watershed-coastal zone questionnaire is being developed for sending to national member institutes to identify sites of significant interest at the European level. It is expected that first results will be available by the middle of the year 2000.

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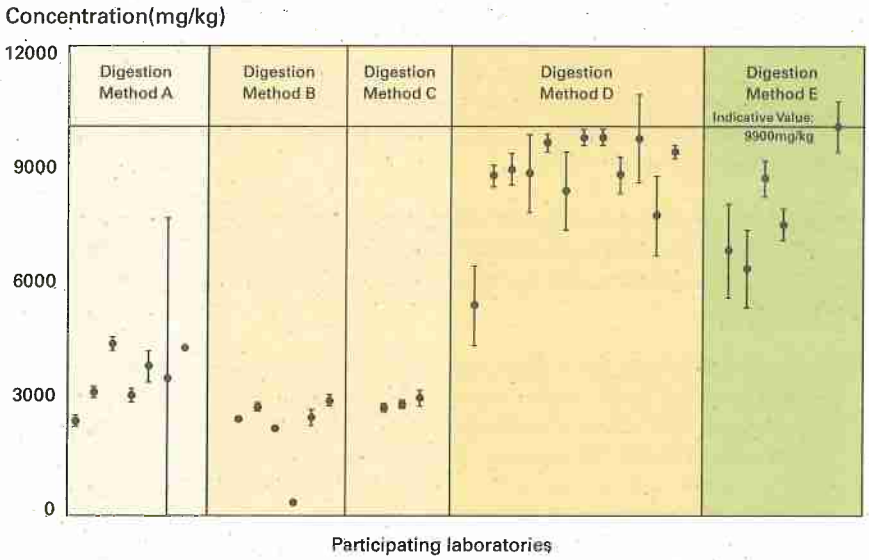
nal measurement quality control with simple and inexpensive means and procedures. The laboratory reference materials produced by the two courses (plant materials for the analysis of pesticide residues and metals) are at present subject to two inter-laboratory exercises in the ten Accession Countries. Following to the analytical characterisation of the materials, they shall be distributed to interested laboratories for daily measurement quality control.

The DAQUA-programme of 1999 launched a series of inter-laboratory exercises for the determination of pesticide residues and metals in wine grapes and tobacco, and the determination of polychlorinated biphenyls, polyaromatic hydrocarbons and metals in a series of materials such as incineration ash and compost from city waste and sewage sludge. The largest inter-laboratory exercise ever performed at the EI, conducted in co-operation with the European Committee for Standardisation (CEN), focused on the validation of CEN standard methods for the analysis of waste materials. Eleven test materials were produced and distributed to 69 laboratories for the analysis of 31 elements by five test methods.



Interlaboratory comparison of 5 digestion methods for the determination of titanium in incineration ash containing 9900 mg kg^{-1} of titanium.

Production of Environmental Reference Materials

Environmental reference materials are produced at Ispra since 1972 and the total production today amounts to some 220 materials, 72 of which were, or are, in the process of certification by Standards, Measurement and Testing Programme. In 1999, work was carried out on the following Shared Cost Actions:

PACEPAC	A series of road dust reference materials for the determination of platinum group metals.
CREAM	The first formal EU-project on the production of laboratory reference materials.
MULSPOT	A series of oyster tissue materials were prepared for the determination of chemical species of arsenic, mercury, selenium and tin.
PCOC	Preparation of a river sediment, which is highly contaminated by organic contaminants.

Additionally, a series of waste materials were prepared in co-operation with UNICHIM for the determination of chlorinated dibenzodioxines and dibenzofuranes. A series of potato powders with increasing spike levels of pesticides were produced in co-operation with International Centre for Pesticide Safety.

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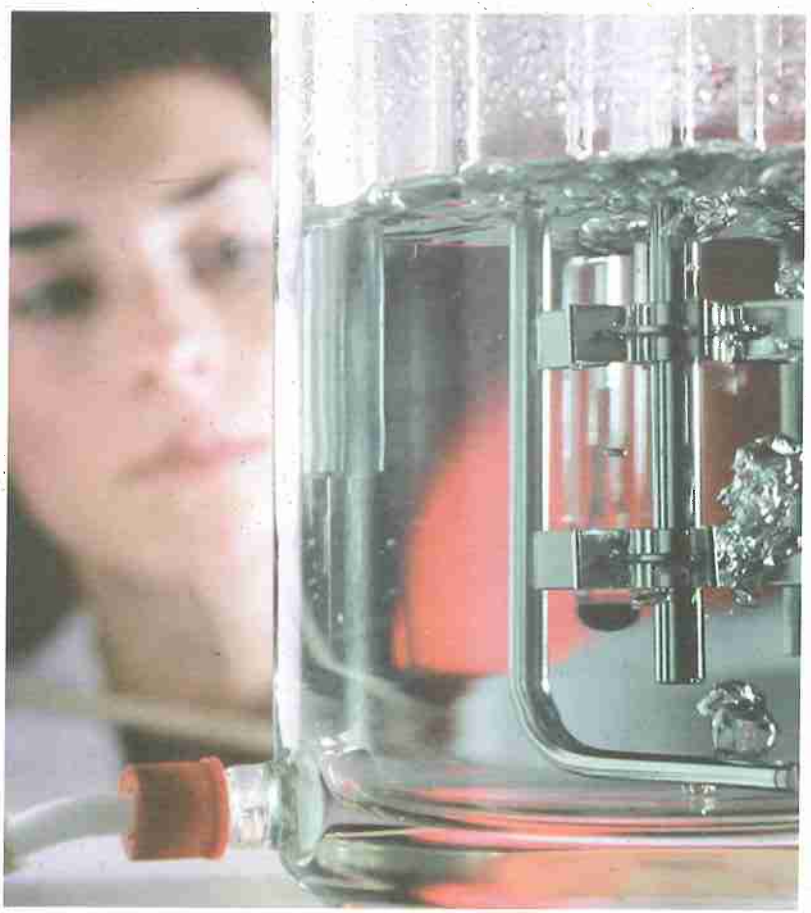
Development of a High Sensitivity Bio-Calorimeter

Heat generation is the final by-product of all metabolic transformations. Therefore the measurement of the thermal behaviour of a biological system can give an overall estimation of its activity. The heat-flows involved in these processes range from 50 to 500 mW L^{-1}, requiring a detection limit of 5 to 10 mW L^{-1}. A high sensitivity calorimeter was developed to investigate both aerobic and anaerobic biological processes. For this purpose a RC1 heat flux reaction calorimeter with an effective volume of 1.5 litres was upgraded. This calorimeter allows on-line monitoring of biological processes and is an efficient bioassay for estimating kinetic parameters, the viable biomass and toxicological effects. This kind of information is crucial for modelling and control of biological wastewater treatment plants.

A series of tests were performed under aerobic conditions and a linear correlation between heat production rate and oxygen uptake rate was determined. The final detection limit reached is very promising for studying anaerobic processes where less heat is produced.



Micro-calorimetric laboratory.

Data Quality

Environmental Data Quality Assessment

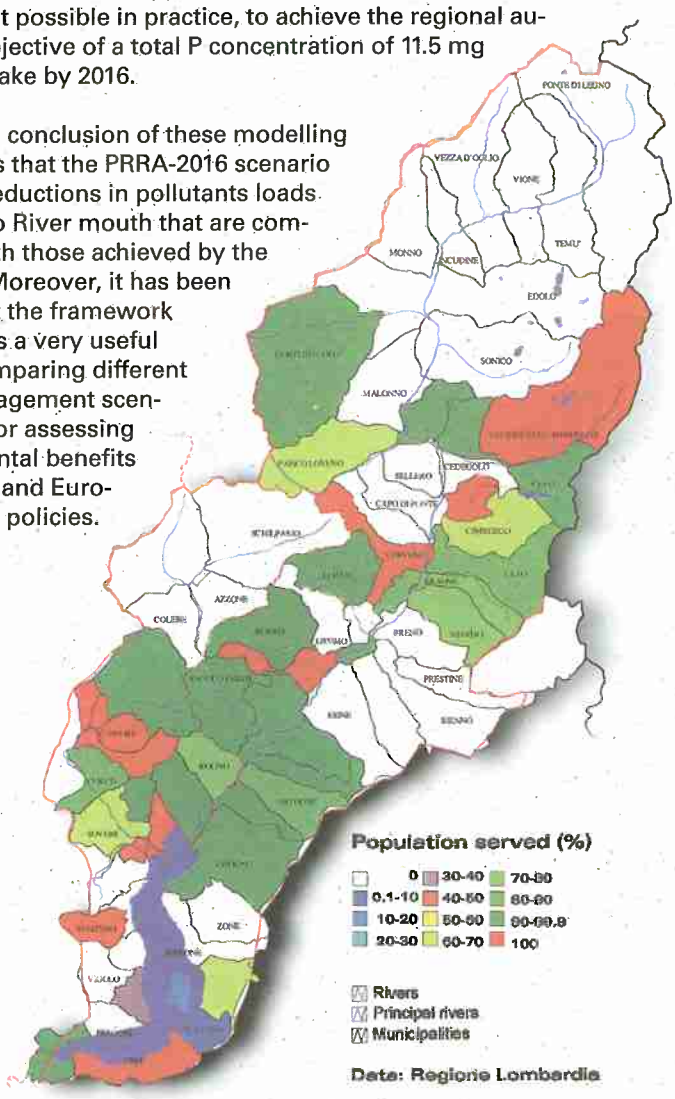
The activities of the Unit in the field of data quality control and assessment in environmental analytical chemistry have been continued in the 5th Framework Programme under the name of DAQUA (Data Quality; ex-AQUACON). The year 1999 was marked with an intense co-operation with the former PHARE-Countries, today Accession Countries, of Central and Eastern Europe.

Following a series of regional seminars in Lithuania, Bulgaria and the Slovak Republic, two hands-on courses were held at Ispra for laboratory representatives of the Accession Countries aiming at the production of laboratory reference materials, intended for internal and exter-

These scenarios have been considered to be representative of the regional authority's objective to reduce the total P loads entering Lake Iseo, and to restore the lake as close as it is practically possible to its former natural status.

Application of DESERT shows that the Regional Water Clean-up Plan can achieve similar reductions in total P concentrations in the basin's main river system compared to the European Directive, but at notably lower economic costs. Application of EVOLA to Lake Iseo shows that it is not possible in practice, to achieve the regional authority's objective of a total P concentration of 11.5 mg m^{-3} in the lake by 2016.

The overall conclusion of these modelling exercises is that the PRRA-2016 scenario achieved reductions in pollutants loads at the Oglio River mouth that are comparable with those achieved by the UWWTD. Moreover, it has been shown that the framework proposed is a very useful tool for comparing different water management scenarios and for assessing environmental benefits of national and European water policies.



Population served by sewer network system in the Oglio river basin.

Sustainable Wastewater Management

The application of physico-chemical methods, e.g. crossflow membrane filtration at micro- and ultra-scale, to the removal of chemicals from wastewater has been continued, studying the behaviour of ethylbenzene, aniline, nitrophenol, chlorophenols and colouring agents. Additionally, "real world" effluents from the wastewater treatment stations Decimomannu, Decimoputzu and Dolianova in Sardinia have been studied achieving removal rates of contaminants present, such that the effluents are suitable for use as water in agricultural irrigation.

The subsurface-flow reed-bed wastewater treatment facility has been used for the degradation testing of a series of organic compounds, likely to be found in municipal wastewater. Urea, surfactants and detergents, phthalates, ethanol, and dyestuffs were tested successfully, as well as concentrated wastewater from a dairy station. In co-operation with the Institute of Ecological Chemistry (GSF Neuherberg), chemicals of industrial origin such as a series of polyaromatic hydrocarbons were shown to be degradable as well.

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Catchment area of the Oglio river.

velop harmonised innovative tests, to study migration mechanisms and to set up and maintain a database that contains information on CPDW.

Inland Water Management

The implementation and the success of legislation require monitoring the changes in water quality. Taking into account the new approach of water management at river basin scale in the proposal of the Water Framework Directive, the Unit is carrying out studies in some Italian river basins of the Po catchment area. The main goal of the project is to define methodologies and instruments that will assist the authorities to manage, restore and protect water resources. The Lake Iseo basin in the Lombardy region is one of the selected study areas. Two types of models were applied in the basin to simulate the impact of several water quality management scenarios on the quality of its surface waters. The DESERT water quality model, which was developed by the International Institute for Applied System Analysis in Austria and the Institute for Water and Environmental Problems in Russia, is a one dimensional water quality model to simulate the transport and decay of nutrients and biochemical oxygen demand (BOD_5) in a river system including its tributaries. The EVOLA lake models, which were developed by our Unit, are dynamic box models to evaluate trends in the average total phosphorous (P) concentration.

Two types of water quality management scenarios were applied to the Oglio river basin: the Regional Water Clean-up Plan PRRA (1992) and the Urban WasteWater Treatment Directive (UWWTD, 91/271/EEC). The scenarios are summarised bellow:

Scenario	Description
2005 PRRA	Constructing wastewater treatment plants (WTPs) and/or connecting population to existing WTPs in administrative communes located at elevations higher than 700 m above sea level.
2010 PRRA	Constructing WTPs and/or connecting population to existing plants in the remaining administrative communes.
2016 PRRA	Enhancing the efficiency of waste water treatment process in a number of WTPs.
UWWTD	The Oglio river basin is a sensitive area. Thus, all the population is served by WPTs.

For the three PRRA scenarios, only administrative communes with greater than 70% of the population covered by a sewer network system were considered. The EC scenario assumes that the Oglio River basin is a "sensitive area" for eutrophication and thus wastewater treatment plants serve the entire domestic and industrial populations. In other words, it also takes into consideration administrative communes with poor or no sewer network coverage.

The preliminary results of the work undertaken show that although the reductions achieved by the PRRA 2016 scenario are lower than the reductions obtained with the UWWTD scenario, the concentration values simulated by both scenarios fall within the same water quality classes. The table below gives the comparison of simulated reductions in pollutant concentrations achieved for various scenarios.

Scenario	PRRA-2005	PRRA-2010	PRRA-2016	UWWTD
Reduction of total P concentrations	5%	24%	30%	42%
Reduction of NH3-N concentrations	4%	25%	29%	60%
Reduction of BOD5 concentrations	0.19%	22%	22%	46%
Rise in dissolved oxygen concentrations	0.19%	0.71%	0.81%	2.0%
Water class	C	C	B	B

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FUTURE ACTIVITIES

The forthcoming years are fully dedicated to the implementation and carrying out of the work programme as was established in 1999. The work on Water Management, Sustainable Wastewater Management and Data Quality will be continued as in the past years. The activities in the framework of the European Observatory on Drinking Water and the European Scientific Coastal Observational Network will be extended according to on-going activity planning.

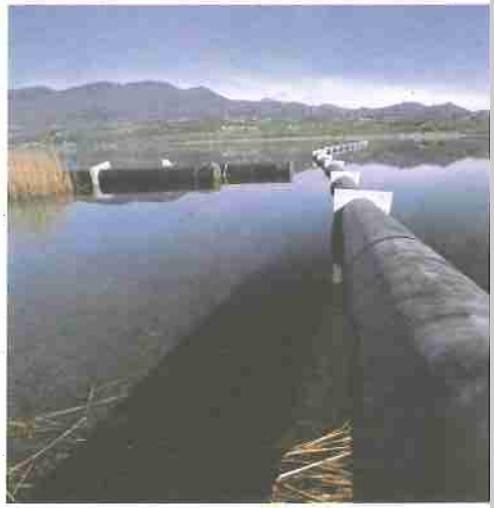
ACTIVITIES AND PROJECTS

Water Quality

European Observatory on Drinking Water

The overall goal of the European Observatory on Drinking Water (EURODWA) is to provide an efficient communication link on drinking water quality among researchers, regulatory bodies, technology and service providers, and consumer organisations at European, national and regional levels. Specific objectives of EURODWA are:

- to support Environment Directorate-General (DG) for the development and implementation of policy on drinking water on the basis of state-of-the-art reviews,
- to respond to the request for greater transparency and clarity of drinking water policy,
- to transfer soundly based scientific and impartial information to the various stakeholders such as standard-setting bodies, companies, consumers and resource managers, in a form which is appropriate to their particular needs,
- to promote research and related initiatives on drinking water and to define emerging priorities as a basis for joint research programme/project development, avoiding duplication of R&D,
- to stimulate industry and water companies in improving the economic efficiency of water treatment, the minimisation/neutralisation of treatment by-products, and the technologies of the leakage detection in the distribution network.



Implementation of research results: installation of 6 km of pipes for hypolimnatic withdrawal of anoxic nutrient rich water in Lake Varese to prevent the outflow of oxygen-rich and nutrient-poor surfacial water in summer.

One of the emerging priorities is the approval of Construction Products in contact with Drinking Water (CPDW) at European level. CPDW depend on the Construction Product Directive (89/106/EEC) that aims at the CE marking of all products, and the Drinking Water Directive (98/83/EC) that aims at good water quality at the consumers tap. Most Member States have a national acceptance scheme to protect drinking water quality. However, the various national approval schemes differ substantially in philosophy, tests and acceptance criteria, which creates a barrier for trade within Europe. Enterprise DG initiated the setting up of a European Acceptance Scheme (EAS) that will harmonise national practises.

In 1999 the Water Research and Monitoring (WRM) Unit participated in a feasibility study to harmonise the national approval schemes of France, Germany, Netherlands and UK. The outcome of this study was a prototype EAS. In order to produce the final EAS a Regulators Group for CPDW (RG-CPDW) was set up involving all the Member States. The role of the WRM unit in the RG-CPDW is to support Enterprise DG to co-ordinate the research that is needed for the EAS, and to organise meetings concerning specific technical aspects with national experts. In 1999 the unit organised technical meetings on "Positive Lists" for compounds that are allowed to be used in CPDW and on "Conversion Factors" to calculate the concentration from a migration rate and the results were reported to the RG-CPDW.

To support the EAS and its implementation, the setting up of a European Testing Laboratory for CPDW was started. The objectives are to de-

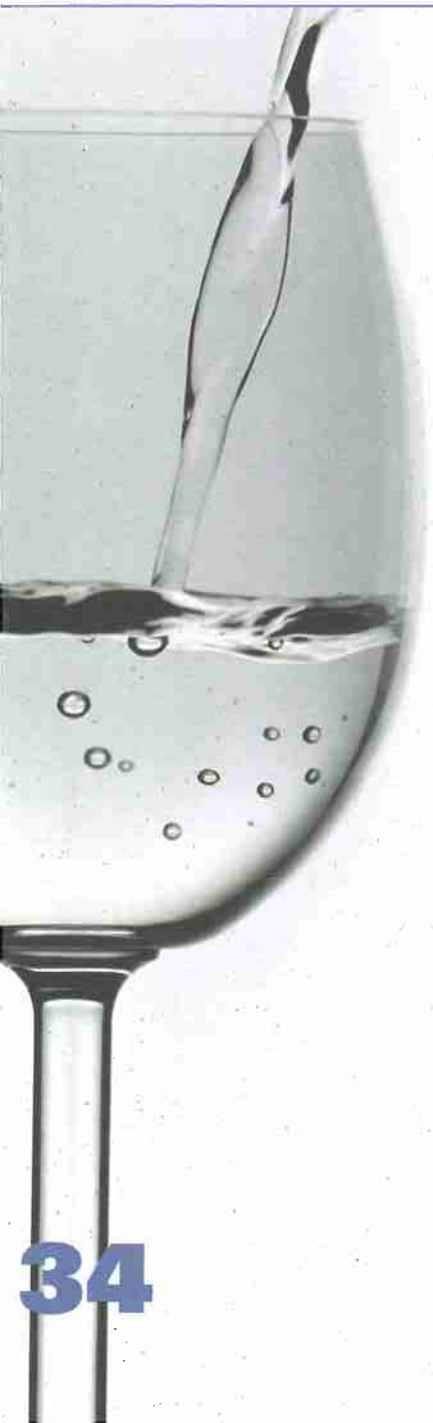
water

Water Research and Monitoring Unit

THE UNIT'S MISSION

The Water Research and Monitoring Unit provides scientific and technical support for the conception, development, implementation and monitoring of European water policy and, in particular, the relevant directives. The unit stimulates collaborative research in the EU through networking.

Homepage: http://www.ei.jrc.it/wrm/intro/



FIELDS OF ACTIVITY

The Water Research and Monitoring Unit carried out research and studies in the following fields:

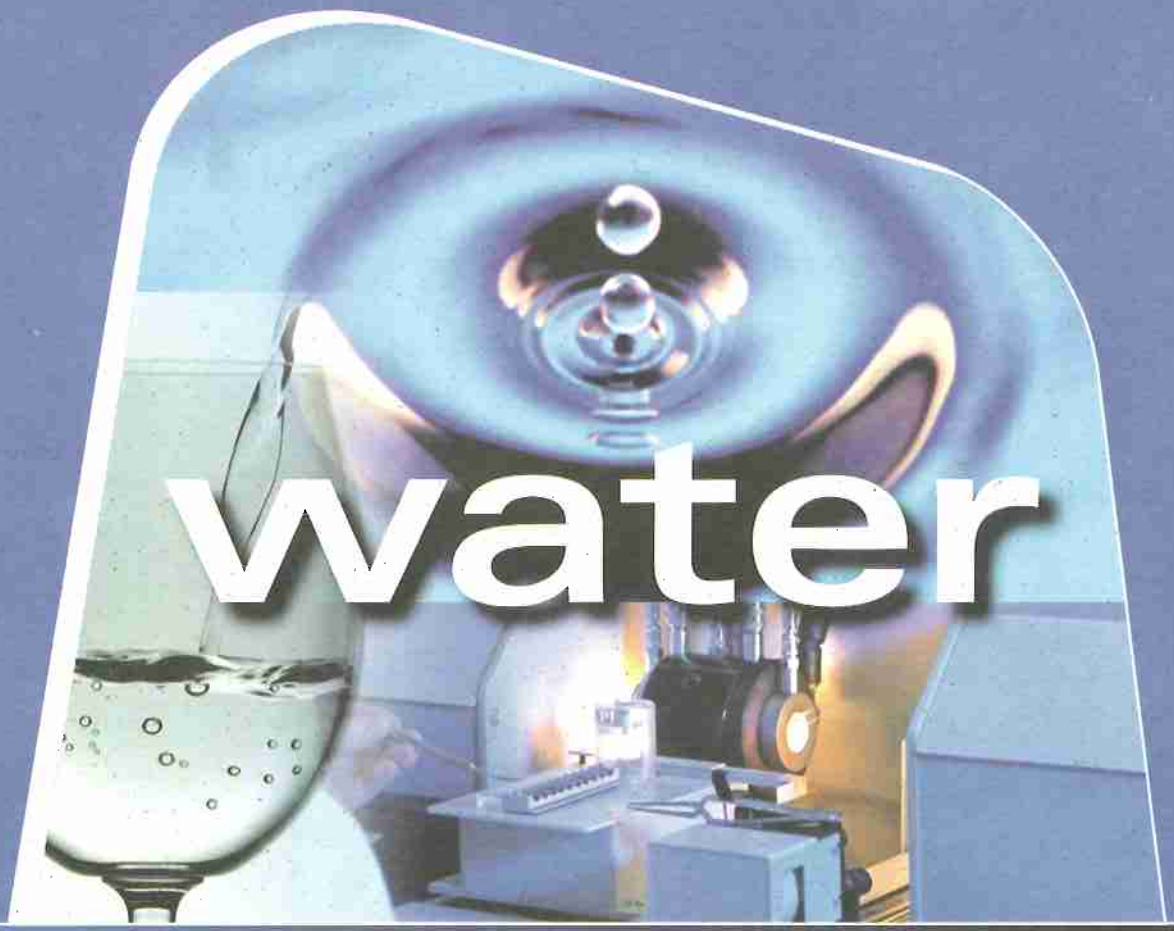
- drinking water quality,
- inland water management,
- coastal interaction processes,
- wastewater re-use,
- data quality.

MAJOR ACHIEVEMENTS IN 1999

- The organisation of two technical meetings and the co-ordination of research in the framework of the set up of a European Acceptance Scheme for Construction Products in contact with Drinking Water.
- Different water management scenarios were compared for improving the water quality in the Oglio river basin and Lake Iseo.
- Cross flow membrane filtration, coupled to photo-oxidation, was used to decompose nitrophenol, aniline, ethylbenzene, chlorophenols and colouring agents in wastewater.
- Subsurface-flow constructed reed bed wastewater treatment was applied to urea, ethanol, phthalate, sodium lauryl sulphate, dodecylbenzene sulphonate, a colouring agent (Ponceau4R), NTA, EDTA and detergents of commercial origin.
- The development of a high sensitivity bio-calorimeter for studying aerobic and anaerobic biological processes.
- Inter-laboratory calibration exercises on the analysis of several compounds in solid wastes, sewage sludge, sediment and plants have been completed.
- Reference materials of solid wastes, soils, plants and oyster tissues for the analysis of several compounds were prepared.
- Two hands-on courses for the production of laboratory reference materials were organised for the ten Accession Countries.
- The set up of a European Scientific Coastal Observational Network.
- The ELOISE project office has been closely involved in running the thematic network, and participating to the 3rd ELOISE Open Science Conference in Noordwijkerhout (Netherlands).

INTRODUCTION

Since the demand on water resources is increasing steadily, for domestic, agricultural and industrial purposes, the availability of naturally occurring good-quality fresh water is decreasing, and more and more attention has to be paid to recovering clean water from used water. It is the goal of the Water Research and Monitoring Unit to develop instruments and methods of water-resource management to obtain good-quality water, including adjacent coastal seas.



Water Research and Monitoring

Unit Head: A. Tilche *until Sep. 99*
P. Pärt *f.f. from Sep. 99*

chiometric and lean-burn spark ignition engines with and with out after-treatment (catalyst) was chemically analysed and compared to the particle matter in two major cities, Milan (I) and Paris (F). This approach facilitated the source apportionments and revealed a substantially higher contribution to airborne particulate matter from diesel vehicles in Paris than Milan. Detailed results on the emissions of polyaromatic hydrocarbons and their nitro-derivatives (PAH and nitro-PAH) from the investigated technologies have been published.

http://www.ei.jrc.it/ap/projects/PARFIN/

KNOW-HOW, INSTRUMENTS AND LABORATORIES

The Atmospheric Processes in Global Change Unit relies on a unique complementary expertise in the fields of aerosol physics, gas-phase photochemistry, plant physiology, biosphere-atmosphere interactions, advanced organic and inorganic analysis, and atmospheric modelling.

Atmospheric Aerosol Laboratory
- Size resolved generation and on-line measurement of aerosols in the diameter range between 3 nm and 20.000 nm.
- Size resolved sampling (PM10, PM2.5, PM1, impactors...).
- Laminar photochemical flow reactors.

Photochemistry Laboratory
- Photochemical reaction chamber, with on-line long-path Fourier-transformed infrared spectroscopy (FT-IR), tunable diode laser and ultraviolet/visible (UV/VIS) spectrometers.
- Large Teflon bags for simulating of chemical and photochemical reactions under close-to-natural conditions.
- Support and preferential access to the EUPHORE facility in Valencia (SP).
- Flow-tube cell with chemical-ionization mass-spectrometry detection.
- Field instrument for measurement of peroxy radicals.

Laboratory for Organic Chemical Analysis
- Ion Chromatography, Total Organic and Black Carbon.
- GC and GC-MS systems for analysis of volatile organic compounds (VOC).
- HPLC and HPLC-mutiple-MS for polar organic compounds.

Laboratory for Biosphere Interaction Studies
- Temperature controlled tree-exposure chambers.
- Cuvette systems for gas-exchange measurements of plants, soils...
- "FLUXNET" tower with Relaxed Eddy Accumulation techniques.

Laser Laboratory for Atmospheric Studies
- Laser fluorescence and ionization methods for ultra-trace-elemental analysis at volumetric concentrations below femto-gram level (< 10^{-15} g).
- Transportable Laser-ionization time-of-flight mass spectrometer for on-line single aerosol particle analysis.

Atmospheric Modelling Group
- 3-D mesoscale/regional scale models with chem. and aerosol modules.
- Access to the Global Circulation Model ECHAM.

The Unit networks with the main atmospheric chemistry laboratories in Europe. It is frequently engaged in field experiments across Europe.

http://www.ei.jrc.it/ap/facilities/

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Beissler, H., Petrucci, G.A., Cavalli, P., Omenetto, N. "Blank Problems in the Detection of Gold by Electrothermal Atomization and Laser Induced Fluorescence", *Spectrochim. Acta*, Part B, 54 (1999), 2115-2120.

Hansen, B., Rahman, M.S., Payá-Pérez, A.B., Larsen, B.R. "QSARs for KOW and KOC of PCB Congeners: A Critical Examination of Data, Assumptions and Statistical Approaches", *Chemiosphere*, 39 (1999) 2209-2228.

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Thunis, P., Cuvelier, C. "Impact of Biogenic Emissions on Ozone Formation in the Mediterranean Area, a BEMA Modelling Study", *Atmos. Environ.*, 34 (1999), 465-479.

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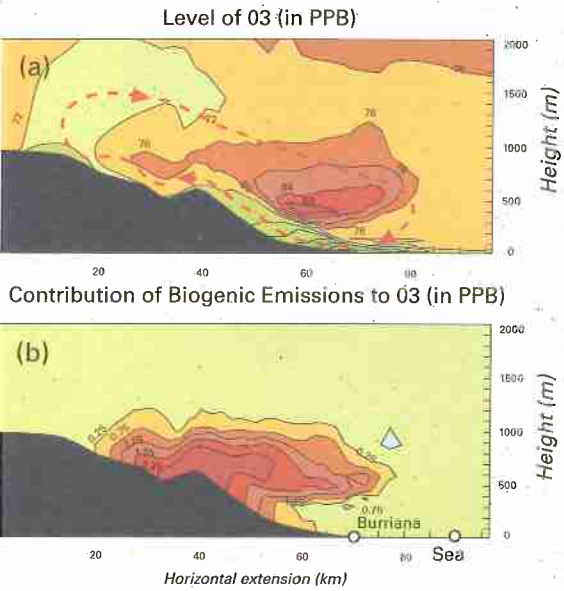

(a) Formation of the ozone reservoir layer by the sea breeze circulation on the East cost of Spain near Burriana modeled by the "Atmospheric Modeling Group". (b) Contribution of the biogenic emissions to the levels of ozone in the upper plot.

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Gornushkin, I., Anzano, J.M., King, L.A., Smith, B.W., Omenetto, N., Winefordner, J.D. "Curve of Growth Methodology Applied to Laser-Induced Plasma Emission Spectroscopy", *Spectrochim. Acta*, Part B, 54 (1999), 491-503.

Gornushkin, I., King, L.A., Smith, B.W., Omenetto, N., Winefordner, J.D. "Line Broadening Mechanisms in the Low Pressure Laser-Induced Plasma", *Spectrochim. Acta*, Part B, 54 (1999), 1207-1217.

Matveev, O.I., Smith, B.W., Omenetto, N., Winefordner, J.D. "A Comparison of the Luminosity–Resolving Power Product for Several Imaging and Non-Imaging Spectrometric Systems", *Applied Spectrosc.*, 53 (1999), 1341-1346.

For prediction of the meteorological fields, the non-hydrostatic meso/regional scale model TVM (Vorticity Model) has been extended by the implementation of a cloud module (collaboration with the University of Louvain-la-Neuve, Belgium). The meteorological module is coupled either on-line or off-line to two different chemical reaction mechanisms: LCC (Lurman-Carter-Coyner mechanism) and RACM (Regional Atmospheric Chemistry Model). One of the RACM mechanism features is a new condensed reaction scheme that includes the biogenic compounds isoprene, α-pinene, and limonene.

Recently, also in collaboration with the EPFL (Ecole Polytechnique Fédérale de Lausanne), two equilibrium aerosol modules (SEQUILIB, and ISORROPIA) have been added to the Modelling System. The following aerosol species are considered: sodium, hydrogen, ammonium, nitrate, chloride, sulphate, water, elemental carbon, organic carbon, and crystal.

In collaboration with the Stanford University, a validation study of the complete Modelling System (including aerosols) has been initiated using the emission inventories and observational data collected during the Southern Californian Air Quality Study that took place in 1987.

In anticipation to a future activity with respect to Modelling support to policy makers and regulatory authorities, the MESOCOM (MESOscale interCOMparison) project was launched in collaboration with the EI Unit on Environmental Impact Assessment aiming at an intercomparison of mesoscale modelling systems available in Europe.

Instrumentation Development

Laser Laboratory for Atmospheric Studies

Development has continued of an instrument for the real-time characterization of single aerosol particles. The single particle mass spectrometer (SPMS), based on laser ionization and time-of-flight mass analysis, is now operational and is being prepared for operation in the field.

A great deal of effort has been expended on the development, fine-tuning and characterization of a unique differentially pumped particle inlet. This inlet is capable of sampling particles from the atmosphere and delivering them to the analytical zone of the instrument in the form of a highly collimated particle beam. Another potential feature is the ability, through judicious control of the operating pressures, to selectively create a particle beam for particles in a given of diameter range, preventing unwanted particles from being analyzed. These features are essential for the on-line, near-real time analysis of single particles with diameters less than about 150 nm, where optical sizing is not possible.

The SPMS has already been used to perform the on-line, near-real time, simultaneous physical and chemical analysis of individual aerosol particles with diameters below 500 nm. Reference particles of interest from the standpoint of atmospheric chemistry have been generated in the laboratory and analyzed. For example, the instrument has been shown capable of differentiating between an external and internal mixture of sodium nitrate and ammonium sulphate. The SPMS has also been used to directly address atmospheric particles in distinct size classes.

Laboratory for Advanced Organic Chemical Analysis

The laboratory has given analytical support to a number of projects within the Unit as well as within other Units of EI (Air Quality-EMEP, Water Unit) and other institutes (IHCP: ECVAM, Food and Beverages). In 1999 the PARFIN project (Characterisation of Engine Exhaust Particulate Fingerprints and the Contribution to Air Quality) completed its experimental activities. The exhaust from modern vehicle/engine technologies including heavy duty and light duty diesel together with stoi-

(Carbon and water fluxes of Mediterranean forests) funded by DG XII within FP4. For 1999 a complete dataset of CO_2/water fluxes and of meteorological, micrometeorological and physiological parameters could be provided to the EUROFLUX monitoring network (Long term carbon dioxide and water vapour fluxes of European forests and interactions with the Climate System).

In addition, our Unit plays an integrative role in the CARBOEUROPE cluster, by building up an information system including all experimental and geographical data and modelling tools available from ongoing and previous European projects on carbon fluxes and pools. This activity contributes to the Post-Kyoto Cluster of JRC and is intended as a first step into developing a monitoring/validation tool for accounting biospheric sinks of greenhouse gases, as requested by the Kyoto protocol. It is a joint activity with the Vegetation Monitoring Unit of SAI, and a contribution to the CARBODATA-project (Carbon balance estimates and resource management–support with data from project networks implemented at European continental scale).

http://www.ei.jrc.it/ap/projects/MEDEFLU/

Studies on DMS Oxidation

A global model analysis (Chin and Jacob, 1996, *JGR*, 101, 18691) indicates that dimethylsulphide (DMS) could contribute as much as 40% to the total global column of atmospheric sulfate. In addition, DMS may also influence sulfate aerosol formation in the upper troposphere and in the stratosphere. The objective of this activity is to contribute to the understanding of the atmospheric fate of DMS and its oxidation products by detailed kinetics and product studies in reaction chambers and implement the results into global models. New results obtained are integrated into a detailed chemical kinetic numerical model, which provides information on the yields of the oxidation products of DMS under different atmospheric conditions and their fate in the marine environment. This work is part of the shared-cost action project Dimethylsulphide Oxidation Mechanism in Relation to Aerosols and Climate (DOMAC).

The work performed in 1999 yielded the following information: Experiments were performed at low NOx concentrations to simulate remote regions: Sulfur dioxide was found to be a major product (50-80%) from the atmospheric degradation of both DMS and dimethylsulfoxide. At ambient concentrations, dimethylsulfone production from the oxidation of dimethylsulfoxide seems to be only a minor channel, indicating that methanesulfinic acid could be a major product in the oxidation dimethylsulfoxide. A laser photofragmentation spectroscopy technique was set-up for detection of sulfuric acid aerosols on a fast time scale, which is very useful when investigating the initial steps in the oxidation of DMS producing new sulfuric acid aerosols. The simulations performed with our multi-phase model of the DMS oxidation highlight the potential importance of aqueous phase chemistry. It was found, that the temperature-dependencies in the [MSA]/nss-[SO_4--] ratio, observed in field measurements, may be explained by considering gas-aqueous phase interactions.

http://www.ei.jrc.it/ap/projects/DOMAC/

Model Development

Development and Application of IMSAQ (Integrated Modelling System for Air Quality)

Both for modelling support to the EU legislation and for environmental research objectives, the Unit on continued the development of its Integrated Modelling System for Air Quality (IMSAQ), which consists now of a meteorological/transport module, two photochemical mechanisms, a radiation module, two aerosol modules, and a module for graphical visualisation.

A minicuvette system to study effects of long-term exposure to double CO_2 on biogenic emissions and physiological gas exchange.

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Kettle, A.J., Andeae, M.O., Amouroux, D., Andreae, T.W., Bates, T.S., Berresheim, H., Bingemer, H., Boniforti, R., Curran, M.A.J., DiTullio, G.R., Helas, G., Jones, G.B., Keller, M.D., Kiene, R.P., Leck, C., Levasseur, M., Malin, G., Maspero, M., Matrai, P., McTaggart, A.R., Mihalopoulos, N., Nguyen, B.C., Novo, A., Putaud, J.P., Rapsomanikis, S., Roberts, G., Schebeske, G., Sharma, S., Simo, R., Staubes, R., Turner, S., Uher, G. "A Global Database of Sea Surface Dimethylsulfide (DMS) Measurements and Procedure to Predict Sea Surface DMS as a Function of Latitude, Longitude and Month", *Biogeochem. Cycles*, 13 (1999), 399-444.

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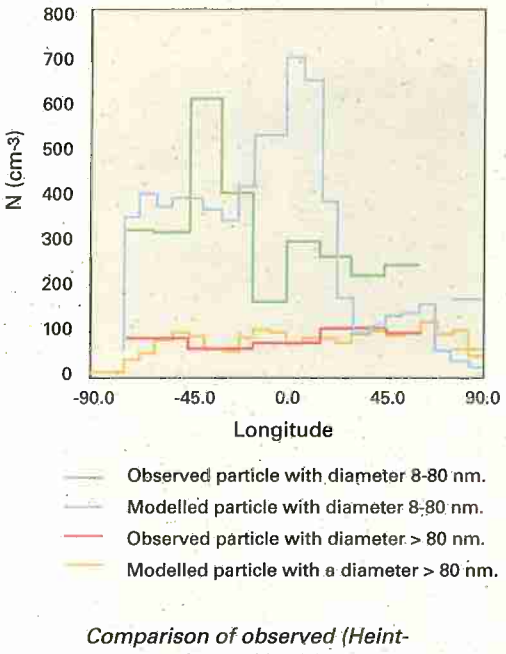
Riccardi, N., Mangoni, M. "Considerations on the Biochemical Composition of Some Freshwater Zooplankton Species", *J. Limnol.*, 58 (1999), 58-65.

Van Dingenen, R., Raes, F., Putaud, J.-P., Mangoni, M. "Processes Determining the Relationship between Aerosol Number and Non-Sea-Salt Sulfate Mass Concentrations in the Clean and Perturbed Marine Boundary Layer", *J. Geophys. Res.*, 104 (1999), 8027-8038.

Putaud, J.P., Davison, B., Watts, S.F., Mihalopoulos, N., Hewitt, C.N., Nguyen, B.C. "Dimethylsulfide and Its Oxidation Products at Two Sites in Brittany", *Atmos. Environ.*, 33 (1999), 647-659.



Comparison of observed (Heintzenberg, Covert, Van Dingenen, Tellus B, submitted) and modelled global mean marine surface level aerosol concentrations.

- identification of entrainment, in-cloud scavenging and coagulation as the major processes acting on a pollution aerosol transported within the MBL,
- the first documentation of the indirect radiative effect of aerosol at the scale of a cloud ensemble in continental pollution outflow,
- the wide range in the contribution of organic material to the submicron aerosol mass, with the highest contribution to the free tropospheric aerosol mass,
- the role of condensing HCl, HNO_3 and NH_3 as a growth mechanism of sub-micron aerosols in polluted air masses advecting over the ocean.

A close connection was observed between meteorological factors (such as horizontal and vertical wind speed, boundary layer development, entrainment, humidity fields) and aerosol and cloud characteristics. In the ACE-2 region, these meteorological factors, rather than aerosol microphysics and chemistry often dominated the shaping of the aerosol size distribution and/or their effect on radiation and clouds. The ACE-2 data were collected by the Unit, and redistributed through Internet and CD-ROM. A special issue in TELLUS B, containing 45 papers and guest edited by a Unit scientist is in print.

The development of aerosol dynamical models for use in global chemical transport models and general circulation models continued during 1999 within the framework of the SCA SINDICATE-3 (Study on the INdirect and DIrect Climate influences of Anthropogenic Trace gas Emissions). A mixed aerosol (sulfate, black carbon and sea salt aerosol) model was extensively tested in the off-line model TM2 (Transport Model) and used to do preliminary comparisons of the industrial and pre-industrial global aerosol burdens. The model reproduces observed zonal profiles of aerosol number concentrations and observed number to sulfate mass ratios. In addition the sulfate aerosol dynamical model M3 (Multi Modal Model) was successfully implemented in the ECHAM (European Centre HAMburg) general circulation model, as a stand-alone module. Consequently the aerosol number concentrations predicted are much greater than in reality as the module does not include mixing with other aerosol components unlike the TM2 model. An objective of the ECHAM studies within SINDICATE is to develop a comprehensive mixed aerosol model scheme, including sea salt, dust, black and organic carbon as well as sulfate and other condensable species.

http://www.ei.jrc.it/ap/projects/ACE-2/
http://www.ei.jrc.it/ap/projects/SINDICATE3/

Management WMO World Data Centre of Aerosols

During 1999 the WDCA (World Data Centre of Aerosols) was extensively revised and a new web site presenting the activities of the data centre, and giving descriptions of the GAW (Global Atmosphere Watch) global sites and their observation programmes together with access to the ftp archives of data from the stations was developed. The data set of surface observations of sulfur species compiled for the WCRP/IGAC model intercomparison COSAM (COmparison of Sulfate Aerosol Models) was added to the archive.

http://rea.ei.jrc.it/~wilson/wdca/wdca.htm

Exchange of Greenhouse Gases in Forests

This activity deals with uncertainties regarding the role of the biosphere as a sink of CO_2, which poses a major problem to close the carbon budget. Manipulation of this sink (vegetation in particular) is proposed as one of the means to implement the Kyoto Protocol. This will require a better understanding of carbon cycling and the setting up and validation of techniques for monitoring fluxes of CO_2, CH_4 and N_2O between the biosphere and the atmosphere.

Such activities started 1998 with a long-term monitoring site for carbon fluxes and pools in a Mediterranean pine forest (San Rossore near Pisa, I), a contribution to the European SCA-network MEDEFLU

pean forest canopies) achieved in 1999 substantial improvements of emission modelling for major European forest types, e.g., by developing validated datasets and correction terms to describe seasonality of emissions due to enzyme activity or water stress.

A pilot study on assessing the uncertainties involved with the use of different landcover datasets and emission factors was performed for the area of the BEMA-modelling domain in the Valencia/Castellón area of Spain. It could be shown that unrealistic landcover characterisation as available from remote sensing datasets may easily create errors of emission estimates in the order of magnitudes.

http://eurovoc.ei.jrc.it/
http://www.ei.jrc.it/ap/projects/ECOVOC/
http://www.ei.jrc.it/ap/projects/BEMA/

Laboratory Studies of Atmospheric Photochemistry and Secondary Organic Aerosol

Along with the field studies of photo-oxidants and aerosols, laboratory studies of related chemistry have been performed. In addition to the small-scale laboratory work, the large EUropean PHOtoREactor (EUPHORE) in Valencia (SP) is frequently used for doing simulation experiments. In 1999 this happened during a joint European SCA project on 'Evaluation of Radical Sources in Atmospheric Chemistry through Chamber and Laboratory Studies' (RADICAL), where EUPHORE was used as a facility to study photolysis caused by natural sunlight. The project gave much relevant new information on photolysis rates and products, particularly concerning the photolysis of important carbonyl compounds, coming from natural as well as anthropogenic sources.

Particulate material formed in the atmosphere by chemical degradation of gaseous organic compounds ('secondary organic aerosol') has been found to constitute a substantial part of the tropospheric sub-micron particles. The Unit has made a large effort to study tropospheric processes that lead to formation of such aerosol. A main focus has been put on the role of the terpenes, emitted from biogenic sources, which are known to react to form condensable products. A detailed chemical analysis of the terpene-derived aerosol formed in out-door and indoor smog-chamber experiments has been performed under the framework of the European project 'Nucleation Processes from Oxidation of Biogenic Volatile Organic Compounds' (NUCVOC). It was found, those reactions initiated by the hydroxyl radical and those initiated by ozone essentially form the same type of condensable oxidation products (C_9-, C_{10}-multifunctional carboxylic acids and carbonyls) but with different chemical yields. The results show that both types of reactions contribute to formation of particulate matter in the atmosphere, but that ozone appears to play a bigger role than the hydroxyl radical.

The oxidation of aromatic compounds was studied in collaboration between the University of Milan and the JRC in the framework of the EU-project 'Uptake and Nitration of Aromatics in the Tropospheric Aqueous Phase' (UNARO) has addressed the multiphase (gas/aqueous phase) reactions of phenols to form nitrophenols. The nitrophenols are of interest both because of their phytotoxic properties and because several of them are found in secondary organic aerosol.

http://www.ei.jrc.it/ap/projects/NUCVOC/
http://www.ei.jrc.it/ap/projects/RADICAL/
http://www.ei.jrc.it/ap/projects/UNARO/

GHOGA

Role of Aerosols in the Climate System

The results of IGAC's 2nd Aerosol Characterization experiment (ACE-2) were finalized.

The major achievements of ACE-2 include:

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Csiky, O., Seufert, G. "Terpenoid Emissions of Mediterranean Oaks and Their Relation to Taxonomy", *Ecological Applications*, 9 (1999), 1138-1146.

Glasius, M., Duane, M., Larsen, B.R. "Determination of Polar Terpene Oxidation Products in Aerosols by LC-MS", *J. Chromat.*, 833 (1999) 121-135.

Hansen, U., Seufert, G. "Terpenoid Emission from Citrus Sinensis under Drought Stress", *Physics and Chemistry of the Earth*, 24 (1999) 681-687.

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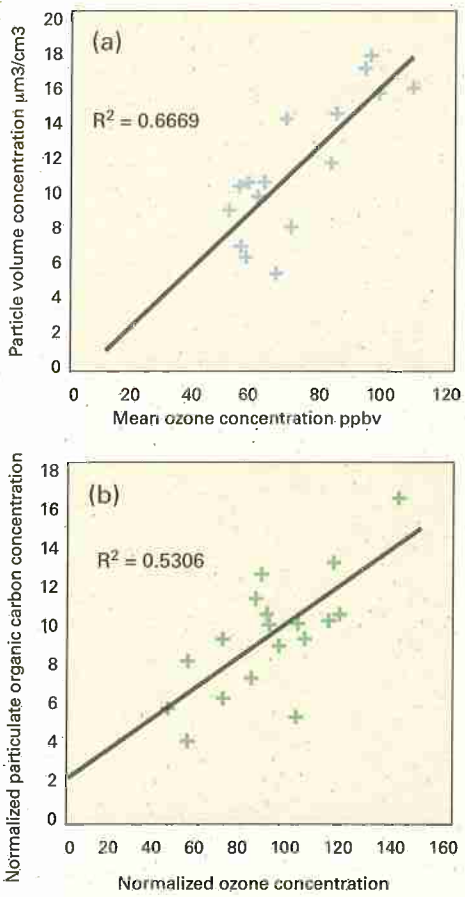
Staudt, M., Bertin, N., Frenzel, B., Seufert, G. "Seasonal Variation in Amount and Composition of Monoterpenes Emitted by Young Pinus Pinea Trees – Implications for Emission Modelling", *Journal of Atmospheric Chemistry*, 35 (1999) 77-99.

Steinbrecher, R., Hauff, K., Rössler, J., Dürr, M., Seufert, G. "Monoterpene Emission from Soils in Orange Plantations of the Valencian Citrus Belt, Spain", *Physics and Chemistry of the Earth*, 24 (1999) 695-698.

Virkkula, A., Van Dingenen, R., Raes, F., Hjorth, J. "Hygroscopic Properties of Aerosol Formed by Oxidation of Limonene, Alpha-Pinene and Beta-Pinene", *J. Geophys. Res.*, 104 (1999), 3569-3579.

Out-door large Teflon bag for experiments to simulate atmospheric photochemistry with sunlight as the light source. R. Winterhalter and G. Acerboni performing a photo-smog experiment using the 3 cubic meter Teflon bag.



Correlations between (a) particle volume and ozone and (b) normalized concentrations of particulate organic carbon and ozone.

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Calogirou, A., Larsen, B.R., Kotzias, D. "Gas Phase Terpene Oxidation Products: A Review", *Atmos. Environ.*, 33A (1999), 1352-2310.

Calogirou, A., Jensen, N.R., Nielsen, C.J., Kotzias, D., Hjorth, J. "Gas Phase Reactions of Nopinone, 3-isopropenyl-6-oxo-heptanal and 5-methyl-5-vinyl-tetrahydrofuran-2-ol with OH, NO_3 and Ozone", *Environ. Sci. Technol.*, 33 (1999), 453-460.

Ciccioli, P., Brancaleoni, E., Frattoni, M., Di Palo, V., Valentini, R., Tirone, G., Seufert, G., Bertin, N., Hansen, U., Csiky, O., Lenz, R., Sharma, M. "Emission of Reactive Compounds from Orange Orchards and Their Removal by within-Canopy Processes", *Journal of Geophysical Research*, 104 (1999), 8077-8094.

- Contribution to the development of the Ozone Daughter Directive, with an assessment of the role of biogenic emissions, and the importance of links between Ozone and Particulate Matter formation.
- Contribution to the revision of the Particulate Matter Daughter Directive, with an assessment of the role of biogenic emissions, and the importance of links between Ozone and Particulate Matter formation.
- Establishing a European Commission infrastructure for collecting and disseminating long term measurements of greenhouse gas fluxes and carbon pools, as a tool for implementing the Kyoto Protocol.

Contributions to the EU Clean Air For Europe (CAFE) programme and the European Climate Change Programme (ECCP) will be made.

ACTIVITIES AND PROJECTS

Atmospheric Processes in Regional and Global Change

PHAMA

Coupling between PM and Aerosols

During summer 1998, the field campaign PIPAPO (Planura PAdania Produzione di Ozono) was organized in the pre-Alpine area by the EUROTRAC project LOOP (Limitation Of Oxidant Production) to study the tropospheric ozone formation in the plume of Milan. JRC participated to this project through field measurement of peroxy radical formation and aerosol characterisation.

The JRC is also involved in the testing and development of a peroxy radical instrument–a modulated chemical amplifier–constructed by the University of Bremen (D), within the EC shared cost action project PRIME ('Peroxy Radical Initiative for Measurements in the Environment').

The data obtained during PIPAPO were subject to a detailed analysis this year. The comprehensive set of chemical and physical parameters measured simultaneously at the same site (Verzago, I) made it possible for scientists at the IUL (Institute of Environment and Agriculture in Bern, CH) to estimate peroxy radical concentrations based on a simplified chemical reaction scheme. The comparison between the concentrations calculated by IUL and measured by JRC shows an agreement that is very satisfactory when the known uncertainties in both modeling and measurements are taken into account. The correlation between the normalized concentrations of ozone and particulate organic carbon (OC) observed in the afternoon downwind Milan (Verzago) indicates a co-production of ozone and secondary organic aerosol in the photochemical smog plume.

http://www.ei.jrc.it/ap/projects/PRIME/

Biogenic Emissions–Atmospheric Chemistry

The Biosphere-Atmosphere Interactions group focussed on gas exchanges of reactive biogenic compounds emitted from terrestrial ecosystems, and their role in atmospheric chemistry of the Mediterranean area. As a follow-up of the BEMA-project (Biogenic Emissions in the Mediterranean Area, 1993-1997), a series of specific activities was executed in 1999 in order to fill some key gaps arising from BEMA-field observations and to support more reliable estimates of BVOC emissions from vegetation.

A key task was the creation and maintenance of the EUROVOC information system and database. It is split in a part open to anyone using the WWW, to present the individual projects. Central parts are an emission factor database of all plant species investigated so far, and a series of rules and datasets supporting the parameterisation of emissions from different species. The projects ECOVOC (parametrisation of environmental and physiological controls of VOC emissions from EUROpean forests) and VOCAMOD (BVOC emission modelling for Euro-

MAJOR ACHIEVEMENTS IN 1999

In 1999, the unit became increasingly involved in supporting the EU policy making process. It contributed, e.g., to the ozone directive development and compilation of research needs to implement the Kyoto protocol.

Research within the unit pointed at the finding that secondary aerosol formation, and its interactions with photo-oxidants, plays a central role in atmospheric processes. As a follow up, in 1999, large efforts were devoted to initiate the PHAMA project. Three workshops were organized at the JRC, together with European partners and resulted in the formulation of the needs for air pollution/air chemistry research in the Mediterranean Area, with a systematic focus on the couplings between photooxidant and aerosol formation within the complex meteorological patterns of the area.

A scientific workshop was held in Varese in December '99 to discuss the results of two major field studies (PIPAPO, Pianura PAdana Produzione di Ozono, and BERLIOZ, BERLIn OZone experiment) of photo-oxidant formation downwind of an urban area.

The Unit's scientific co-ordination of IGAC's 2nd Aerosol Characterization Experiment (ACE-2) came to an end with the editing of an ACE-2 special issue.

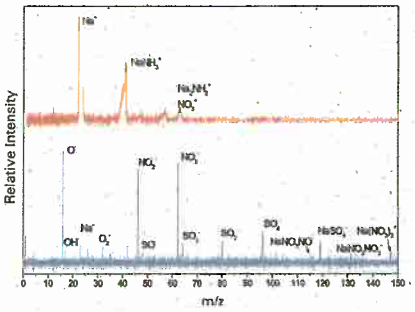
WMO's World Data Centre for Aerosols, hosted by the Unit, compiled a selected global set of SO_2 and sulfate aerosol data that was subsequently used in an intercomparison and validation exercise of global models of the sulfur cycle. The Units own modelling activities lead to the first calculated global fields of aerosol number concentrations. The Unit also collaborated in the compilation of a global data set of aerosol size distributions over the oceans. The model calculations compared well with these data.

The laboratory for advanced organic analysis developed and successfully applied methodologies for PAH (Poly-Aromatic Hydrocarbons) and nitro-PAH present in engine exhaust and in ambient particulate matter. The on-line single particle mass spectrometer produced the first results in the laboratory. These developments put the Unit at the front line among the world leaders of aerosol characterisation.

IMSAQ (Integrated Modelling System for Air Quality) has been further developed by the inclusion of an aerosol equilibrium module and is currently being validated against the Los-Angeles dataset in the frame of the PHAMA project. Validation of the meteorological module of IMSAQ is also being performed in the frame of a European intercomparison exercise for mesoscale models (MESOCOM) initiated by the JRC.

Much of the research was performed in collaboration with European partners, in the framework of EU's SCA projects (Shared Cost Actions). During 1999, some of these projects were successfully concluded (DOMAC, RADICAL, UNARO, PARFIN, ECOVOC, VOCAMOD, MEDEFLU, SINDICATE). 6 proposals by the Unit to the 1999 call have been approved.

In 1999 the Unit published/got accepted 58 papers in the refereed international literature.



Mass spectrum of a single aerosol particle (containing $(NH_4)_2SO_4$ and $NaNO_3$), which was generated in the laboratory.

FUTURE ACTIVITIES

For the remainder of the 5th Framework Programme, the Unit will remain active in laboratory, field and modelling studies. However the results of these activities will be increasingly integrated in specific contributions to EU policy making process. In particular:

air

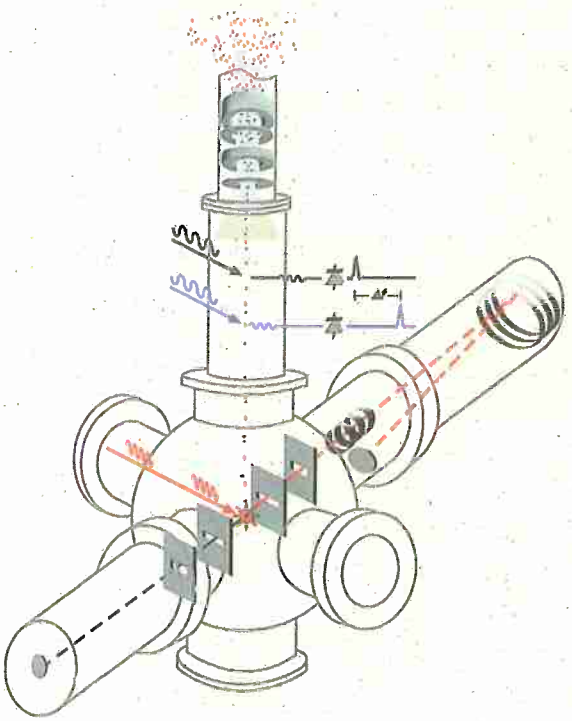
Atmospheric Processes in Global Change Unit

THE UNIT'S MISSION

Understanding changes in the chemical composition of the atmosphere, and their effect on the regional and global environment. Transfer of the basic knowledge to the area of European environmental policy development.

Homepage: http://www.ei.jrc.it/ap/intro/

FIELDS OF ACTIVITY



A single particle mass spectrometer for the analysis of individual atmospheric particles in real-time has been constructed by the "Laser Laboratory for Atmospheric Studies". This front-line instrumentation will be used on the effect of aerosols on climate and human health.

- The Unit provides expertise and facilities to study physical, chemical and biological processes controlling the tropospheric concentrations of ozone, greenhouse gases, and aerosols. It aims at understanding the relationship between these three kinds of pollutants in order to provide an integrated scientific basis for EU environmental regulatory actions. The latter include the implementation of the Kyoto Protocol, and the development and revision of EU air quality directives (e.g. for ozone and particulate matter).

The Unit's activities are structured around two thematic tasks:

1. *PHAMA* (coupling between PHoto-oxidants and Aerosols in the Mediterrenean Area): study of the links between photo-oxidants, aerosols, and specific meteorological patterns.
2. *GHOGA* (GreenHOuse Gases and Aerosols): study of the role of the biosphere-atmosphere interaction in climate control and the role of reactive chemical species (e.g. ozone, aerosols) in global warming.

Additionally it builds on two horizontal tasks:

3. Development and validation of the JRC Integrated Modelling System for Air Quality (IMSAQ).
4. Development of state of the art analytical techniques for atmospheric research.

- The Unit builds on active scientific research and collaborative networking with research teams in Europe and the World. It includes a strong interaction between experimental work and model development, and is directed to continuous improvement of operational models, monitoring strategies, and assessments.

- The Unit contributes to major international programmes such as EU 5th Framework Programme, the International Geosphere-Biosphere Programme (IGBP)'s project IGAC (International Global Atmospheric Chemistry) for which, a.o., it runs the European IGAC Project Office (EIPO); the Global Atmosphere Watch (GAW) of the World Meteorological Organization (WMO); and EUROTRAC, an EUREKA environmental project.

- develop and validate new measurement techniques for air samples;
- organise pilot studies of air-quality monitoring;
- carry out groundwork for air-quality regulations;
- harmonise measurement methods and strategies for current directives.

Mobile laboratories equipped with hi-tech facilities, such as remote sensors for tracking pollutant emissions from tall stacks, differential optical absorption spectrometers, and instruments to calibrate monitoring stations in the field, enable ERLAP to measure air quality and map pollutant concentrations at ground level. The laboratories are also equipped to measure ozone, nitrogen oxides, sulphur dioxide, carbon monoxide, particulate matter and aromatic hydrocarbons. The ERLAP laboratory prepares and tests gas calibration standards and multi-pollutant gas mixtures for intercalibrations and intercomparisons. It also has the facilities and expertise to apply a range of chemical and physical analytical techniques, from wet chemistry to non-destructive spectrometry.

The Urban Impact Assessment sector under the frame of Auto-Oil programmes developed a unique methodology (ENVISOR) for assessment of air quality by using technology and expertise at its disposal to:

- develop emission inventories in high spatial and temporal resolution;
- organise studies of the assessment episodic condition through data from air-quality monitoring and/or campaigns;
- harmonise the representation of air-quality concentrations; and
- carryout short and long term forecast of emissions and air-quality in any European domain.

In addition the sector is equipped with the latest technology of monitoring and forecasting regional and urban meteorological fields under any type of complex terrain and varying atmospheric conditions including propagating mesoscale systems. Environmental test chambers for studying emission and absorption of indoor pollutants and for testing analytical equipment and procedures:

- four small environmental test chambers (0.074, 0.28, 0.45 (2x) m^3) featuring controlled temperature (18-30°C or 18-150°C), relative humidity (0-90%), air quality and air exchange rate (0-2 ach);
- a walk-in type of environmental chamber, Indoortron, of 30-m^3 volume featuring controlled temperature (15-40°C), relative humidity (20-90%), air quality and air exchange rate (0.1-2 ach); this chamber can also be used for controlled human exposure studies.

Emissions from Stationary and Mobile Sources

The European Reference Laboratory on Waste Incineration and Vehicle Emission Measurements (ERLIVE) with its available facilities, instrumentation and expertise in emission can:

- develop a database of gaseous and particulate emissions from mobile and stationary sources;
- contribute to the development of new norms and standards, harmonisation of testing methods, maintenance and inspection procedures in the areas of transport and industrial pollution control;
- develop and improve incineration technologies for special waste;
- develop techniques for the measurement of dioxin precursors.

As its main resources, ERLIVE has available a pilot incinerator equipped with all necessary instrumentation for gaseous stack emissions. Additional aerosol instrumentation (a single-particle counter, 3-wavelength extinction meter, differential mobility analyser, photoelectric aerosol sensor, low-pressure impactor) can be used for detailed particle characterisation and subsequent chemical analysis of aerosol samples. A laboratory with glove boxes for sample handling, an optical microscope (x 1500) and an X-ray fluorescence spectrometer allow a first analysis of samples. Two 100-kW plasma guns can be used for the simulation of engine emission sources, for tests on hazardous waste treatment and for tests on ash vitrification.

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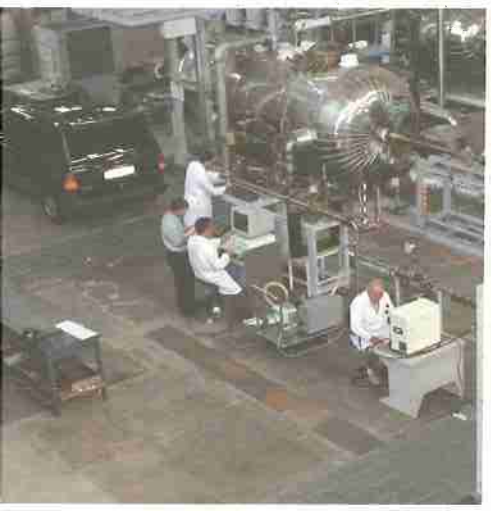


The VELA static vehicle test facility.

the European Community. In 1999, the data collection for environmental indicators–nature, forests, water–as well as socio-economic ones–demography, economy and employment, agriculture, tourism, transport and energy–continued with a view to their next publication: the prototype of the Alpine Catalogue of Data Sources was published with the international and Swiss metadata in collaboration with UNEP-GRID. The Internet information service (http://www.soia.int) was updated. This service provides information, often in five languages, on:

- the specification of all the indicators and the results for the assembled ones;
- an information system on alpine research covering research institutes;
- the Alpine Catalogue of Data Sources.

European Reference Laboratory for Waste Incineration and Vehicle Emission Measurements (ERLIVE)

WIND A pilot incinerator was set up at the JRC to study pollutant emissions and to develop abatement and measurement techniques. The research programme includes tests with waste mixtures of paper, cardboard, wood chips, non-chlorinated plastics and added heavy metals. The main objectives of the work are the determination of heavy-metal partitioning in the incinerator, the development of a database of gaseous and particulate emissions, the harmonisation of measuring methods and a substantial contribution to the development of new standards and norms in the field of waste incineration. Finally, the toxicological evaluation of the emissions is one of the project's key points. A first phase of the experimental programme started in early 1999 and its conclusion is planned for the second semester of 2000. In parallel to the above work, a shared-cost action project COMFIL on combined hot gas cleaning and particle filtration was initiated in co-operation with the University of Karlsruhe (Germany), Schumacher (Germany), Solvay (Belgium) and Ciemat (Spain) as partners. The planning foresees comparative tests of a dry gas cleaning system with the flue gas generated at the JRC pilot incinerator. To this end, preparatory measurements on particle concentrations and size distributions have been performed. As a general result it was found that the concentrations were already relatively low, typically between 1 and 10 mg/m^3.

VELA During 1999 a large number of tests has been performed at a new static facility at the JRC Ispra and at a dynamometer facility (in collaboration with EURON). New and old technology Diesel and gasoline vehicles have been used in these tests for

- comparison of different instruments;
- instrument calibration;
- comparison of old and modern Diesel technology;
- dilution effect on particle size measurements;
- effect of maintenance on emission;
- evolution of emission as function of warm-up.

Mass/size and number/size distributions of particulate matter from Diesel-driven vehicles showed a broad variety. Among others it was observed that the main mass is concentrated below 0.5 μm, while the number/size distributions of the same vehicles had the main peak in the size range below 0.1 μm. In some cases, especially for the newest direct injection Diesel vehicles, a second unstable peak was observed in the size range below 30 nm.

KNOW-HOW, INSTRUMENTS AND LABORATORIES

Air Quality in Urban and Rural Areas

The European Reference Laboratory for Air Pollution (ERLAP) answers questions on air quality by using technology and expertise at its disposal to:

air pollution exposure assessment, seen as part of environmental risk assessment and considering the needs of urban and indoor air quality management. Specific examples of the working areas of ECA are: relative significance and assessment of urban outdoor and indoor sources of pollution, interaction between outdoor and indoor air quality of buildings, and exposure to pollutants from the different outdoor and indoor sources in relation to health and comfort. By addressing such topics ECA will lay the ground for integrated air urban quality management to minimise exposures to air pollutants. It will thus continue to contribute to pre-normative research needed by EC services and national authorities responsible for preventing pollution and promoting health, comfort and quality of life.

Atmospheric Surface Layer Observation Laboratory in 1999

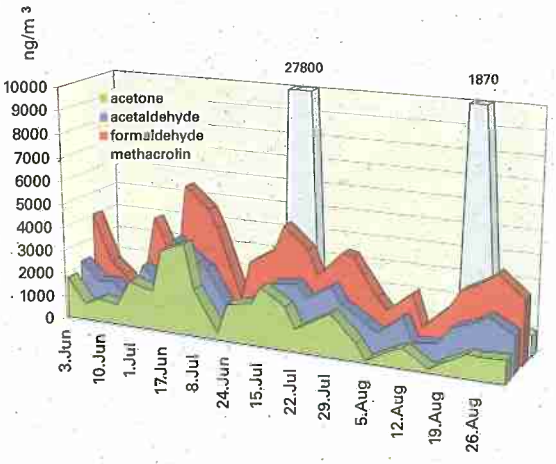
The JRC atmospheric surface layer observation laboratory is a mobile facility aimed at carrying out a variety of studies focused on physical and chemical processes occurring in the atmospheric surface layer. This facility has two main applications:

- measurement of surface (deposition or emission) fluxes of air pollutants (ozone, nitrogen oxides) or biogenically emitted compounds (isoprene, methane...);
- determination of micro-meteorological parameters necessary as input data for modelling studies subsequent to air pollution transport measuring campaigns, e.g. using atmospheric tracers.

The surface layer observation laboratory was involved among others in the following projects:

The RICEOTOPES Project The main scope of the RICEOTOPES Project was the measurement of vertical fluxes of methane emitted by rice fields. Methane is an important greenhouse gas, which is likely to contribute by 25% to the overall greenhouse effect. The presence of rice fields in Northern Italy is obviously a good occasion of observing methane emissions. The micrometeorological method known as "eddy-correlation", based on the use of fast-response chemical (tuneable diode laser absorption spectrometer) and meteorological (sonic anemometer) sensors, was used during a measuring campaign near Vercelli (Italy), during June and July 1999 to observe the evolution of methane emissions during the rice growing season, in close co-operation with the University of Edinburgh, which used the same technique. Results of both groups are very similar to each other, and show a daily cycle. Emission fluxes seem to follow the growth of rice, with higher values in July than in June.

The Mesoscale Alpine Project (MAP) is a large project involving a number of European and American laboratories, aimed at gaining knowledge on mountain meteorology as applied to forecasting emergency situations such as floodings etc. Our group was measuring micrometeorological parameters using sodar and sonic anemometer techniques in the Riviera valley (Ticino, Switzerland) in August and September.



Carbonyle Air concentration June-August 1999.

Alpine Observatory System for the Observation of and Information on the Alps (SOIA)

The main aim of the Alpine Observatory is to provide scientific support to the monitoring of the Convention on the Protection of the Alps (Alpine Convention) and its specific protocols to ensure the sustainable development of the whole Alpine arc. This requires the assembly, quality control and harmonisation of a wide variety of disparate data from national sources, to create harmonised environmental-quality and other relevant indicators, maps, catalogues, thesauri, and eventually the preparation of a report on the state of the Alps. Eight alpine countries (Austria, France, Germany, Italy, Liechtenstein, Monaco, Slovenia, and Switzerland) are participating in the SOIA together with

impact assessment covered three types of modelling: full photochemical modelling for CO, NO_2, NOx, benzene, and "urban" ozone; PM10 modelling; and street canyon modelling. Several research institutions (DRI, SENCO Ltd, Axon Enviro-Group Ltd, IVU Gesellschaft für Informatik, Physics Department Aristotle Univ. Thessaloniki, Danish Nat. Environ. Research Institute) from five European Member States are contributing to the technical phases of AUTO-OIL II, which is funded by several Directorates-General participating in the European Commission's ad-hoc management group, and by contributions from the European automobile and oil industry associations.

http://www.ei.jrc.it/aq/projects/AUTO-OIL/content.html

UV and Ozone Measurements Daily total ozone column measurements, made by a Brewer MKIV spectrophotometer, were continued during 1999. The data have contributed to the world ozone mapping activity co-ordinated by the World Meteorological Organisation (WMO). In the cold season the data have been also submitted every day to the WMO Centre in Thessaloniki in the frame of the 1998-1999 and 1999-2000 northern-hemisphere campaigns aimed to investigate the ozone layer thinning over Europe (THESEO project). Daily spectral measurements of solar UV-B were continued. The data obtained have been transferred to the SUVDAMA (Scientific UV Data Management) database together with ancillary data like ozone, UV-B, UV-A and total radiation doses. The SUVDAMA shared cost action has been concluded in 1999. Daily measurements of the aerosol optical depth (AOD) by a sun-tracking photometer have been pursued. Rough data are processed by NASA Goddard Centre that has included our station into the AERONET world network. NASA calculates AOD and parameters that characterise the aerosols like size distribution and scattering phase function.

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Indoor Pollution

In 1999, activities of the indoor air pollution group were focused on exposure modelling and data analysis of the EXPOLIS study. In addition, experimental work was carried out for the gas chromatographic determination of specific volatile hydrocarbons e.g. 1,3-butadiene, butane-, propane-and ethanethiol. Combining the indoor, outdoor and exposure level European urban benzene data from the MACBETH and EXPOLIS (Athens, Milan, Basel, Prague and Helsinki) databases has produced a broad and comprehensive view on how differently urban population exposure to benzene is related to benzene concentrations in residential and occupational indoor and ambient air across Europe. The combined database will also help assess the contributions of the different outdoor and indoor sources to benzene exposures. New collaboration in the fields of air pollution exposure modelling and source apportionment of exposure between IAQA (Integrated Air Quality Assessment project) and the EXPOLIS team has produced its first promising results on both fronts; a Monte Carlo based probabilistic micro-environmental model produces highly accurate estimates of urban (no-smoking) population exposure distributions to PM2.5 (percentile range 0-95 within ±1μg/m³), and the PCA (principal component analysis) technique has identified the sources (soil dust, traffic, long range transport, de-icing salt) that are responsible for 2/3 of the PM2.5 exposure variation in Helsinki, Finland.

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European Collaborative Action (ECA) Urban Air, Indoor Environment and Human Exposure For more than 12 years now the European Collaborative Action ECA "Indoor Air Quality and Its Impact on Man" has been implementing a multi-disciplinary collaboration of European scientists for healthy and environmentally sustainable buildings. The ECA has been hosted by the JRC/EI Air Quality Unit and managed by an independent and scientific Steering Committee. In order to establish a more direct and mutually beneficial co-operation with the IAQA programme, the ECA Steering Committee decided in 1999 to broaden its scope under a new title "Urban Air, Indoor Environment and Human Exposure". The focus of the renewed activity is urban and indoor

tember '97 to September '98, the benzene levels in six European towns –Padova, Copenhagen, Antwerp, Rouen, Athens and Murcia–were monitored six times during a period of 4 to 5 days over the year. In the same time, the personal exposure and the indoor pollution levels were measured in collaboration with fifty volunteers in each city.

ERLAP acted as scientific co-ordinator of the project, and was responsible for the definition of the measurement strategy, the validation of the measurement method and the QA/QC of the measurements. The main conclusions of the project were presented at the Venice Conference (19-21 May 1999). The results of the MACBETH project played an essential role in the preparation by the Commission of the Benzene Daughter Directive proposal.

Hamaq The HAMAQ project was also concluded during 1999. The aim of the project was to support the harmonisation of air quality measurements for gaseous pollutants (sulphur dioxide, nitrogen oxides, carbon monoxide, benzene) by

- assessing the reliability of gravimetric gas mixtures used as calibration standards;
- comparing the performance of various primary calibration methods;
- improving the quality of the measurements through the organisation of inter-laboratory exercises.

ERLAP was responsible for co-ordinating the activities related to the sulphur dioxide measurements, and also participated in the inter-comparison exercises for the other pollutants. The main conclusions were presented during the Workshop jointly organised in London (27-29 September 1999).

Auto-Oil II The first Auto-Oil Programme was launched in 1992 and identified the best measures that could be introduced in Europe, starting in 2000, for reducing man-made pollutant emissions, with a view to reaching specific air-quality objectives for the year 2010. The Auto-Oil II Programme (AOP-II) started in spring 1997 initially in order to fulfil the aims of the review clauses in the Commission's "AOP-I" proposals. The new objectives of this programme were:

- to complete the work which is being done to assess future air quality and establish a consistent framework within which different policy options to reduce emissions can be assessed using the principles of cost-effectiveness, sound science and transparency; and
- to provide a foundation (in terms of data and modelling tools) for the transition towards longer-term air quality studies covering all emission sources.

These referred to the need to come forward with an updated strategy to meet the requirements of the Community air quality standards and related objectives by 2010 at least cost. Under this new programme trends in air quality towards the year 2010 and beyond were examined. The effects of reducing noxious pollutant emissions from transport and non-transport sources were analysed. An estimate of the contribution of existing and pending and potential emission reduction measures from all sources could make towards improving air quality was assessed. Ten European city domains of differing characteristics form the core of the database for this study: Athens, Berlin, Cologne, Dublin, Helsinki, London, Lyons, Madrid, Milan and Utrecht. Those domains represent 47% of the urban population living in the 15 Member States. Strong reliance is placed on the use of several well known models, for determining optimum simulation periods, for establishing the link between relevant urban studies and region-wide projections, and for predicting air quality in terms of ozone, carbon monoxide, benzene, nitrogen dioxide and particulate matter from the 1995 baseline values. These models were utilised for assessing the evolution of air quality under different abatement scenarios took into account the long-term analysis of air quality in various urban situations. The urban

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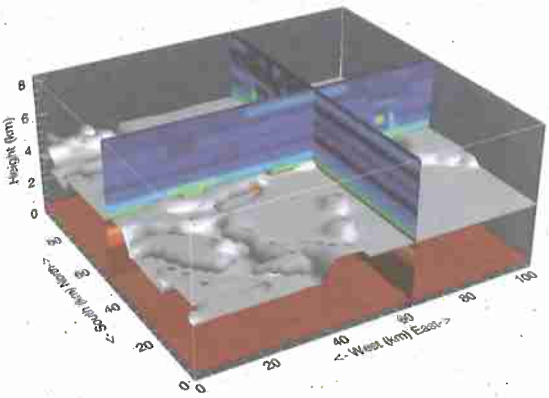

Three dimensional representation of ozone concentrations during 98% ozone episode in Athens. The grey area represents the surface area with concentrations of 100 µg/m³.

measuring campaigns will be the main tasks to be tackled during FWP 5 and FWP 6.

The European Reference Laboratory on Waste Incineration and Vehicle Emission Measurements (ERLIVE)

The European Commission and the European Parliament are steadily progressing to a more comprehensive and integrated approach in solving problems that affect the life of the citizens and their environment. The forthcoming Clean Air For Europe (CAFE) programme will regulate pollutants coming from a variety of combustion sources, both stationary (industrial and power generation plants) and mobile (light and heavy-duty vehicles, off-road machinery) sources within a unique Framework Directive. Accordingly, the Environment Institute is now developing ERLIVE as a priority activity, in order to give a scientific support to the European Commission and the European Parliament in the field of emissions. The project includes a pilot plant for waste incineration (WIND) and a vehicle emission laboratory (VELA).

ACTIVITIES AND PROJECTS

Integrated Air Quality Assessment

European Reference Laboratory for Air Pollution (ERLAP)

ERLAP was set up in 1994 with the aim to contribute, in collaboration with Directorate-General Environment (Unit on Air Quality, Urban Environment, Noise, Transport, and Energy) and with the Member States, to the implementation of the Air Quality directives in the European Union. In view of the preparation of new air quality regulations, notably the Daughter Directives on Ambient Air-Quality Assessment and Management, ERLAP contributes to the definition of measurement strategy by a number of actions:

- Assessment of the performance of measurement techniques used in the Member States in order to establish reference measurement methods of the directives.
- Development and validation of new methods for sampling, calibration and monitoring.
- Participation to CEN and ISO standardisation activities in the field of air quality metrology.
- To ensure quality and comparability of air pollution measurements in the European air quality monitoring networks, quality-assurance programmes are carried out through the organisation of round-robin tests, inter-laboratory exercises and quality controls in the monitoring stations, with the collaboration of the Member States.
- To respond to specific problems of air-quality monitoring, pilot studies are either co-ordinated or conducted by ERLAP. Particular attention is given to the design and optimisation of monitoring networks assessment of air-pollutant levels and population exposure in urban areas and areas at risk; new air-monitoring techniques are validated and demonstrated.

In the framework of the UN Economic Commission for Europe (UN-ECE) EMEP programme, ERLAP has been operating an AIR MONitoring station since 1985, providing information on the deposition and concentration of air pollutants and on the long-range transport of pollutants across national boundaries. The systematic analysis of VOCs at the AIRMON station has been started in May 1999 with the identification and quantification of 24 compounds from C_4 to C_9.

Macbeth The MACBETH project (Monitoring of Ambient Concentrations of Benzene in European Towns and Homes) was concluded in June 1999. Aim of the project was to collect and to provide the European Commission and the scientific community with experimental data on urban pollution from, and population exposure levels to benzene. From Sep-

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Measurement of polyaromatic hydrocarbons with HPLC technique.

- Integrated modelling methodologies capable of assessing the overall picture of environmental pollution and forecasting the constituents of pollution under long term (annual mean conditions) or short term (episodes).
- Assess the validity of pollution-control measures through scenario calculations.

MAJOR ACHIEVEMENTS IN 1999

- Accreditation of the ERLAP laboratory (including the Ispra Air Monitoring Station station-AIRMON) for the measurement of inorganic air contaminants (SO_2, NO_2, NO, O_3).
- Organisation of the Air Quality 2000 Congress from May 19-21,1999 in Venice (ca. 550 participants from national and regional authorities, non-governmental organisations, universities, instrument manufacturers, industries).
- In view of the development of new directives: organisation of the PAH workshop (March 22-23,1999) in Ispra with the participation of representatives from research laboratories, national authorities and industries The full proceedings were published in the scientific journal Fresenius Environmental Bulletin.
- In the frame of the co-operation with UN-ECE (EMEP program) publication of the annual report with the measurements at the Air Monitoring Station Ispra as EUR report (No. 18741).
- To compare calibration standards of the Member States two intercomparison exercises for the compounds SO_2, NOx, O_3 and CO have been carried out with the participation of 17 national reference laboratories in 1999.
- The European Collaborative Action "Urban Air, Indoor Environment and Human Exposure" approved and released the report No. 20 on "Sensory Evaluation of Indoor Air Quality".
- Completion of the Auto-Oil-II air-quality modelling work for ten city domains containing 46% of the EU15 population living in urban areas. The conditions representative of 1995 mean concentrations were analysed together with episodes for NO_2, CO and separately for O_3 and PM10.
- Emission from incineration: first tests using artificial waste samples spiked with heavy metals. A preliminary report has been prepared for DG Environment.
- A measurement campaign has been performed at a dynamic test facility comparing particle emissions from gasoline and diesel vehicles.
- An advanced nano-particle characterisation facility has been constructed and used to build up a relevant emission data base.

The Air Monitoring Station at the Ispra site.

FUTURE ACTIVITIES

Integrated Air Quality Assessment (IAQA) Project

In the frame of the project Integrated Air Quality Assessment (IAQA) future work will be focused on:

- Methodologies needed for exposure based urban air quality assessment from sources identification, micro-environmental and personal monitoring to the development of modelling tools for the analysis of data, the assessment of abatement scenarios and the development of measures.
- The impact of trans-boundary pollution on urban and con-urban ecosystems. Here future work will be focused on how long range transmission of air pollutants in Europe will affect air quality in urban areas, including information on transport of photochemical-oxidants, e.g. ozone and of other pollutants, across national boundaries.
- Support to directives on noise. Which is in line with activities started within different Commission services for the regulation of noise pollution. Harmonisation of different models describing noise propagation and the validation of modelling results through intensive

THE UNIT'S MISSION

The Air Quality Unit provides scientific and technical support to policy-makers in the formulation, implementation and monitoring of EU directives in the fields of air pollution and emissions from mobile and stationary sources.

Homepage: http://www.ei.jrc.it/aq/

For the efficient implementation of a European air-quality policy and the development of new directives, the European Commission requires:

- sound scientific knowledge on the origin, the levels and the fate of air pollutants
- harmonised and validated monitoring methods and strategies to ensure valid and comparable air quality and emissions data over Europe
- practical guidance to the Member States on the implementation of the relevant European directives
- instruments and methods for evaluating/improving the impact of air-quality and emissions policies and directives on total human exposure to air pollution (ambient and indoor)
- modeling tools for the analysis of data, the assessment of abatement scenarios and the development of pollution-control measures.

Under the 5th Framework Program on research and technology, which started in 1999, the activities of the unit will be mainly directed towards two projects:

- the Integrated Air Quality Assessment (IAQA) project, which includes the work of the European Reference Laboratory for Air Pollution (ERLAP), as well as a range of studies on urban air-quality impact assessment. The project will link regional, urban and micro-scale air-quality analysis to develop strategies and models for assessing total human exposure to pollutants (indoor/outdoor). In addition modeling tools will be developed to support the implementation of the upcoming directives on noise pollution
- the European Reference Laboratory on Waste Incineration and Vehicle Emission Measurements (ERLIVE). The principal goal of the project is to give technical/scientific support for the preparation, implementation and verification of new EU Directives concerning hazardous industrial waste incineration and vehicle emissions (in particular non-regulated pollutants).

FIELDS OF ACTIVITY

The main focus of the Air-Quality Unit is to provide decision-makers with the necessary expertise and scientific means, such as:

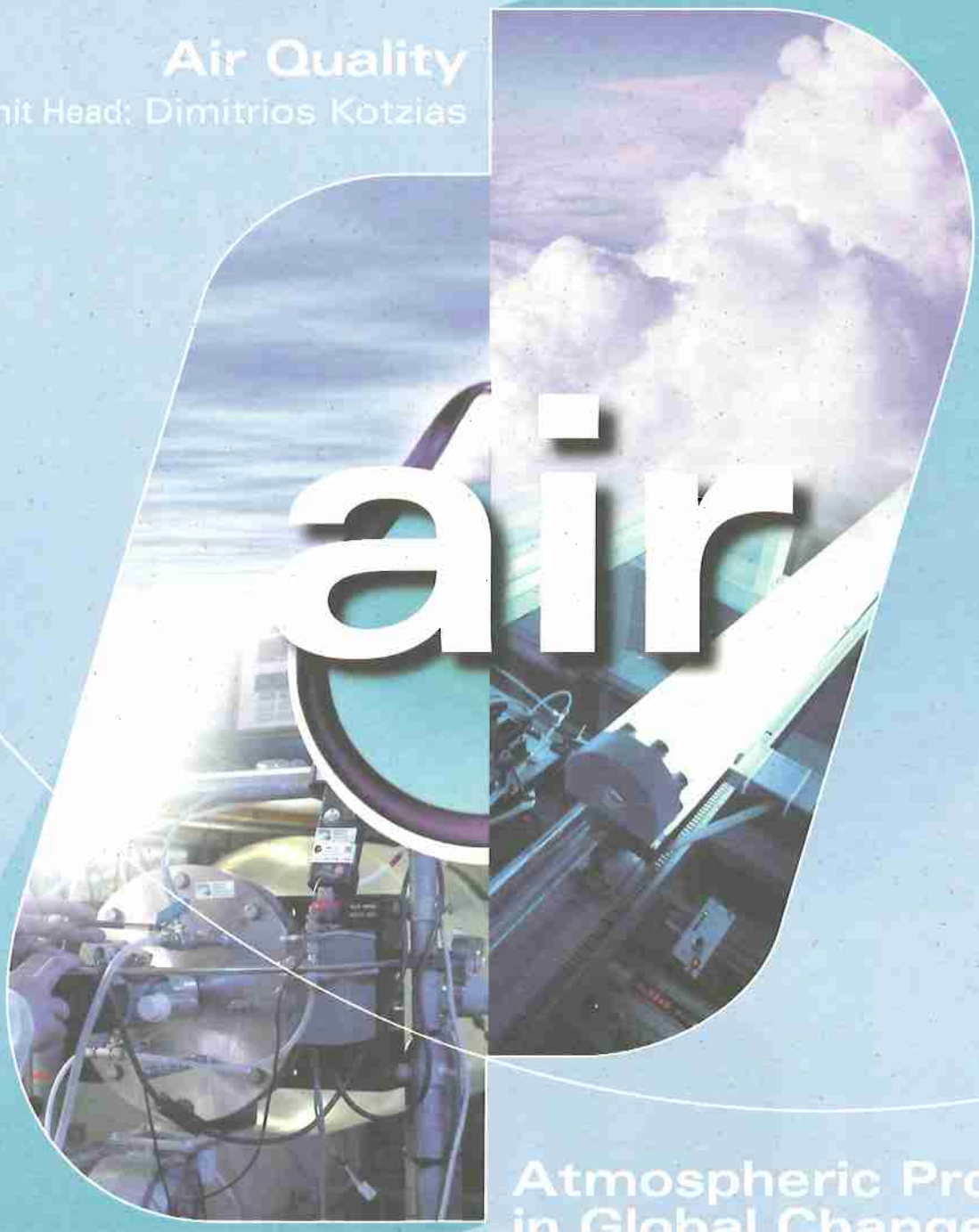
- Appropriate analytical instruments and methods in terms of precision, accuracy, reliability, cost, etc.
- Harmonised data based on comparable measurement methods and strategies.

INTRODUCTION

Monitoring and understanding changes in the chemical composition of the atmosphere at local, regional and global scale are essential parts of an integrated environmental policy. It is the task of the Air Quality Unit and of the Atmospheric Processes in Global Change Unit to study the anthropogenic and biogenic emissions and other physical, chemical and biological processes that control the tropospheric concentrations of air pollutants such as reactive (ozone) and stable greenhouse gases, as well as aerosols. Building on this expertise both Units contribute to the development, implementation and monitoring of abatement strategies of air pollution, as support to EU regulatory actions.

Air Quality

Unit Head: Dimitrios Kotzias



Atmospheric Processes in Global Change

Unit Head: Nicolo Omenetto *f.f. until June 99*
Frank Raes *from June 99*

Environmental Impact

Environmental toxicology and human health

- Successful use of the EI's patented transgenic mice model on chemical stress response in toxicological experiments with environmental chemicals and drugs.
- A JRC web site on endocrine research within the Environmental Impact Unit (http://endocrine.ei.jrc.it).
- Implementation of the EU-US co-operation in the field of Endocrine Disruptors (EDCs).
- Kick-off meeting of the Hormone and Endocrine Disruptors JRC cluster.
- Development of *in vivo*/*in vitro* tests for suspected EDCs within the SCA project "Endocrine Disrupting Activity of Environmental Pollutants".
- Development of molecular biology-based testing methods for EDCs.
- Development of Strategies for Integrated Risk Assessment and on identification of biomarkers for stress response induced by environmental pollutants.
- Publication of results on candidate biomarkers for risk assessment in metal contact dermatitis and neurotoxicity.

Radioactivity Environmental Monitoring

- Extension of the data input processing software for REM (Easy-Proteo) with the possibility to read tabular ASCII.
- Automation of the software to aggregate the incoming EURDEP (European Union Radiological Data Exchange Platform) data.
- Development of the VSS (Valorisation Support System) of the CIVERT (Centre for Information and Valorisation of European Radio-active contaminated Territories (SCA with DG RTD).
- Preliminary release of The CoDecS (Coding Decoding software for ECURIE) sent to the Member States.
- Conclusion of the RTMOD project. A follow up of the project that includes also links with decision making has been accepted for funding by DG RTD.

soil

Soil and Waste

- Establishment of the EuWASP (European Watershed Observational Network on Soil and Water Pollution). Creation in collaboration with DG Environment and the European Environment Agency of a catalogue of existing study areas.
- Development of a model of watershed processes and transfer of diffuse sources of pollutants to river systems.
- Development in collaboration with the European Chemicals Bureau (JRC-IHCP) of models to assess chemical pollution in soils and groundwater.
- Field campaign organised jointly with JRC-SAI following the accident that occurred at the Aznalcóllar mine (Andalucia, Spain) in 1998.
- Development of a series of region-based indicators for contaminated sites in Europe; in collaboration with the European Environment Agency and the Austrian partners (UBA, Vienna) of the Topic Centre Soils.
- Start of an activity to gather information on concentrations of heavy metals and organic matter in European soils. Support DG Environment on the application of Sewage Sludge on agricultural lands.
- Installation of a new High-Resolution Gas Chromatography/Mass Spectrometry (HRMS) laboratory to measure dioxins and related Persistent Organic Pollutants.
- Significant progress in the development of applications that integrate the potential of GIS and WWW technologies. The Unit organised the 1st JRC Global GIS Day Workshop.

energy

Renewable Energies

Photovoltaic and Solar Thermal Electricity

- Implementation of controlled indoor test programme for Solar Home Systems.
- Laser Scanning Technique as a characterisation tool for thin film solar cells.
- Production of the first Absolute Silicon Reference Solar Cell (Self-calibrating).
- Workshop on R&D roadmap for Crystalline Silicon Solar Cells.
- Patent on Water desalination using cost-effective solar energy.
- Establishment of New Calibration Site.

Electricity Storage

- Set up of facilities for measurements of Hydrogen adsorption in carbon nanostructures.
- Development of a new method for producing nanotubes for Hydrogen storage.
- Proof of Concept of innovative Fuel Cell.

Environmental friendly and efficient energy

- Further development of the GreenLight Programme in support to DG Energy.
- Data Base on Electric Motor Systems in collaboration with manufacturers and Member States.
- Workshop for Internet-based Energy Management.
- Operating Agent for IEA Implementation Agreement on Energy Efficiency in Buildings.

Hydrogen fuel

- Successful extraction of Hydrogen from Ethanol without using precious metals.
- New method for Biodiesel upgrading.

air

Atmospheric Processes in Global Change

- Contribution to the ozone directive development and compilation of research needs to implement the Kyoto protocol.
- Three workshops in the context of the PHAMA project resulting in the formulation of the needs for air pollution/air chemistry research in the Mediterranean Area.
- Scientific workshop in Varese in December '99 to discuss the results of two major field studies of photo-oxidant formation downwind of an urban area.
- Finalisation of the scientific co-ordination of IGAC's 2nd Aerosol Characterization Experiment (ACE-2) with the editing of an ACE-2 special issue.
- Compilation of a selected global set of SO_2 and sulfate aerosol within WMO's World Data Centre for Aerosols, hosted by the Unit.
- First calculated global fields of aerosol number concentrations by the Unit's own modelling activities.
- Development of methodologies for PAH (Poly-Aromatic Hydrocarbons) and nitro-PAH present in engine exhaust and in ambient particulate matter.
- Production of the first results in the laboratory by the on-line single particle mass spectrometer.
- IMSAQ (Integrated Modelling System for Air Quality) has been further developed by the inclusion of an aerosol equilibrium module.
- During 1999, some of the competitive activities (SCA) were successfully concluded (DOMAC, RADICAL, UNARO, PARFIN, ECOVOC, VOCAMOD, MEDEFLU, SINDICATE). 6 New proposals have been approved.
- Publication/acceptance of 58 papers in the refereed international literature.

water

Water Research and Monitoring

- Set up of the European Approval Scheme for Construction Products in contact with Drinking Water.
- Definition of methodologies and instrumentations for the management, restoration and protection of water resources.
- Use of cross flow membrane filtration, coupled to photo-oxidation to decompose various pollutants and colouring agents in wastewater.
- Application of subsurface-flow reed bed wastewater treatment in various pollutants including colouring agents and detergents.
- Development of a high sensitivity bio-calorimeter for studying aerobic and anaerobic biological processes.
- Inter-laboratory calibration exercises on the analysis of several compounds in solid wastes, sewage sludge, sediment and plants.
- Reference materials of solid wastes, soils, plants and oyster tissues for the analysis of several compounds.
- Two hands-on courses for the production of laboratory reference materials for the ten Accession Countries.
- The set up of a European Scientific Coastal Observational Network.
- The ELOISE project office has been closely involved in running the thematic network, and participating to the 3rd ELOISE Open Science Conference.

Major results in 1999

air

Air Quality

- Accreditation of the ERLAP laboratory according to EN 45000 (including the Ispra Air Monitoring Station AIRMON) for the measurement of inorganic air contaminants (SO_2, NO_2, NO, O_3).
- Organisation of the Air Quality 2000 Congress from May 19-21,1999 in Venice (ca. 550 participants from national and regional authorities, non-governmental organisations, universities, industries).
- Organisation of the PolyAromatic Hydrocarbons workshop in view of the development of new directives. The full proceedings were published in the scientific journal Fresenius Environmental Bulletin.
- Publication in the frame of the co-operation with UN-ECE (EMEP program) of the annual report with the measurements at the Air Monitoring Station Ispra as EUR report (Nr.18741).
- Two inter-comparison exercises for the compounds SO_2, NOx, O_3 and CO with the participation of 17 national reference laboratories.
- Approval of the report No. 20 on Sensory Evaluation of Indoor Air Quality by The European Collaborative Action "Urban Air, Indoor Environment and Human Exposure".
- Completion of the Auto-Oil-II air-quality modelling work for ten city domains containing 46% of the EU15 population living in urban areas.
- Completion of the MACBETH project (Monitoring of Ambient Concentrations of Benzene in European Towns and Homes. The results played an essential role in the preparation by the Commission of the Benzene Daughter Directive proposal.
- Emission from incineration: First tests using artificial waste samples spiked with heavy metals. A preliminary report has been prepared for DG Environment.
- A measurement campaign has been performed at a dynamic test facility comparing particle emissions from gasoline and diesel vehicles.
- An advanced nano-particle characterisation facility has been constructed and used to build up a relevant emission data base.
- Contribution by daily total ozone column measurements to the world ozone mapping activities of the World Meteorological Organisation (WMO).

The Environment Institute

DIRECTORATE

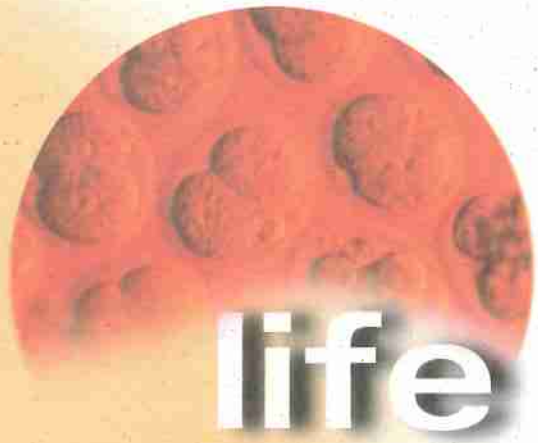
Director: **Jean-Marie Martin**

Scientific Co-ordinator: **José María Jiménez**

Secretariat: **Maria Grazia Grassi**

MANAGEMENT SUPPORT UNIT

Unit Head: **Emanuela Rossi**



environmental impact

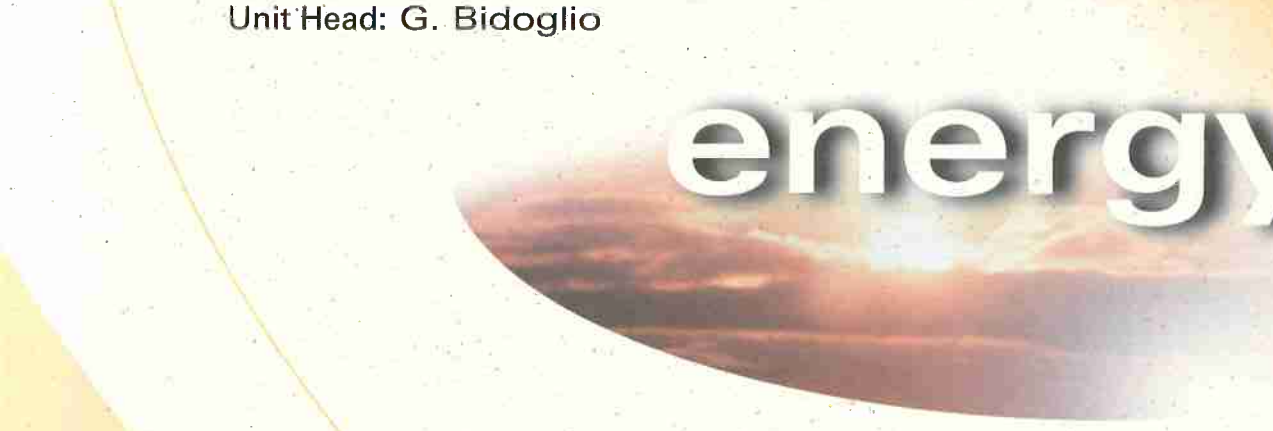
Unit Head: P. Pärt

Air Quality
Unit Head: D. Kotzias

Atmospheric Processes in Global Change
Unit Head: N. Omenetto *f.f. until June 99*
F. Raes *from June 99*

Water Research and Monitoring
Unit Head: A. Tilche *until Sep. 99*
P. Pärt *f.f. from Sep. 99*

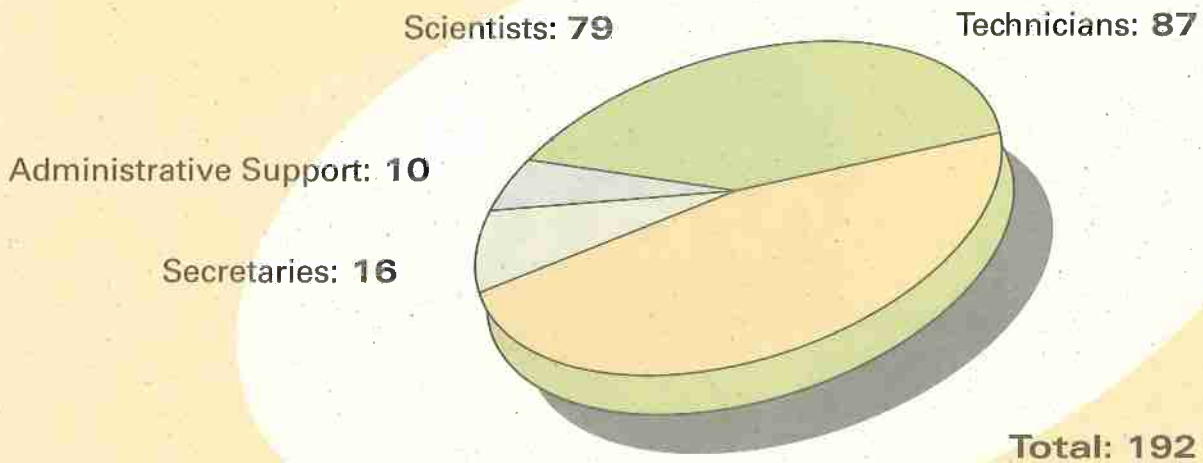
Soil and Waste
Unit Head: G. Bidoglio



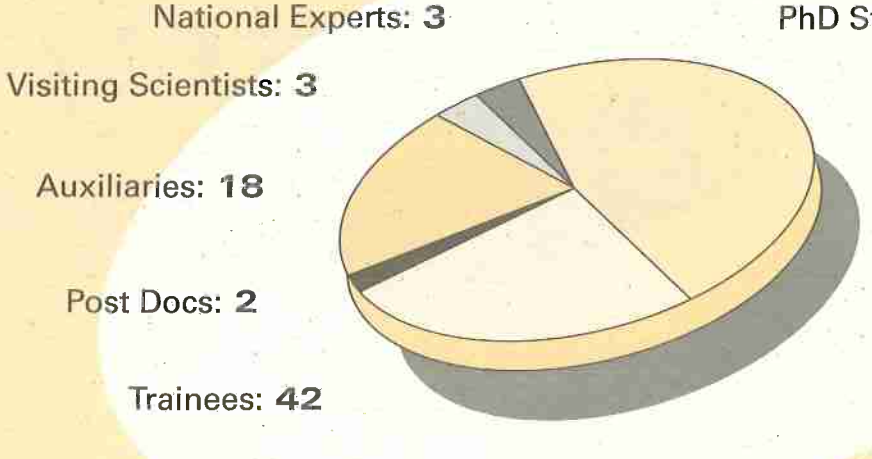
Renewable Energies
Unit Head: H. Ossenbrink

Staff

Officials and Temporary Agents



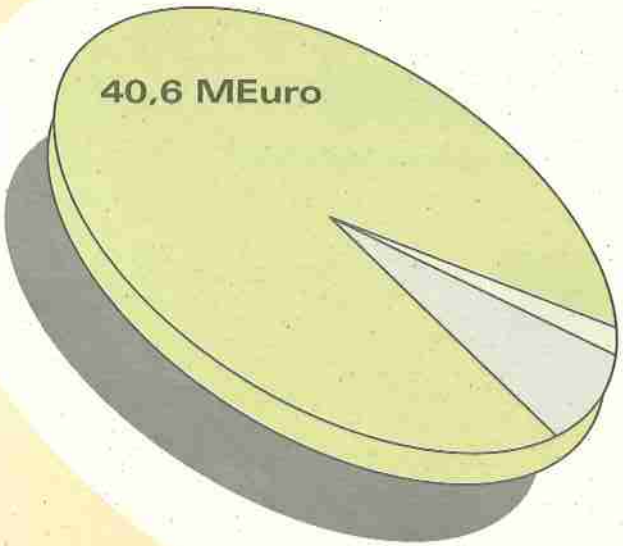
Other



Budget 1999 (Executed)

Institutional Activities

EI activities are funded through the specific programme of the Joint Research Centre within the 5th Framework Programme for Research and Technological Development and Demonstration of the European Union.



Competitive Activities

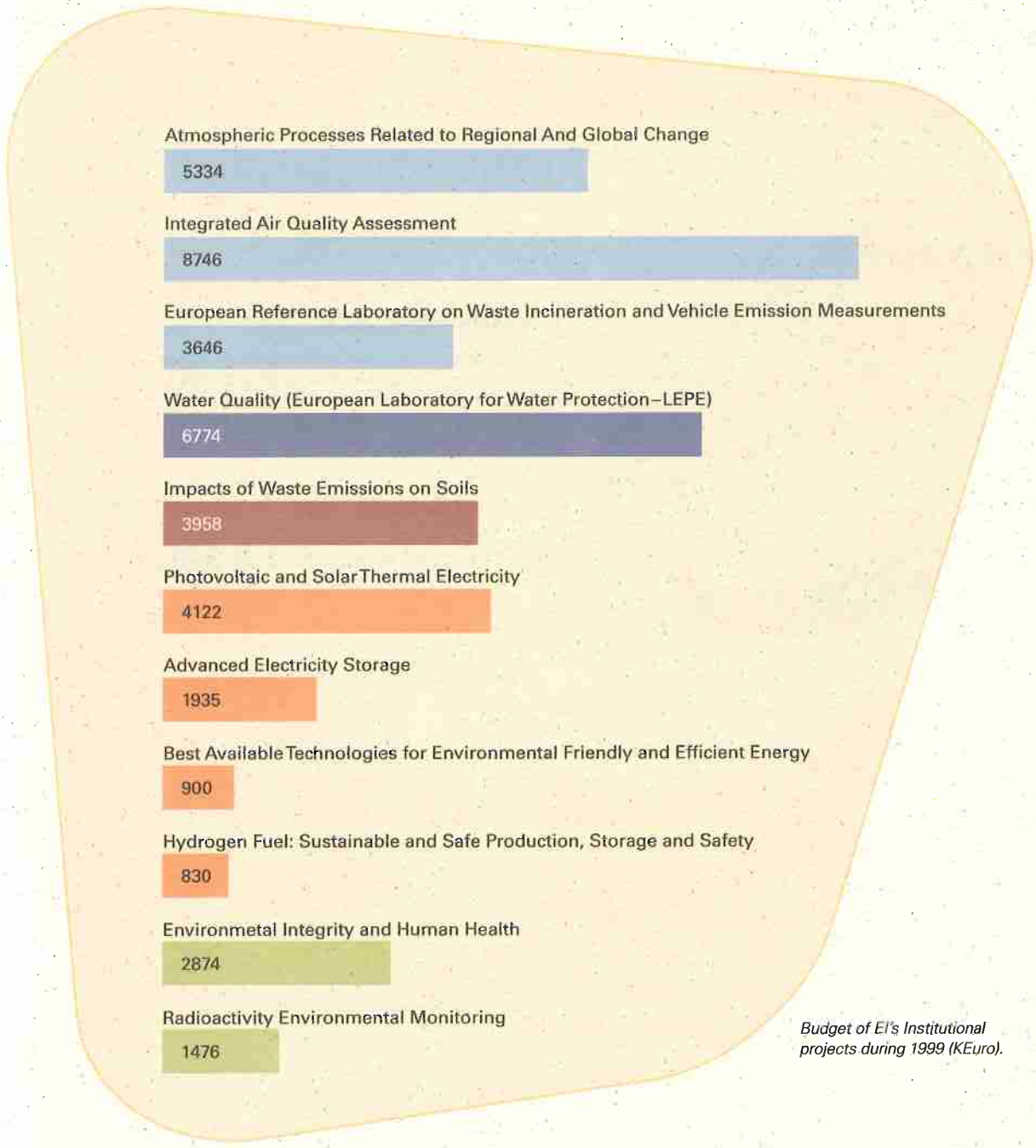
EI has continued to work in competitive schemes in fields complementary to its institutional activities mainly through its participation in the research programmes of the EU (Shared-Cost Action projects...) and through services provided to third parties (Third Party Work).

Third Party Work Contracts: **1,6 MEuro**

Shared-Cost Actions: **4,9 MEuro**

EI Work Programme 1999-2002

The work programme of the EI during the 5th Framework Programme (1999-2002) is customer-driven, with a project-oriented structure operated on sound project-management principles in accordance with the JRC's Quality Policy. It aims at optimizing the use of resources and the delivery of results to the end users of our research. It comprises eleven major projects, which maintain the momentum developed by the Institute in the 4th Framework Programme.



Budget of EI's Institutional projects during 1999 (KEuro).

Preface

Located in Ispra (Italy), the Environment Institute (EI) is one of the eight institutes that constitute the Joint Research Centre of the European Commission. In line with the JRC mission, EI supports the development of environmental policies by seeking to create a sound scientific and technical basis and, in the longer term, the preservation of Earth's natural resources for future generations.

During 1999–the first year of the fifth Framework Programme–EI has further reinforced its activities in support to the development, implementation and monitoring of the European Union Environmental Policy. The main users of our research were the Commission's DG Environment, the European Environment Agency and the Commission's DG Energy and Transport. The JRC has recently signed two Memoranda of Understanding with the first two, consolidating the very fruitful relationship maintained in the past.

This year has been characterised by the introduction of a new management culture in the whole JRC based on two main elements: Total Quality Management and Project Management. This very challenging continuous process is already having a very positive effect on the efficiency of the Institute in responding to an ever increasing demand for sound factual information in the environment policy-making process.

A major feature of the fifth Framework Programme is the introduction of the "Cluster" concept in order to better co-ordinate the activities of the various JRC institutes in relevant issues with the objective of generating synergies among the various individual projects. The EI is playing a key role co-ordinating the activities of four of the eight existing clusters, namely: Global Change, Water, Emissions and Health-related Effects, Hormones and Endocrine disruptors.

The Institute's activities foreseen in the work programme for the period 1999-2002 were assessed during the Scientific Audit in July 1999 in terms of their scientific content and the Institute capabilities. I am extremely satisfied with the very positive overall results and with the very valuable recommendations given by the team, which are currently being implemented. In relation to the JRC Mission in support of EU policies, the Audit Team expressed "its strong belief that the EI constitutes a major strategic resource for the European Institutions".

The new structure of the Institute, in place since October 1998, covering all compartments of the environment–air, water, soil, energy and life– is proving very efficient in coping with the vast variety of environmental issues in which the European Institutions have a strategic role.

I am convinced that the Institute is now in a unique position to contribute to the EU strategy on sustainable development.

I should like to thank all those who made possible the achievements of the EI during 1999: the staff of the Institute, our colleagues in the JRC and in other Commission services and our partners with which we co-operate in order to achieve a clean, safe and healthy environment.

Jean-Marie Martin
Environment Institute
Director

ENVIRONMENT INSTITUTE

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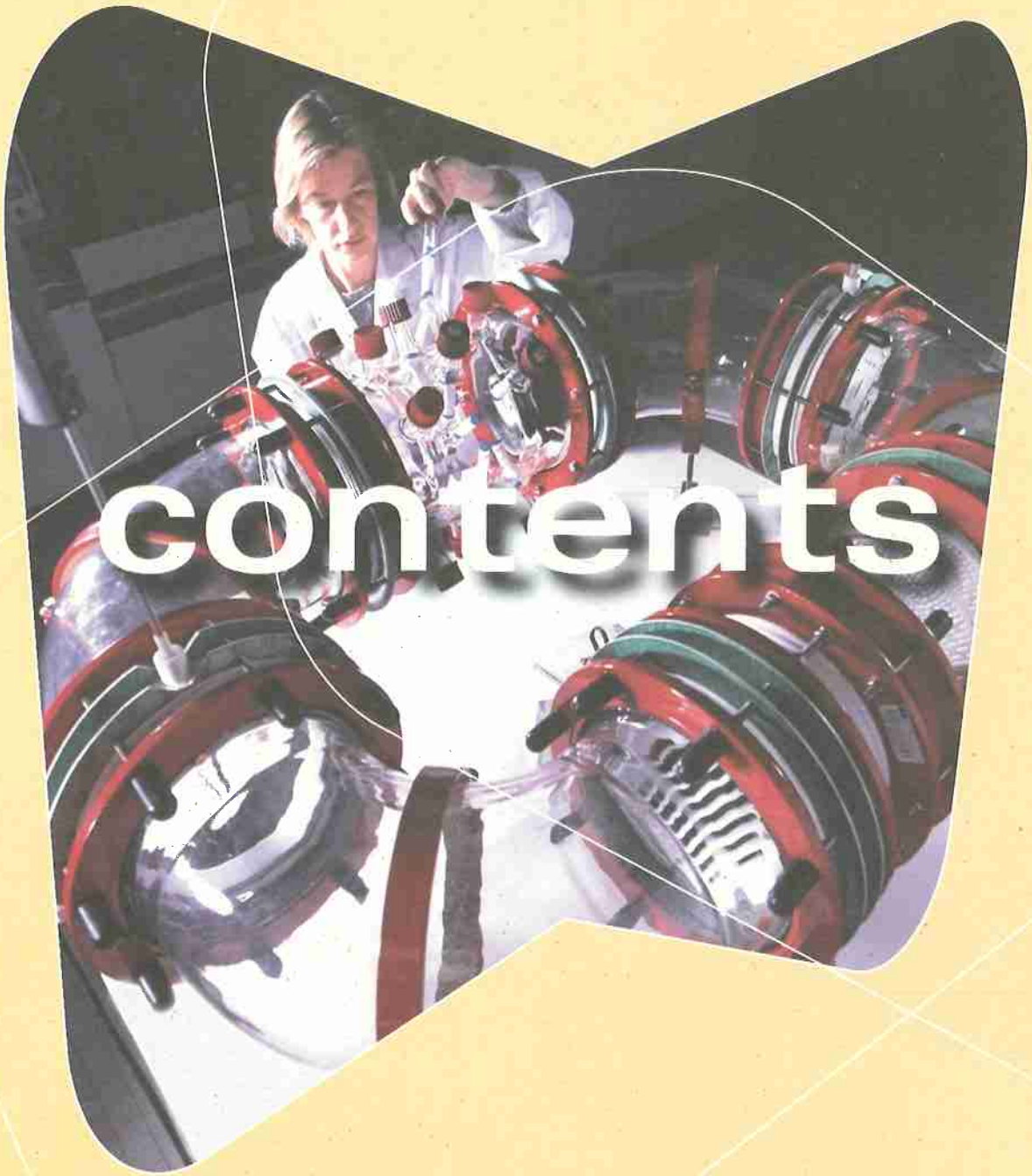

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ENVIRONMENT INSTITUTE

Annual Report 1999

EUROPEAN COMMISSION
JOINT RESEARCH CENTRE

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Edited by the
Communication Task Force *of the* **Environment Institute**

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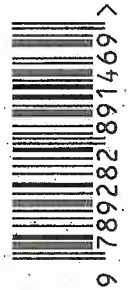
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