joint research centre
EUROPEAN COMMISSION

Annual Report

Space Applications Institute

Spatial Information Services

1999

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EUROPEAN COMMISSION
JOINT RESEARCH CENTRE

Report EUR 18987 EN

Space Applications Institute

Spatial information Services

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ANNUAL REPORT 1999

EUROPEAN COMMISSION
JOINT RESEARCH CENTRE

Space
Applications
Institute

European Commission
Joint Research Centre (DG JRC)
Space Applications Institute

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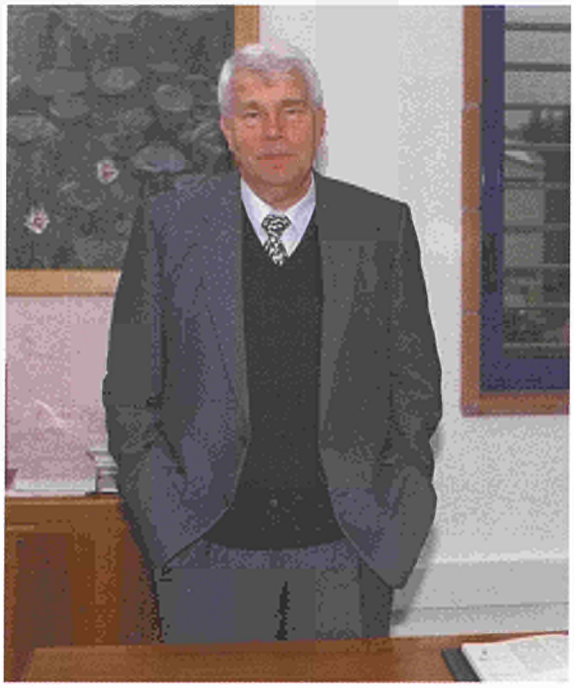
Foreword

1999 was an exciting year for the Space Applications Institute. It marked the first year of the Fifth Framework Programme, which runs from 1999-2002. At the beginning of 1999 the Space Applications Institute concentrated its entire work into eleven institutional projects. Some of the projects constitute a further development of work initiated in the past, while some others are new and explore new areas of interest, thus following some of the emerging needs of European policy and decision makers.

Examples of new activities include work in support of the reconstruction of Kosovo by providing decision support information related to the damage caused by war, research on civilian demining, or the provision of information relevant to food security in the war-torn area. Other emerging research activities include the development of techniques to monitor landslides and avalanches in the Alps, or the initiation of pilot projects demonstrating the integration of Earth observation with satellite navigation and communication, hence expanding our Institute's role from Earth observation to other space technologies. Technical support has been provided to DG Transport of the European Commission in the context of the Galileo project, which is the largest space initiative planned for the next decade.

The Institute has further developed and strengthened its expertise acquired over the past ten years in various domains, in particular related to agriculture, the global environment and here in particular the global vegetation cover, coastal zones and the marine environment, and the European landscape in general. Research on the development of technologies for the detection and positioning of anti-personnel land mines, the monitoring of air quality, and the assessment of natural risks and hazards has provided interesting results. Within the frame of the Centre for Earth Observation the first Earth observation information system (INFEO) available at a global scale was launched, using a catalogue interoperability protocol jointly developed with international partners such as ESA, NASA and NASDA. Policy support and technical work on the harmonisation and standardisation of geographic information and geographic information systems has substantially supported the Institute's activities in the geo-spatial domain.

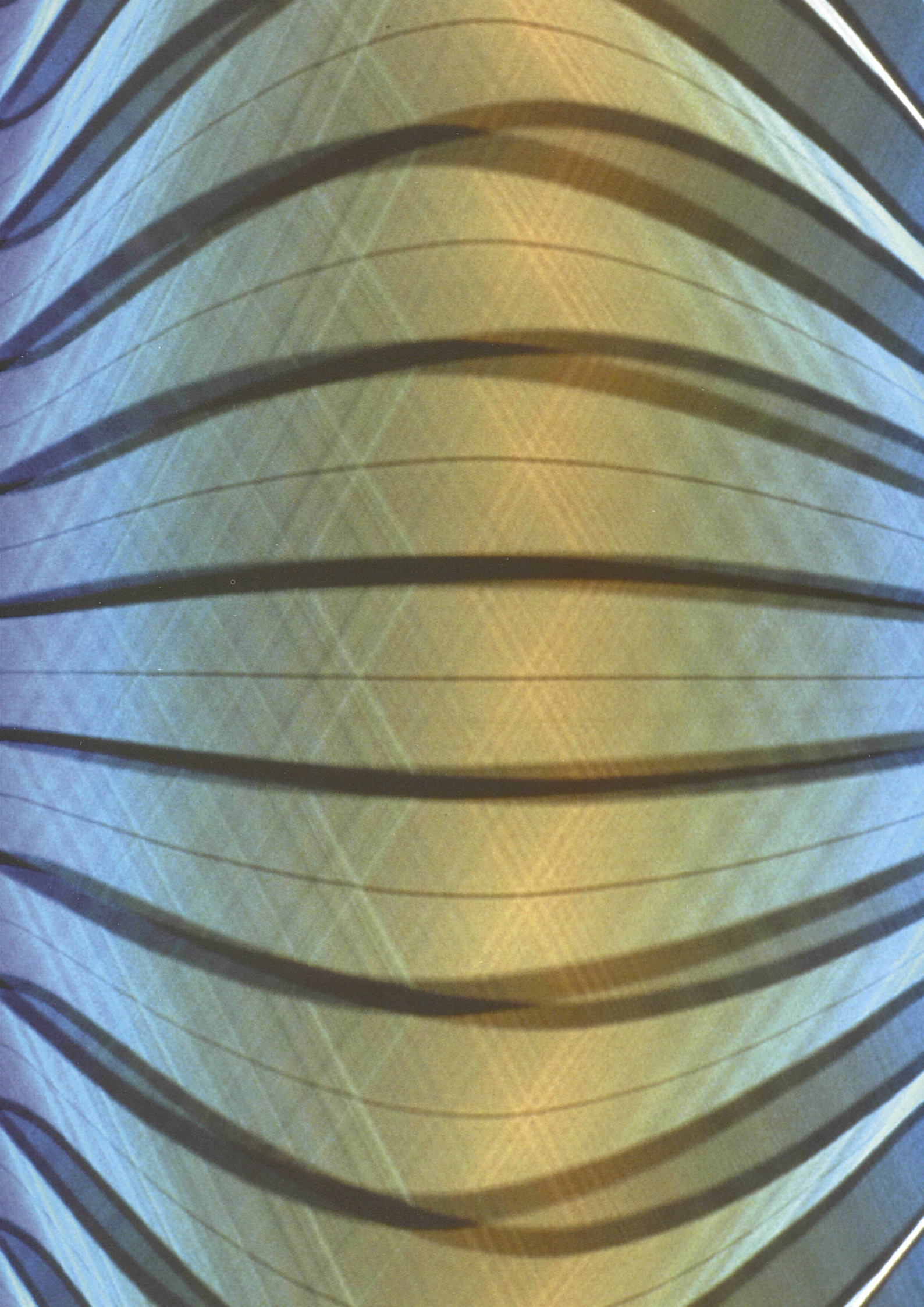


The Space Applications Institute has long recognised that information derived from space-based systems is most valuable when combined with other sources of data and information. Furthermore, the Institute recognises that the true value of any information is for it to get into the hands of decision-makers who need synthesised information based on a strong scientific and technical foundation. Recognising the importance of this aspect has led to the addition of the sub-title "Spatial Information Services" to the Institute's name.

This annual report presents the activities carried out during 1999 and shows the results achieved. I believe that the work presented here shows a considerable value to be gained from exploiting space for the benefit of Europe's citizens and policy makers.

I would like to take this opportunity to thank the 237 staff of the Institute, scientific visitors, students and in particular all partners of the institute in the EU Member States and worldwide who helped making these achievements possible.

Rudolf Winter
Director



Contents

Mission

The primary mission of SAI is to develop and promote the use of space derived data and geo-spatial data from other sources in the service of EU policies, especially those relating to agriculture, fisheries, transport and anti-fraud. SAI also seeks to make the best use of information from space systems, to maximise the return from European investments in space and to help the Union reinforce its role in international action on the environment and sustainable development.

http://www.sai.jrc.it/

Space Applications Institute

Director: Rudolf Winter

Deputy Director: Jean Meyer-Roux

Scientific Assistant: Josef Aschbacher

Directorate

Units

TDP Technologies for Detection and Positioning

http://www.tdp.sai.jrc.it/

The TDP Unit primarily supports the European Commission in its action against anti-personnel mines. It is involved in the design, assessment and implementation of advanced tools and processes to speed up civilian demining, to make it safer for the demining personnel and to reduce the costs of demining. In addition, research work is conducted to develop advanced techniques using remote sensing data.

Head of Unit: Alois J. Sieber

EGEO Environment and Geo-Information

http://www.egeo.sai.jrc.it/

The EGEO Unit carries out research and development work on the use of remote sensing for environmental purposes focusing on the European environment. The unit has three main areas of research: mapping and monitoring of the main ecosystems of Europe, development of methods for environmental protection and monitoring of ecologically sensitive regions, and development of methods to monitor urban dynamics.

Head of Unit: Jacques Mégier

ARIS Agriculture and Regional Information Systems

http://www.aris.sai.jrc.it/

The ARIS Unit is a reference centre in the fields of remote sensing, modelling, spatial analysis and statistics applied to agriculture. The unit supports the Common Agricultural Policy by generating agricultural statistics and developing systems for management, verification and control. Other more recent activities include the harmonisation and interoperability of Geographic Information and Geographic Information Systems and monitoring of natural hazards such as fires and floods.

Head of Unit: Jean Meyer-Roux

Organisation

Assistant for Project and Quality Management: Raymond Crandon

Head of Unit: Albert Jerabek

MSU Management Support

MSU assists the Institute with the sound and efficient management of all the resources, which are necessary to guarantee the successful progress of research projects. MSU co-ordinates all matters of administration, personnel, budget and infrastructure in close collaboration with the Institute Director, the scientific units and the JRC Director of Administration. Acting close to the operational level of the Institute, MSU holds an important responsibility for implementing the administrative reforms of the Commission.

Head of Unit: Alan S. Belward

GVM Global Vegetation Monitoring

http://www.gvm.sai.jrc.it/

The GVM Unit provides the European Commission with relevant, timely and accurate information on changes in the location and condition of global vegetation types. Key actions within the unit specifically address the information needed for the implementation of environmental treaties and conventions, such as the United Nations Framework Convention on Climate Change. It also develops and tests methods to identify significant events heralding land cover change, such as fires and short-term climatic variations, and to determine their impact.

Head of Unit: Peter Schlittenhardt

ME Marine Environment

http://www.me.sai.jrc.it/

The ME Unit conducts thematic research and seeks operational applications of remote sensing for the coastal and marine environment. It also develops an integrated approach to environmental issues, combining the use of remote sensing data, in situ measurements and modelling. Numerical simulations of both open ocean and near-coastal processes are carried out. Information systems and Internet-based facilities are also being developed, primarily to support policies and decision making in the environmental sector.

Head of Unit: Peter N. Churchill

SSSA Strategy and Systems for Space Applications

http://www.sssa.sai.jrc.it/

The objective of the SSSA Unit is to develop and test how information from space can be used to help implement EU policies. Work is focused on the development and operation of on-line information systems, the synergy of Earth observation with communication and navigation data, the development of Earth observation applications to support regional, transport, environment and common foreign and security policies, and the development of strategies leading to a sustainable Earth observation industry in Europe.

Directorate

Director: Rudolf Winter

Deputy Director: Jean Meyer-Roux

Scientific Assistant: Josef Aschbacher

Assistant for Project and Quality Management: Raymond Crandon

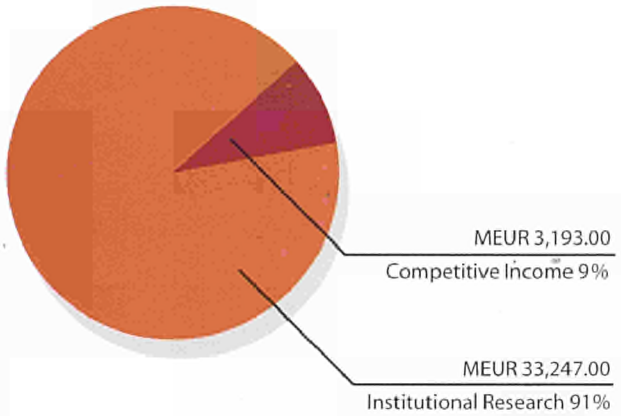
Units

Unit	Head of Unit	Sector	Head of Sector
MSU Management Support	Albert Jerabek		
TDP Technologies for Detection and Positioning	Alois J. Sieber	Civilian Demining Environmental Security Experimental Facilities	John Dean Dario Tarchi Giuseppe Nesti
EGEO Environment and Geo-Information	Jacques Mégier	Advanced Methods (AMS) Forest and Catchment Studies (FORECAST) Mediterranean Ecosystem Monitoring (MECOM)	Ioannis Kanellopoulos Sten Folving Stefan Sommer
ARIS Agriculture and Regional Information Systems	Jean Meyer-Roux	Geographic Information and Spatial Applications (GISA) Monitoring Agriculture with Remote Sensing (MARS) Natural Hazards Informatics Support	Alessandro Annoni Olivier Léo Guido Schmuck Michel Amsellem
GVM Global Vegetation Monitoring	Alan S. Belward	Applied Microwave Remote Sensing Forest Ecosystems Grassland and Savannah Ecosystems Science and Technology for Applied Optical Remote Sensing Information Systems	Gianfranco de Grandi Frédéric Achard Jean-Marie Grégoire Michel Verstraete Tim Richards
ME Marine Environment	Peter Schlittenhardt	Remote Sensing – Data Assimilation Remote Sensing – Data Elaboration	Walter Eifler Nicolas Hoepffner
SSSA Strategy and Systems for Space Applications	Peter N. Churchill	Information Extraction and Optimisation Systems Development Satellite Communications and Navigation Systems and Services Strategy Development for Space Air Quality	Carlo Lavalle Michel Millot Michalis Ketselidis Neil Hubbard Jean Verdebout

Resources

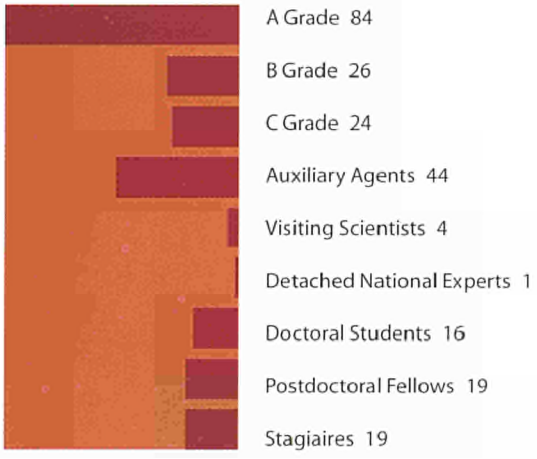
Finances

SAI finances its work through the institutional, or direct action, budget and by means of competitive activities. The direct action budget of SAI is, as for the whole of the JRC, negotiated for the duration of a Framework Programme, or four years. 1999 was the first year of the Fifth Framework Programme. In addition to its institutional budget, the institute benefited from over 3MEURO of income on competitive activities (shared cost action, competitive support to the Commission, third party work) signed in the Fifth Framework Programme. During 1999, SAI made shared cost actions proposals up to the value of 8MEURO. At the time of writing, many of the proposals are under negotiation.



Staff

As of December 1999, a total of 237 employees worked for the Space Applications Institute. More than 200 of them are scientific staff while 29 work either in the administrative support group or in secretarial support of the scientific units. There has been a slight decrease in the number of permanent staff due to retirements and staff transferring out. There were, however, at the time of print, 27 recruitment procedures under way, which will bring the institute staffing level to that required to meet its commitments under the Fifth Framework Programme.



Selected Highlights of 1999

January

- Launch of the Fifth Framework Programme projects
- ASTRON Information Day

February

- Annual Review Meeting of the SNSB – SAI agreement

March

- JRC Launch Conference, Ispra
- Annual Review Meeting of the EUMETSAT – SAI agreement
- InfoTERRA/TerraSAR workshop

April

- Conference on "MARS – 10 years of demand driven support", Brussels
- CEO workshop entitled "Has EO found its customers?", Ispra

May

- 4th SAI Users Seminar, Baveno

June

- Second flood meeting on the Oder catchment with participants from the Czech Republic, Germany and Poland
- 5th EC-GIS workshop organised jointly by SAI and DG INFSO, Luxembourg

July

- IGARSS 1999, co-organised with SAI, Hamburg

August

- Launch of the Total Quality Management initiative

September

- World Fire Web network reported on the CNN web site
- CEO Design and Implementation Phase Steering Committee
- Joint FAO & EC meeting on the development of the European Soil Information System
- MoU signed by CNES and JRC
- 2nd International Workshop on Multiangular Measurements and Models (IWMMM-2)

November

- Course on Remote Sensing of the oceans co-organised by SAI in Thailand
- IKONOS and Landsat 7 Seminar
- EMSL Advisory Committee

December

- EU Council of Ministers adopt Resolution on Space

Projects

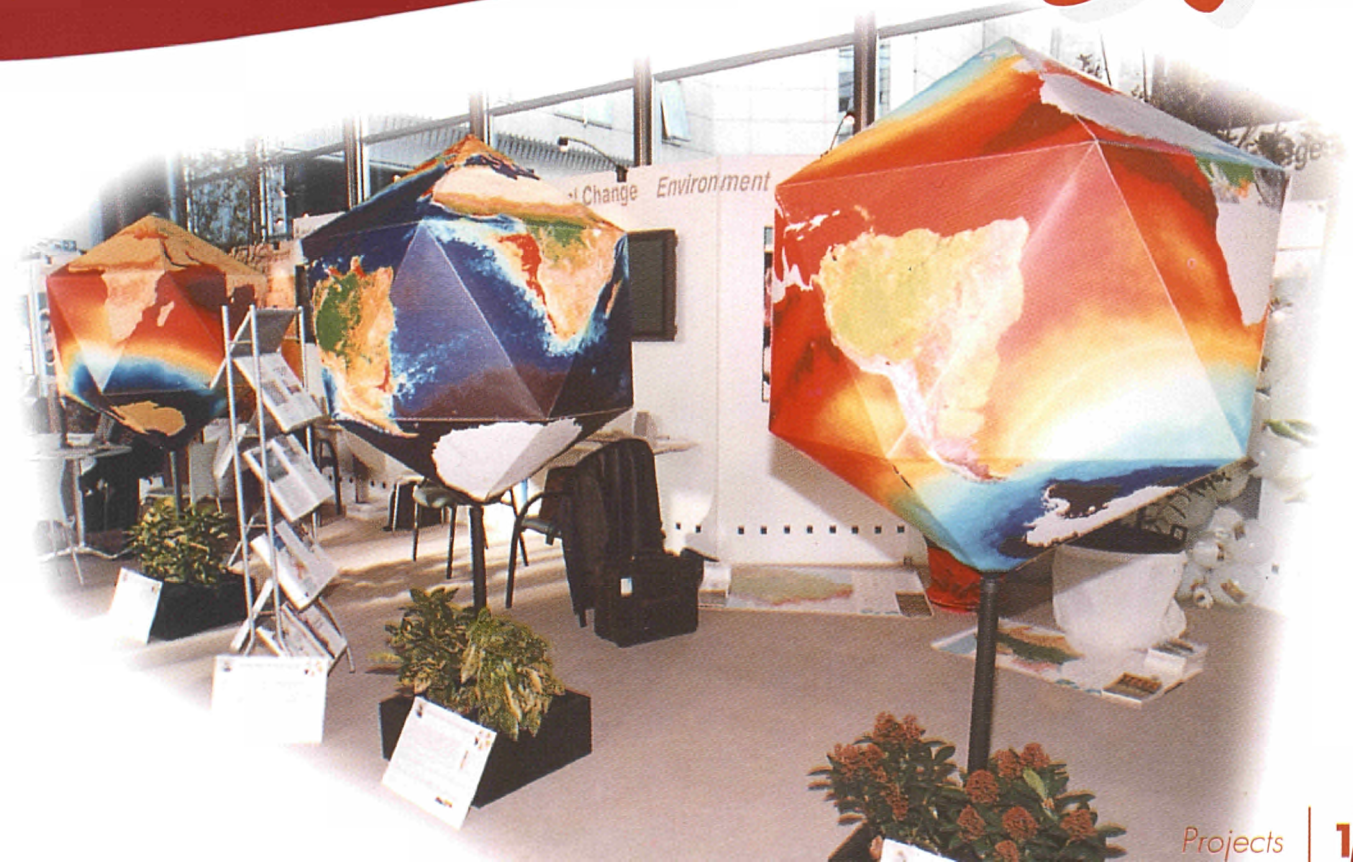
Horizontal distribution of projects by Unit

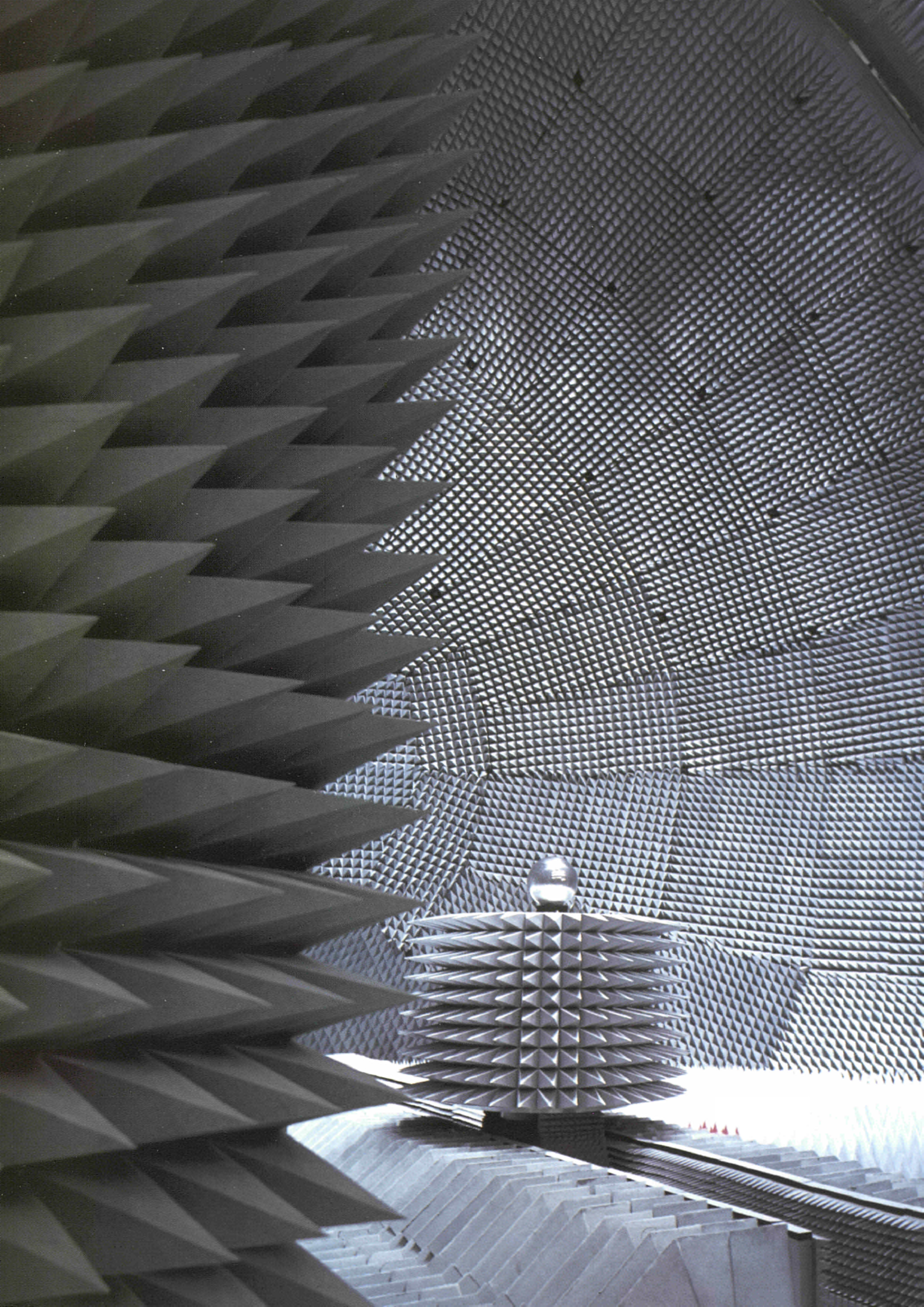
	Technologies for Detection and Positioning	Environment and Geo-Information	Agriculture and Regional Information Systems	Global Vegetation Monitoring	Marine Environment	Strategy and Systems for Space Applications
Sampling for information on Genetically Modified Organisms (SIGMO)			■			
Technologies for Detection and Positioning of Anti-personnel Mines	■					
Natural Hazards	●	●	■		●	
EURO-LANDSCAPE: Geo-Information for Development and Environmental Monitoring		■	●			●
Coastal Monitoring & Management (COAST)	●				■	
Global Environmental Information Systems (GEIS)				■	●	
Air Quality Monitoring Using Space Techniques						■
Monitoring Agriculture with Remote Sensing (MARS)			■			
Centre for Earth Observation (CEO)				●		■
Synergy of Earth Observation with Satellite Telecommunications and Navigation (ASTRON)						■
GI and GIS: Harmonisation and Interoperability		●	■			●

■ Leading Unit

● Participating Unit

Sci





Project Co-ordinator:
Alois J. Sieber (f.f.)

The European Commission, which together with the EU Member States is the major source of funding for mine action, strongly supports the 1997 Ottawa Landmine Convention, and recognises the need to reduce the landmine threat. The Demining Technologies project addresses the development of demining technologies for application in the field. Work includes investigation of techniques such as sensor data fusion to create improved systems for minefield survey and mine detection, development of better sensors for close-in detection, and the improvement of processes for clearance and quality assurance. The JRC is implementing a strategy to improve the overall effectiveness and efficiency of demining actions in support to the respective European Commission services involved in civilian demining activities. The objective is to ensure that appropriate and safe equipment is made available quickly to mine action programmes, and that key technologies necessary for demining activities will be further developed and improved. The work programme also aims to contribute to the standardisation of requirements documentation and test criteria; the assessment of the performance of demining methods, systems and sensors; and demonstration of new technologies with the support of international partners. To realise these objectives this project is tasked to develop International collaborations; facilitate the intercommunication between the different stakeholders and the development of new partnerships through a demining network of excellence; to create an institutionalised, international network of test and validation facilities for the assessment of demining tools; to conduct joint demonstration experiments as part of the international co-operation, in order to deploy newly adapted technologies and prototypes in selected mine-infected areas; to compile the needs of priority mine-infected countries in a reference catalogue of standard statements of operational requirements; to provide access to the JRC test facilities to sensor systems developers and provide a standardised measurement process for reference assessments and benchmarking; to create and establish efficient information management systems (this task is being executed jointly with ISIS and aims to develop standardised information management systems and databases); and to execute leading in-house research, especially in the area of signature measurement and algorithm development in order to support the development of sensors for minefield survey, as well as, close-in detection. Components of this work are being communicated to the demining community through the World Wide Web – references are provided at appropriate points in the text to allow readers to easily access further information.

Technologies for Detection and Positioning of Anti-Personnel Landmines

Technologies for Detection and Positioning of Anti-Personnel Landmines

International collaboration

The Demining Technologies Information Forum (DTIF) was initiated at the request of the Director General JRC, Dr. H. Allgeier and the Canadian Ambassador for Mine Action, Mrs Jill Sinclair, following principles formally agreed at a summit meeting in December 1998. The forum recognises the contributions by the many countries that support R&D to provide new tools for mine action to make the demining process faster, safer and more cost effective and includes the EU, Canada, USA, South Africa and the EU member states. DTIF will provide a systematic, multi-disciplinary opportunity for the identification of demining technology gaps, for the synergistic exchange of ideas, for international programme co-ordination and planning and for the review of progress in the mine-action technology area. The operation of the DTIF is guided by a steering committee. This is chaired jointly by the EC, represented by Director General JRC, and by the Canadian Ambassador for mine action. Additional members of the steering committee include representatives from the USA, the UN, the chairman of the Mine Action Support Group, and the Director of the Geneva International Centre for Humanitarian Demining, and the Chairman of the Standing Expert Committee on Technologies (known as intersessional working group).

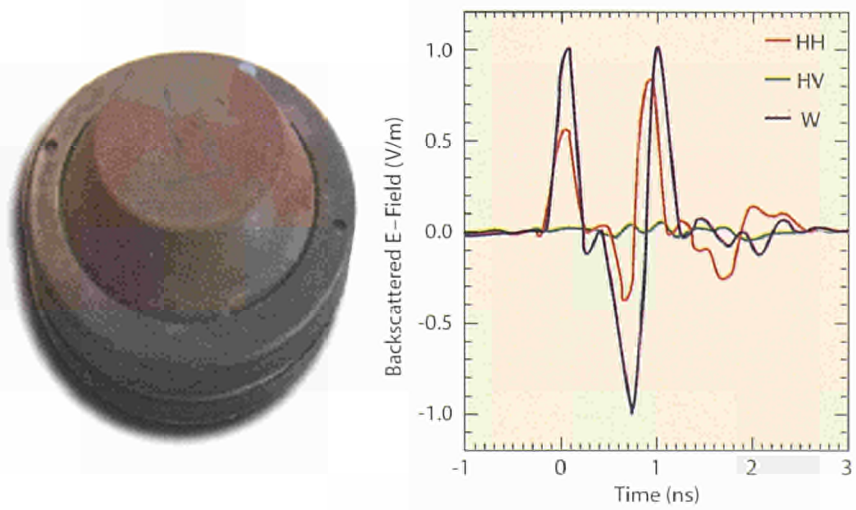
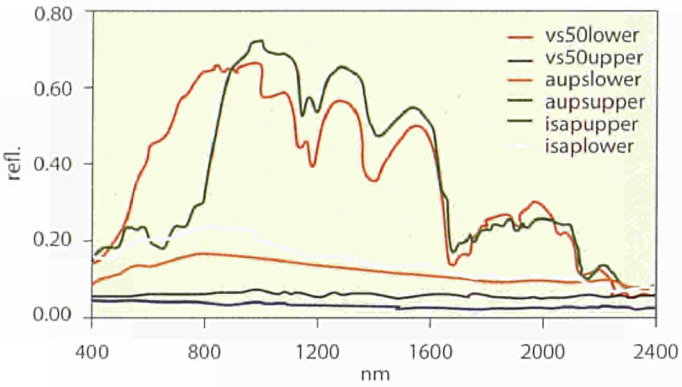


Image and time domain signature of the Technovar MAUS APL in the three polarisation channels.

The Action for Research and Information Support in Civilian Demining (ARIS) is a European Network of Excellence that is intended to improve the effectiveness of R&D in demining technologies. It is a forum for information exchange between users, researchers, developers and producers of detection devices and systems. ARIS is co-ordinated by the JRC against objectives agreed with DG Information Society. Members' interests are represented by an elected steering committee, which meets regularly to review progress and to advise on future needs. Primary communications of the network are through the World Wide Web (http://demining.jrc.it/aris). The web site consists of a public area and private areas for the members. There are also areas dedicated to the use of special interest groups and to the Steering Committee. The European Commission has committed funding to support R&D in demining technologies, which complements existing national initiatives. The ARIS Network of Excellence works to assure a coherent strategy for R&D in civilian demining technologies as well as providing a resource of information on demining R&D for the public. For developing synergy in the demining community, ARIS is stimulating information exchange; orienting technological innovation towards the operational needs; and stimulating the use and development of standards in demining technologies. ARIS activities will assist members to concentrate their R&D efforts more effectively by providing information on existing work, user needs and opportunities and by encouraging collaborative partnerships. ARIS is developing co-operation in many areas, including user needs, equipment and technology, test and evaluation, threat description, operational problems, current R&D, and the definition of future R&D requirements. ARIS is also facilitating improvements in technology available to civilian demining by providing a forum for the exchange of ideas to help resolve technology problems related to demining actions. Key workshops held under the sponsorship of ARIS include a course on current demining practice for researchers and developers (under the leadership of and supported by SWEDEC); a visit to the Bosnia Mine Action Centre and some nearby mined areas (led by SWEDEC and the NGO Norwegian Peoples Aid); and a workshop on Ground Survey techniques at Brest, led by GESMA. Reports of these activities are available from the referenced web page. The ARIS Network of Excellence is open to end-users and RTD teams from industry, universities and research centres with common technology goals in the area of humanitarian demining R&D and aims to maximise the outcome from research, training and technology transfer initiatives. User inputs help to ensure R&D addresses realistic, operational requirements.

The purpose of the International Test and Evaluation Program (ITEP) is to develop the co-operative test and evaluation efforts of members of the international research and development (R&D) community in support of technology developments aimed to contribute to

the solution to the global landmine problem. ITEP is a global network of test and evaluation capabilities for measuring performance scientifically and evaluating the effectiveness and suitability of all forms of humanitarian demining equipment, systems and methods. Founder members are Belgium, Canada, Germany, the European Commission, the Netherlands, Sweden, the UK, and USA. A number of other nations are in the process of joining this venture. With effect of 1st December 1999 the interim ITEP Secretariat started its work. Until the full Secretariat is in place, foreseen on 1st July 2000, and following the signature of the Memorandum of Understanding, to be signed in June 2000, the interim Secretariat will initiate the actions to realise the objectives of ITEP. These actions will include the development and application of universally accepted and respected Test and Evaluation protocols and methodologies; the collection, generation and distribution of robust, scientifically objective data and information products on technology, materiel, and systems for humanitarian demining; the establishment of a cost-effective and responsive international test and evaluation programme; and the ongoing process of test and evaluation of existing demining equipment and systems, equipment and systems under development, and promising technologies, processes and algorithms.



Spectral Signals of some plastic mine casings.

The TDP Unit participated strongly in the organisation of international demonstration experiments to deploy newly adapted technologies and prototypes in selected mine-infected areas. The demonstration experiments are divided into three phases, aimed to develop and integrate advanced demining technologies. The first concrete action is the International Pilot Project for Technology Co-operation (IPPTC) in mine detection. It is a co-ordinated multi-national technical evaluation of commercial-off-the-shelf metal detectors for possible use in humanitarian demining. IPPTC seeks to demonstrate, through a consumer report type of evaluation, the mine detection performance capabilities of commercially available metal detectors. This activity will result in a performance assessment that will be shared with governments and organisations involved with the global humanitarian demining effort, to assist them to select the detectors most suitable for their particular operational conditions. The pilot project also serves as a test vehicle to identify and resolve problems in demining technology co-operation and is the first exercise in ongoing international test and evaluation actions. During 1999 the outdoor evaluation was completed and the tests under laboratory conditions were well advanced. In 2000 the practical, field tests will be completed and the report issued. Moreover, the JRC acted as a technical advisor, alongside SWEDEC, in the evaluation of hand-held metal detectors conducted in Afghanistan and led by the United Nations mine action program. The test involved samples of each of eleven types of detectors from eight manufacturers. This project complements IPPTC as well as the ITEP work reported above.

A Russian "butterfly" mine seen by the CCD camera in EGO through a narrow pass-band filter centred at 750nm.

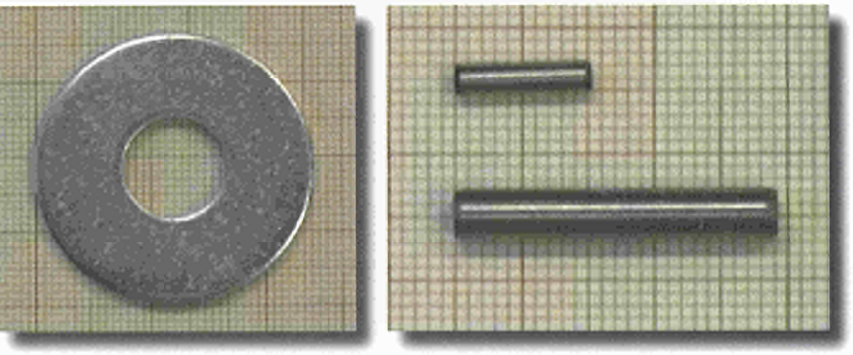
Documenting User Needs and Creating a Reference Catalogue of Standard Statements of Operational Requirements

Documentation of the needs of all priority mine-infected countries in form of a reference catalogue of standard statements of operational requirements is being undertaken, starting with countries of ex-Yugoslavia. For this purpose co-operative links are being developed with the United Nations, the Geneva International Centre for Humanitarian Demining, and with in-country demining organisations and support groups. The operational requirements are being translated by the JRC into technical specifications to allow the testing and further development of demining methods, systems and sensors. To complement this, efficient access to information is required. This task will be defined and executed jointly with ISIS with the objective to develop standardised information management systems and databases.

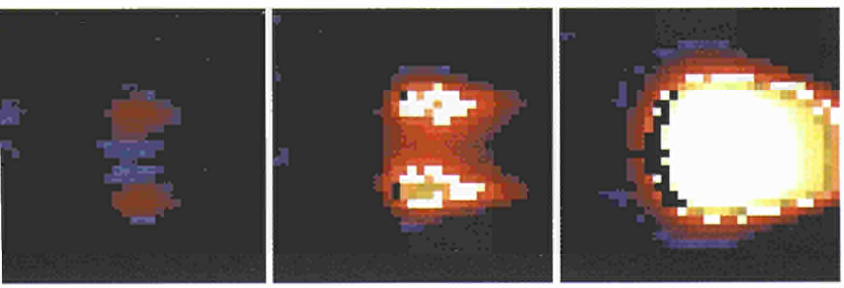
Standardisation of Measurement and Assessment of Detection and Demining Systems

The need to have an easily understandable and repeatable means of assessing the performance of existing and new technologies is well recognised. A Technical Workshop titled "Needs for Standards in the field of Humanitarian Demining Technologies and Detection of

Buried Materials" was held in November, jointly, with the European Committee for Standards (CEN) and the International Standards Organisation (ISO) to initiate the process. At the conclusion of the workshop, attendees agreed a position statement which included recognition of ongoing actions including the merits of on-going standardisation efforts undertaken by various bodies, such as UNMAS, GICHD, NATO, etc.; the need to carefully co-ordinate with these bodies in order to avoid duplication of work; and the remaining need for a hierarchy of performance and testing standards for humanitarian demining tools starting from the component level through the subsystem to the system level. It was also agreed to identify work topics to be addressed in the field of research and development, including the collection of detailed information on existing practice; definition of terminology; identification of end-user requirements; and co-ordination with various standardisation groups of areas which use related techniques. These would include aspects of dog training and handling, medical assistance to mine victims, design considerations for man-machine interfaces, and effects of the workload on an operator (such as aspects affecting air-traffic controllers' level of attention). ISO offered to support the objectives, providing access to the ISO on-line catalogue and database, allowing use of the available templates when drafting standards, and offering to describe and grant access to the "ISO Standard Development Information System (SDIS)". The meeting agreed to recommend that actions should be supported by the JRC in the context of the ITEP Secretariat.



Targets used in the metal detector tests: washer (left) and cylinders (right).



Example responses from a metal detector, scanning small cylinder, larger cylinder and washer (l to r) at a sweep speed of 0.5 m/s.

Support to Sensor Development Measuring and Disseminating Target Characteristics (MINESIGN and SIGEX)

The European Commission is currently leading an R&D programme on civilian demining through its DG Information Society and the JRC. Within the frame of this programme, part of the mission of the DG Joint Research Centre (JRC) is to measure APL (Anti-Personnel Landmine) signatures and develop database results from three sensor classes – radar, thermal infrared (TIR) and metal detectors. This work provides reference information on the responses that result from the illumination of targets by electromagnetic waves at various frequencies. The information database, accessible through the World Wide Web, includes measurements made by the TDP Unit, complemented by other data measured in Europe, Canada and the US. The measurements database, makes information available to developers of demining multi-sensor systems and any expert interested in mine signatures. This will allow developers to optimise their selection of sensor characteristics to match for their concept, and then develop decision algorithms, avoiding repetition of work and ensuring their research is focused on aspects especially relevant to the development of their system.

Mine signature measurements performed by the TDP Unit, include far-field radar measurements in the European Microwave Signature Laboratory (EMSL), thermal infrared measurements in the European Goniometric Facility (EGO), and metal detector measurements on the outdoor test range and within the Karl Friedrich Gauss laboratory. Targets included reference objects, army training surrogate anti-personnel landmines (APL), simulant APL and mine-like objects. The environments used in 1999 were sand and different soils at different moisture levels, gravel, and mixtures of gravel and soil, with and without vegetation cover. The test programme may include, in future, emerging sensor technologies such as bio-sensors, microwave radiometers or nuclear quadrapole resonance as such technologies mature and can be applied to the field of humanitarian demining. The measurements made during 1999 are classified below by electromagnetic spectral region.

Radar Measurements

In the EMSL, full-polarimetric ultra-wideband backscatter measurements were completed with stepped-frequency radar on a number of plastic APL and other mine-like objects. Measurements were made in two stages. First, the APL and mine-like objects were measured in free-space. Then, the same objects were measured and buried in different types of soil at varying depths. Four types of plastic APL were characterised: Tecnovar MAUS (high metal content); Valsella MK2 (low metal APL); Tecnovar VAR/40 (low metal APL); and Tecnovar AUPS (low metal APL). Time-domain signatures in the three polarisation channels (HH, HV and VV) of the different types of mine were found to yield significantly

different responses. The measurement frequency range ranged from 1.5 to 9.5 GHz. This points to a means of classifying mines and other objects and could help to reduce the false alarm rate.

For measurements of buried objects, a cylindrical container of diameter 2m and depth 0.5m was used. The container was filled with dry sand. The mine-like objects measured vary in shape, for example, cylinders, discs, and cubes were used in various materials including metal, teflon (ptfe), and rohacell (expanded polystyrene). These measurements presented a number of challenges. With a forward looking geometry, the return from the surface is significant even if the interface is perfectly flat, mainly because the area of the surface illuminated by the antenna is by far larger than that of the buried object. Isolation of the response of the object becomes extremely difficult unless the contrast between the object and the surrounding medium is high. Also the returned signals from the surface and the buried object will overlap in the time domain. These difficulties were overcome by synthesising a very narrow antenna beam using SAR (Synthetic Aperture Radar) techniques. The coherent averaging, associated with the synthetic aperture, filters out the surface responses and increases the level of the signal compared to the unwanted returns or clutter. Measurements taken with a metal cylinder and a teflon disc have confirmed the usefulness of this technique.

Optical TIR Measurements in the European Goniometric Facility (EGO)

Preliminary test measurements of the Bi-directional Reflection Distribution Function (BRDF) were made in the thermal infrared band (6-20 µm). A significant change in BRDF, due to specular reflection, was observed for some of the possible materials for APL casings. Overall it was found that the BDRF signatures for plastics and rubber were not useful as the scene is generally dominated by the response from vegetation. Metals, such as copper, and steel tripwires, which currently present significant difficulties for detection in field conditions yielded a strong specular component.

The spectra of a number of mines were measured in the range of 400-2500 nm. Partially or totally exposed targets of plastics and rubber gave a clear spectral signature. Mine casings are often made from plastics, some of which can be more readily distinguished than others due to characteristic absorption bands. Future work will investigate the portion of a mine that must be exposed in order to give a significant signature. BRDF measurements in TIR and visual/NIR of certain soils were also made with flat surfaces and with surfaces of known Gaussian distributed roughness. With the targets a few centimetres below the surface of dry sand, we were able to recognise mines by scanning with a TIR radiometer. With vegetation and soil moisture present, the recognition is, according to primary tests, practically impossible.

APLs placed on a background of dry sand were analysed in the EGO using a high-resolution CCD camera and a narrow band infrared filter centred at 750 nm. Images were collected over a range of azimuth and zenith angles. Investigations into influences of some other objects in the detector field of view, such as debris or a metallic trip wire were started and included comparison of results both with and without a controlled source of illumination. Investigations of the long-term variation of the temperature of soils have begun. The sub-surface temperature is being studied using TIR in the range 8-13 µm. The solar irradiance, surface and sub-surface (at -8 cm) temperatures were measured continuously for several weeks and the relationship between these parameters has been observed. Further verification of atmospheric transmittance measurement procedures was also performed during this period.

Demining R&D test field at JRC showing the Karl Friedrich Gauss laboratory.

Assessment of metal detectors in Afghanistan.

Metal Detector Measurements

Metal detectors (MDs) are used for search for buried antipersonnel landmines. They give information about detection results to the user in several ways: optical displays with a variety of visualisation types are used, but more often information is given to the user by audio signals. Our work has concentrated initially on analysing the ways that MDs give audio alarm information, and to better understand the factors affecting sensitivity, discrimination and the man-machine interface (MMI).

In the controlled assessments, detectors were fixed to a computer-controlled two-axis positioning frame and moved in a raster of straight lines, advancing across the top of a target. Initial measurements were conducted as an in-air test to avoid ground influences. The detectors were scanned over an area of 850 mm by 850 mm on paths separated by 25 mm. The detector was moved at speeds of 0.25m/s, 0.5m/s and 0.75m/s. The distance between the detector coil and the target was about 40 mm. Results give indications of the sensitivity and positional resolution of the detectors.

The audio output from a detector is in a frequency range adapted to the human ear. This means that information must be conveyed in the bandwidth between several hundred Hertz and maybe 5 kHz. The human ear is better at detecting change in the audio signal than in determining the exact characteristic. Audio signals will be simple and generally vary within the above frequency range. In the analysis, only the fundamental frequency was measured. In the tests the audio output was sampled with a digital oscilloscope, digitising and storing the signal for later analysis. The visualisation of some processed data shows the detector output frequency over position. The frequency information is colour coded. Black: represents 0 Hz and white: the highest frequency, in this example 4 kHz. Positions in the image relate to the position of the centre of the detector coil over the test area. Scan speed affects audio responses. Detectors have a certain delay to the increase and decrease in their indication. Recording the response using a left to right transit for each sampled sweep, the metallic object seems to be displaced several centimetres to the right. A sweep in two directions might result in a much broader indication of a buried object, consequently more difficult to pinpoint. As part of a multi-sensor system computer analysis may help to find the exact target position using knowledge gained from these kind of measurements.

Establishment of an International Database of Mine Signatures

As a first step to create an international database of signatures, the JRC organised an international workshop aimed to identify the needs of the potential database users; define a strategy for the creation of a user-friendly and representative database of APL signatures; define, wherever it is possible, standard measurement procedures; and identify the requirements of data providers regarding data sharing and use by third parties.

The workshop was attended by researchers and developers from industry from Europe, Canada and the USA. Discussions covered the definition of signatures, achievement of sensor independence in the signatures (to allow wide applicability), the methods to retrieve the signatures for each sensor class, and data formats as they relate to the users and providers. All participating organisations underlined their readiness to provide existing signature measurements into the database. Among the available data sets is an extensive set of GPR data by EPFL-VUB as well as a collection of IR images provided by RMA (Belgium). Access to these data sets is being provided to complement measurements provided by the JRC. A further report of the workshop is available on the web at the following URL: http://www.tdp.sai.jrc.it/~jfortuny/Workshop/summary.html.

Developing Mine Surrogates

For safe testing of developed tools it is desirable that non-explosive targets shall be used for the initial evaluation of developed equipment. Development of mine surrogates is performed within the Institutional programme and within the Mimeva (Mine IMitation and EVAluation) project sponsored by DG Information Society (Projects performed for DG Information Society were initially awarded from DG Industry under support to Esprit actions) within the IST programme.

Work to date has identified the prime threats for one geographical region that has a serious mine problem (ex-Yugoslavia). Surrogates are being developed to match the characteristics of those mine types. The designs will be assessed in the three spectral regions of primary interest (low frequencies (for metal detectors), radar frequencies for GPR and at optical and infra red wavelengths for sensors in this region). As a parallel exercise live mines will be measured in these spectral regions to confim the validity of the proposed design. In this way we are establishing the feasibility of providing safe and reproducible surrogate mines for sensor and system evaluation in safe conditions.

Providing Access to Test Facilities

Provision of access to test facilities to evaluate mine detection sensors and systems is performed within the Institutional programme and also within the MINETEST (Mine detection equipment test) project sponsored by DG Information Society within the IST programme (further information on this activity is available at http://www.cordis.lu/esprit/src/hphdhome.htm).

The JRC has developed its test facilities and support structure to allow independent assessment and benchmarking of sensors and systems. The facility has been designed to allow benchmarking of a wide range of systems and sensor types that may have application in the mine detection in humanitarian demining scenarios. The same facilities as are used in the measurement of mine signatures are used to support the assessment of sensors. These facilities are used to benchmark performance achieved at intermediate stages and at the completion of projects undertaken by consortia contracted within the EC civilian demining R&D programme. JRC staff assist in the design of the experiments to ensure the objectivity of the test approach and to fully assess the capability of the equipment offered. In support to the definition of the test conditions all necessary environmental measurements are taken on the site. The measurements made include surface and air temperatures, solar irradiance, wind velocity, air and soil humidity and air pressure.

International Collaboration Schemes

DTIF	Demining Technologies Information Forum
ARIS	Action for Research and Information Support in Civilian Demining
ITEP	International Test and Evaluation Program
IPPTC	International Pilot Project for Technology Co-operation

Contact: John Dean, Giuseppe Nesti, Joaquim Fortuny Guasch, Brian Hosgood, Steve Lewis

Metal detector being scanned over target.

http://demining.jrc.it/

http://www.tdp.sai.jrc.it/

http://www.tdp.sai.jrc.it/~jfortuny/Workshop/summary.html

http://www.cordis.lu/esprit/src/hphdhome.htm

Highlights

- Action for Research and Information Support in Civilian Demining Network of Excellence in Demining (ARIS) Website operational.
- ITEP – Agreement of a Letter of Intent to operate an International Test and Evaluation Programme in respect of developed equipment applicable to civilian demining, between EC JRC, Canada, Belgium, the Netherlands, Sweden, the US, and UK.
- Demonstration of high precision monitoring of Landslides by RADAR interferometry in Schwaz, Tyrol.
- Inauguration of the international signature database for demining with access provided to the international community via the World Wide Web.
- Participation in the International Pilot Project for Technical Co-operation (IPPTC) to demonstrate, with the US, the Netherlands, Canada and the UK, possibilities to co-operate in constructive demining R&D projects. This first project will result in a "consumer report" on the effectiveness of metal detectors in demining applications.
- Participation as technical authority in the assessment of metal detectors for UN demining projects in Afghanistan.

Technical Workshops

- Workshop on the Establishment of an International APL Signatures Database – discussed the options for dissemination of mine signatures including preferred standard formats for the data (June 1999).
- Demining training course in Sarajevo and visit to demining actions in Sarajevo for members of ARIS Network of Excellence, with SWEDEC and Norwegian Peoples Aid (August).
- ARIS Technical workshop on Technologies for Ground Survey for demining, with GESMA, Brest. This workshop considered new and current technologies that can be used to address requirements for minefield survey.
- Detection of Buried Material, including Landmines (Joint JRC, CEN/STAR Workshop). Strategic Workshop on Pre-normative Research and the Needs for Standards in the Field of Humanitarian Demining Technologies and Detection of Buried Material.


http://natural-hazards.aris.sai.jrc.it/

Natural Hazards

Project Co-ordinator:
G. Schmuck

Within the institutional activities of SAI in the Fifth Framework Programme, the Natural Hazards project was launched aiming at the provision of scientific and technical support (European risk indicator development) for the conception, implementation and monitoring of EU policies linked to protecting individual citizens from natural hazards, such as forest fires and floods. Work is in progress for the development of information on forest fires in Europe. This information includes historical series of forest fire risks, daily and forecast forest fire risk, evaluation of burnt areas, and estimates of forest fire damage. Envisaged flood risk assessment is linked directly to the ongoing development of a flood simulation model for national and transnational catchment areas. Flood damage assessment tools are in preparation. During 1999 the project reached an excellent visibility outside the JRC, which is expressed in the increasing number of customers within and outside the EU. A MoU has been signed between the JRC and DG Environment specifying the deliverables that were requested to be produced within the project. DG Agriculture also expressed its interest and willingness to work together with the project team. The National Water Authorities of Poland, Czech Republic, Germany (in the frame of the International Commission on the Protection of the Oder River IKSO) and the National Forest Fire Services of Portugal, Spain and Greece are directly involved in the ongoing project activities. Within the framework of STRIM, France, Greece, Portugal, Spain, Algeria, Russia and Bulgaria requested the proposed project services. The co-ordination with the customers from these countries is performed via the Council of EUROPE – Major Hazards Agreement (OPA agreement). Ad hod meetings and direct requests from civil protection authorities to STRIM Technical Co-ordination Group is the actual communication line. The institutional activities are partly complemented by Fifth Framework Programme competitive activities in the above-mentioned fields. Contacts have been established with new potential customers from industry like OPENGIS and Daimler-Chrysler Aerospace. Common demonstration projects are under discussion for the next year.

Natural Hazards

Forest Fires

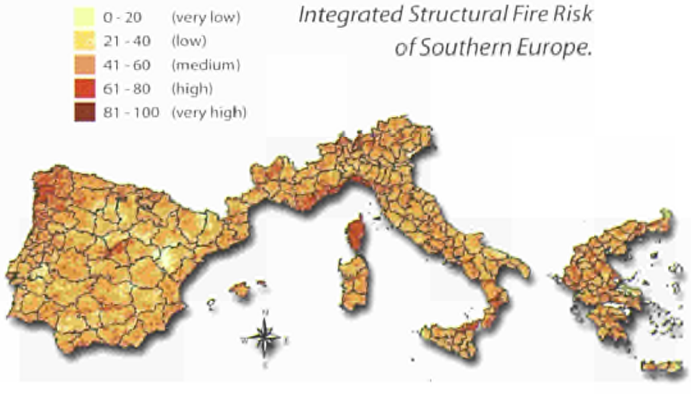
In 1999 the development of processing chains for several fire products in the fields of forest fire risk evaluation, burnt area mapping, and forest fire damage assessment, was initiated. The area of application of these products is the pan-European region, including the EU, eastern European and northern African countries. A model for a structural forest fire risk, that is, one that takes into account structural (static) factors was developed. Structural factors or variables are those that do not change in a short period of time. Some examples of this type of variables may be topography and vegetation. The objectives in the development of this type of risk indicator were to determine which physiographic and socio-economic variables best explain the fire regime in the south of Europe and the relative degree of influence of each of them; to predict the forest fire risk in a structural time scale, i.e. on a medium-long term basis (one year or longer periods); to derive a forest fire risk map that would serve as a useful tool for the implementation of forest fires related EU policies.

In the model, the dependent variable referred to as Structural Forest Fire Index (SFFI) is explained by a series of predictor structural variables. The SFFI classifies the study area according to the estimated annual mean number of fires by square kilometre (km^2). Data from the forest fire statistics collected at the EU level were used in the dependent or response variable (annual mean of fires by square km) to build and validate the model. Data for the predictor structural variables were extracted from European wide data sources such as the GISCO and EUROSTAT databases. A total of 32 independent or predictor physiographic and socio-economic variables were considered, such as, slope, aspect, elevation, fuel type, agricultural uses, agricultural and cattle production, road network density, population, unemployment, and subsidies provided by the European Commission. Multivariable regression techniques were used to select the variables in the model. As intended, the resulting model determines which of the 32 potentially explicative variables are certainly relevant. It also sorts them according to their relative importance in explaining the response variable. Although some of the socio-economic variables may suffer slow and continuous changes, they were considered as structural in the model. In order to reinforce this perspective, mean values over a minimum period of 5 years and maximum of 10 years were computed and used instead of the series of annual values. Although the predicted variable may be considered structural, the SFFI was not conceived as a static index. This is because, on the basis of analytical results, the index has a fairly good predictive capacity, which means that if up to date data for the independent variables are available, it is possible to update the index. The model will be valid as long as the values of the variables included in it remain within the range of values used to build and validate the model.

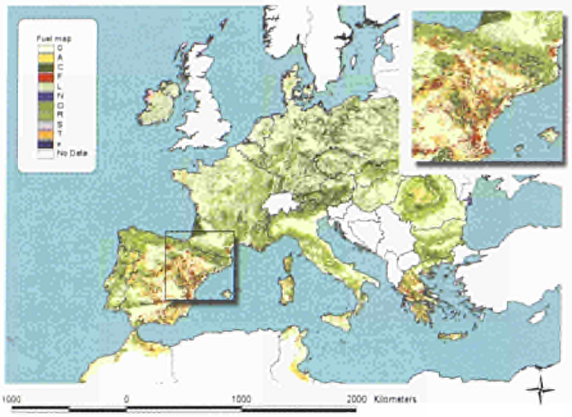
Improvements in other types of fire risk indices were also achieved. Time series of dynamic forest fire risks derived from NOAA AVHRR NDVI profiles and from meteorological data are also under development. The process to validate the algorithms and to determine the thresholds for the different levels of fire risk is ongoing. It is foreseen to produce forest fire risk forecast by using the meteorological forecast models in the coming years. An advanced forest fire risk index that integrates structural and dynamic variables is under development in collaboration with other European and US forest fire services and research organisations. Data layers for the computation of this index for a test period were prepared. These layers include the vegetation status profile derived from NOAA AVHRR data, meteorological data, and fuel type information. As in the case of the meteorological forest fire risk index, it is foreseen to derive forest fire risk forecast using this type of index.

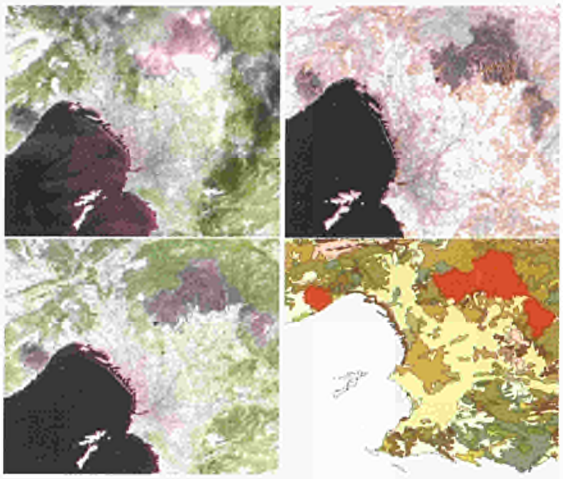
The activities on burnt area mapping and forest fire damage assessment led to the development of improved algorithms for burnt area mapping. These new methods for classifying burnt areas on satellite imagery fall in the category of the non-supervised and non-parametric algorithms. They use the information content of the image histograms to determine spectrally homogeneous groups of pixels. These correspond, in the case of forest fires, to areas that were burnt. The algorithms are flexible enough to permit the processing of images as a whole, or previously segmented into small windows (sub-images). The segmentation of the images in small windows permits improving the relative frequency of the burnt pixels in the sub-images. This further facilitates the classification process. Whenever information on the location of the burnt areas is available, the algorithm can work as a seeded classifier that "grows" from the seed until it reaches the border between the burnt and the non-burnt areas. If integrated with a reliable forest fire detection system, this classifier could be used to automatically map the areas burnt around the detected fire spot. Work is in progress for mapping burns in the south of the European Union using medium spatial resolution satellite imagery.

Contact: Jesús San Miguel-Ayanz



Integrated Structural Fire Risk of Southern Europe.





Left: *Fuel map of Europe derived by integrating the CORINE land cover database and the Vegetation Map of Europe.*

Right: *Large fire in the surroundings of Marseille in July 1997 burning over 3700 hectares. Due to the proximity of the city, areas of Marseille had to be evacuated. SPOT imagery was used for burnt area mapping and forest fire damage analysis. Images during and after the fire (left). Image warped to fit the CORINE landcover (right), and the CORINE landcover for the area the burnt areas highlighted in red.*

Floods

During 1999 a group of three simulation models has been developed for the assessment of flood risk in transnational catchments in Europe.

The components of the LISFLOOD family of models
LISFLOOD-WB: a catchment-scale water balance model
LISFLOOD-FS: a catchment-scale flood simulation model
LISFLOOD-FP: a high resolution flood inundation simulation model

LISFLOOD-WB simulates the daily water balance in a catchment in the period before the flood, typically a year or longer. The results of the model are the initial hydrological conditions (soil moisture, groundwater, snow cover) of a catchment prior to a major flood. LISFLOOD-FP simulates the same hydrologic processes as LISFLOOD-FS with a higher time resolution, to allow for a more precise routing of the discharge, and to allow for a higher temporal resolution of rainfall data. The typical time step of LISFLOOD-FS is 1 hour. LISFLOOD-FS produces flood hydrographs at desired locations in the catchment, and a series of maps that can be used for spatial planning. Using LISFLOOD-FS with meteorological forecast data would result in flood forecasts. This will be tested in 2000. Together with the University of Bristol (UK), LISFLOOD-FP has been developed. LISFLOOD-FP simulates flood inundation using high resolution Digital Elevation Models (grid sizes in the order of 5-100 m). LISFLOOD-FP simulates flood extent and flood depths in space and time. The model uses the hydrographs produced with LISFLOOD-FS.

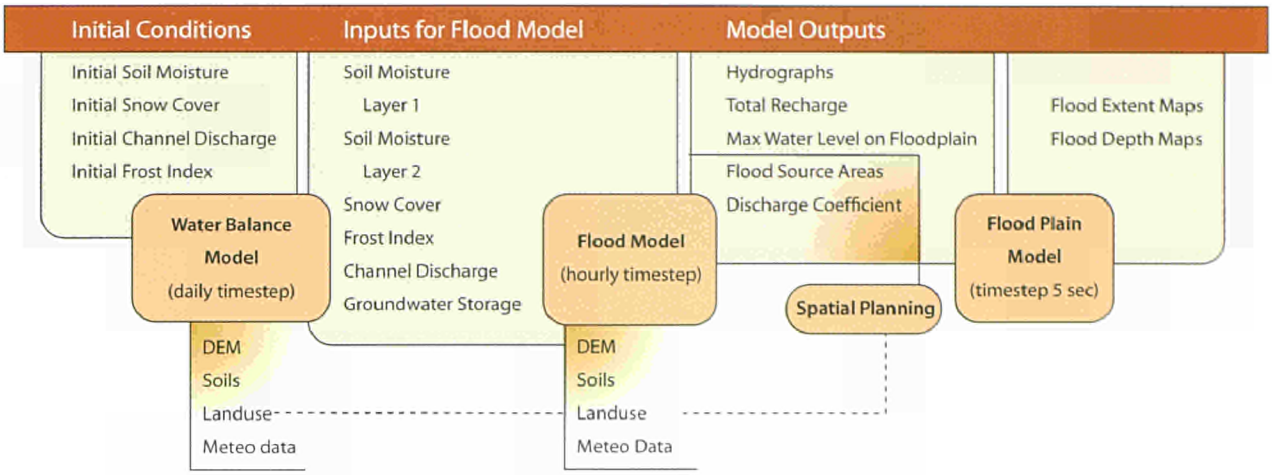
The three models can be run together or independent. The LISFLOOD models are fully integrated in a GIS environment, using the PCRaster dynamic modelling software. The LISFLOOD family of models can be used to simulate the effects of a land use change in the upstream part of a catchment (such as a forest clear cut, or the construction of a water reservoir) on the peak discharge and flood extent and depth of downstream locations. LISFLOOD-FP can be used to simulate the effects of land use and topographical changes in the floodplain on flood extent and flood depths. The quality of these simulations will be investigated in the next years.

A large part of the work in 1999 consisted of model development, testing, sensitivity analysis and initial model validation for the two pilot areas: the Meuse and the Oder catchment. GIS databases and measured meteorological and hydrological databases were constructed using the data that have been received from the National Water Authorities and the National Meteorological Services in the countries involved: the Czech Republic, Poland, Germany, France, Belgium, and the Netherlands. Data on seasonal vegetation changes used in the evapotranspiration subroutine were obtained from the NOAA-AVHRR NDVI archive available within the ARIS unit. Work has started to use higher resolution data from IRS-WIFS.

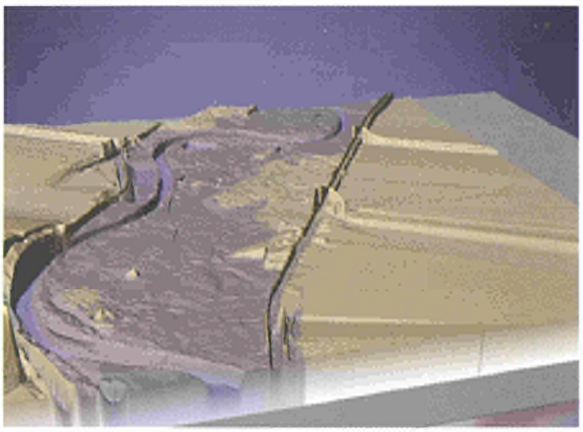
The first validation results showed promising results for the Meuse catchment. In the Oder catchment, the influences of dyke-breaks on the Oder floodplain and water reservoir operations in the Polish and Czech mountains complicate the model validation. Apart from the 1997 flood, also the 1985 and 1977 floods will be investigated for the Oder site. First results of LISFLOOD-FP showed an 85% correlation between aerial photos of the Meuse flood and the simulated flood extent. In several sub-catchments of the Meuse (Lhomme, Molignee and the Geul), a study on the effects of historic land use changes on floods has been continued with the Free University of Amsterdam (NL). Land-use maps going back as far as 1780 are used for this study. For the Oder catchment, land use data are now available from 1975 and 1995, which allows an assessment of the effects of land use changes during the last 20 years on floods.

As a tool for flood damage assessment and to validate the flood inundation model, a Windows NT version of the 'Snake' algorithm is under development, which automatically detects the flood extent from an ERS-SAR image. Combining the flood extent with high resolution Digital Elevation Models and land use information will yield flood inundation depths and land use statistics of areas damaged by floods.

Contact: Ad de Roo



Flowchart of the LISFLOOD model.



Simulated Flood Extent at 30 January 1995 on the Meuse floodplain north of Maastricht, using the LISFLOOD-FP model (DEM data courtesy of Dutch Ministry of Transport, Public Works and Water Management).

STRIM Support

The STRIM (Space Techniques for Major Risk Management) programme was designed as a user-driven programme, involving organisations in charge of disaster prevention and monitoring with space agencies devoted to provide Earth observation data to their customers. The additional involvement of specialised centres such as the Space Applications Institute (SAI) of the JRC helps in transforming the data into valuable information. Support activities in STRIM were defined to demonstrate how value added products can be derived in a timely and efficient manner to help organisations dealing with disaster management.

The EUR-OPA Major Hazards Agreement ensures the liaison with the partners of Eastern Europe, northern Africa and the European Union. In this way, the STRIM Programme shows its global approach and the top-bottom structure involving the data users from the very beginning. The steering committee of STRIM is composed by a representative of each institution participating in this initiative and the representatives of the data users at European and national level.

STRIM is structured in four activities

Activity 1	Training information and awareness raising
Activity 2	Pilot Projects
Activity 3	Future Systems
Activity 4	Support Activities

SAI's input to the STRIM common basket includes: (1) results of the pilot projects on forest fires and floods; (2) support activities on forest fires and flooding; (3) human resources to support co-ordination activities; (4) interface to other relevant Commission services (ECHO, DG Agriculture, DG Environment). A support activity that may serve as an example is that of monitoring burnt areas of forest fires over Europe.

The overall STRIM system can be structured in five steps

1	Alert
2	Image acquisition
3	Image processing
4	Product sent to the customer
5	Analysis of results

Once an alert for a large fire is provided, the image acquisition procedure is automatically started, acquiring pre and post fire high-resolution imagery. Then the image processing step is performed. The processing chain for mapping the burnt and assess the damage will be one that is applicable over all the European territory in such a manner that inter-comparison of damages occurred in different countries can be performed. The overall methodology uses the land-cover CORINE database and two images one before and another one after the fire event. In the next step the result is sent to the customer, which is able to perform the analysis of the results.

The presented support activity will be able to provide cartography of the damage area within two-three weeks after the fire event. It is foreseen that in addition to the perimeter of the fire, information on the levels of damage could be provided. The information provided by this system will not only help the local customer but will also provide harmonised information on fire damage all across the members of the EUR-OPA Major Hazard Agreement. In the EU, forest fire damage information is at present collected at regional level within each country, the aggregated at national level and the further aggregated at European level. The diverse definition of burnt and non-burnt areas, as well as the different definitions of forests among different countries makes this data compilation somewhat heterogeneous.

The structure of a system that integrates all the information concerning the forest fire activities in support to STRIM is under development. The system, initially located at SAI, will store all the information on forest fire risk and burnt area mapping produced in support to the STRIM programme. The system has been defined as a PC server with a large capacity for processing, storing and transmitting data. Once it becomes operational, it will be accessible via Internet to authorised users.

During 1999 questionnaires concerning the support on burnt area mapping were sent to the STRIM users. A positive reply was received from the EU Mediterranean countries and other non-EU countries such as Bulgaria and Algeria. Requests for mapping either determined fire events, a given region, or the whole country were received from Portugal, Spain, and Bulgaria. The support to Russia and France is under definition. As mentioned above all information concerning requests, products, and evaluation will be stored in the STRIM server. As this is the first year that the system has been tested, these first results will provide information for the improvement of the STRIM support in the coming years.

Contact: Guido Schmuck, Jean Meyer-Roux

Agri-Environment Cluster

Taking into account the complex relationship between agriculture and environment (agri-environment) the risk assessment activity on floods and burnt area mapping work of the forest fires activity of the Natural Hazards project will contribute to a better understanding of the above mentioned interdependence and will provide some tools (for example: LISFLOOD for hydrological applications) to simulate the environmental degradation caused by agriculture.

Contact: Jean Meyer-Roux

Selected Further Reading

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De Roo, A., Van Der Knijff, J., Horritt, M., Schmuck, G., De Jong S. (1999) Assessing Flood Damages of the 1997 Oder Flood and the 1995 Meuse Flood. Proceedings. 2nd International Symposium on Operationalization of Remote Sensing, Enschede, The Netherlands, 16-20 August. In press.

San Miguel-Ayanz, J. (1999) The STRIM Programme: A multidisciplinary, multi-agency application to risk management. Proceedings of the First International IDNDR Symposium on the Prevention and Reduction of Natural Disasters in the Mediterranean, Valencia, Spain, 4-7 June.

San Miguel-Ayanz, J., Salvador Civil, R., Schmuck, G., and Peedell, S. (1999) Monitoring Forest Fires in Southern Europe with Medium Spatial Resolution Remotely Sensed Data. Proceedings of the IUFRO '99 Conference on Remote Sensing and Forest Monitoring, Rogow, Poland, 1-3 June.

San Miguel-Ayanz, J., Meyer-Roux, J., and Schmuck, G. (1999) Forest Fire Activities of SAI (Space Applications Institute of the JRC) in Support of STRIM (European Programme on Space Techniques for Major Risk Management). Proceedings of the International Symposium on Operationalization of Remote Sensing, Enschede, The Netherlands, 16-20 August.

Highlights

1999

- Launch of the Natural Hazards project.
- European Forest Fire Risk Indices: available regularly on the web site.
- Structural Vegetation stress.
- European Node of the World Fire Web in operation.
- Non-parametric and non-supervised classification algorithm for burnt area mapping.
- First test of the LISFLOOD model by the IKSO (International Commission for the Protection of the Oder) partners.

2000

- IKSO Flood WG meetings in SAI.

Disaster and Crisis Monitoring

The Joint Research Centre uses information technology to assist decision-makers in dealing with natural or man-made crises. This provides support to the services of the Commission since the European Union is involved in humanitarian operations world-wide both as the largest donor and in assisting with post-conflict rehabilitation. A prototype system, which was developed for Kosovo, is presented in this chapter. This system could be used in similar crises. Oil pollution represents yet another serious man-made threat to the environment. Research at SAI focuses on modelling of airborne SAR for oil pollution detection, dealing with aspects such as ship detection, and retrieving information about oil slick properties. To assist in assessing the impacts to the environment caused by natural events such as avalanches and landslides, SAI has invested in research using radar and high-resolution optical imagery. Interferometry is being used to detect surface movements of land, ice, and snow. Catastrophic avalanches and landslides, which recently occurred in the alpine region, have been used as case studies to evaluate the potential of radar techniques.

Research on Security Issues

Spatial Information Technology to Assist Humanitarian Operations

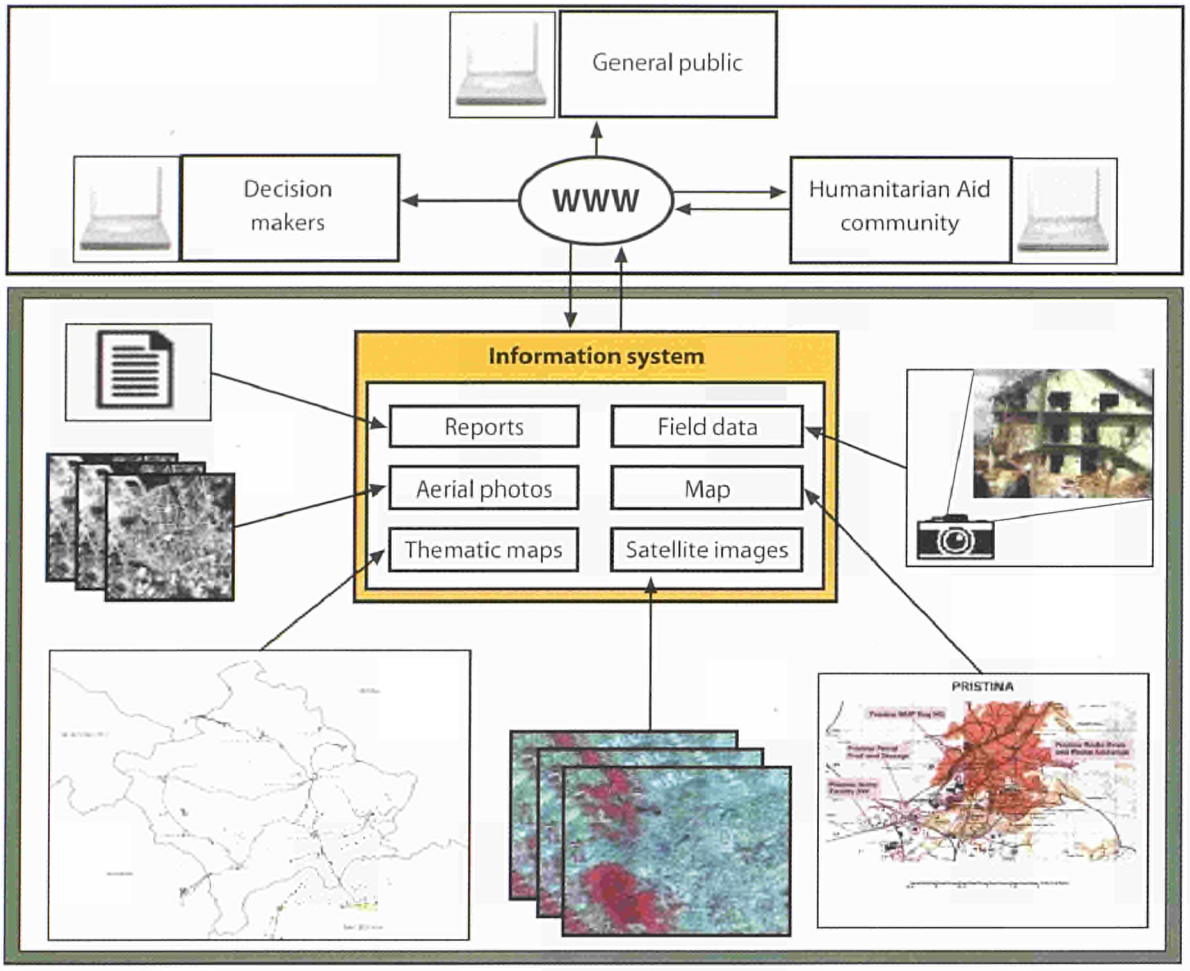
Natural or man-made crises occur continuously and the global community has to be prepared to respond to them. Humanitarian operations aim to provide emergency help when such crises occur and help restore infrastructure and living conditions. The EU is involved in humanitarian operations throughout the world and, through the European Commission Humanitarian Office (ECHO) and national aid programmes, is also the largest donor. In fact, in 1997 the EU pledged 44% of the total world aid of 2,532 MEURO. In 1999, the EU was present during the emergency phase of the conflict in Kosovo, and will assist in the post-conflict rehabilitation and reconstruction activities.

The Joint Research Centre has recently initiated activities that assist services of the Commission and the International Aid Community to better respond to humanitarian crises around the world. The JRC uses the latest technology in spatial information to assist and improve humanitarian aid and provides tools to officials involved in the prevention, emergency, rehabilitation and reconstruction phase of humanitarian crises. This spatial information technology includes Earth observation as a data collection method, satellite navigation for positioning, and satellite telecommunication, and Internet for data transfer. Data collected by these technologies together with data collected via traditional means are then stored, managed, processed and visualised within an information system thus providing ready-to-use information. The Humanitarian Aid Community will, when possible, update the database using the tools described above. The general public can have access to information through web sites set up by non-profit foundations, with the aim of disseminating information on humanitarian aid operations.

A prototype spatial information system has been developed for Kosovo. The data stored and organized in the information system can be retrieved on demand and visualised on-screen. Access to the database will be allowed through a direct link in a more restricted way via the internet. Users will visualise the datasets as maps complemented with photos and text deriving from reports. Officials will thus be provided with general information for improved decision making. The humanitarian aid community will have access more detailed information on the landscape within which they operate.

Contact: Daniele Ehrlich

Locations where humanitarian aid is currently needed. Kosovo is the focus of this chapter but the concepts developed here can be adopted in other crisis areas (natural and man made crises area are labelled in blue and red respectively).



Conceptual representation of the prototype information system for Kosovo.

Assessment, Monitoring and Surveillance of the South Mediterranean Ecosystem

Within the frame of International Co-operation (INCO), one important programme line of the European Commission, DG Research B has specific actions fostering "Scientific and Technological Co-operation with Developing Countries". One such project is "Airborne Remote Sensing Techniques Simulation for Assessment, Monitoring, and Surveillance of the South Mediterranean Maritime Ecosystem" (AMED), successfully proposed by a team including the TDP Unit (Technologies for Detection and Positioning) of SAI. AMED is developing a software simulator to assess the potential for airborne systems to complement satellite remote sensing.

The impact of fisheries and pollution on the ecosystem is of particular interest. The simulator is complemented by new analysis techniques to monitor the maritime ecosystem. The work is focused to realise a software tool to simulate real-time surveillance operating conditions. Simulations will be validated against experimental data and archives. The work performed by TDP Unit during 1999 concentrated on two specific objectives. Firstly work focuses on modelling of airborne SAR techniques for oil-spill pollution detection simulation. A model to generate the spatial distribution of the sea surface wind field has been developed and successfully proven using spaceborne ERS SAR imagery. The second part of the work involves collecting and analysing satellite images to extract information on oil spills and ships in order to feed the scenario simulator. Particular attention was paid to the problem of detectability of ships. In order to overcome limitations of earlier automatic algorithms for ship track detection at sea, a new procedure was realised and tested on archived ERS images. In addition, acquisition of a set of new ERS images is planned. In parallel sea truth data campaigns have been organised to validate and improve the proposed procedure. Preliminary results of this activity are very encouraging.

Contact: Dario Tarchi

Avalanche Monitoring System Using an Imaging Radar

Recent catastrophic avalanches in the European alpine region (Switzerland, Austria, France, and Italy) highlighted the limitations of current techniques for avalanche forecasting and monitoring. Events are often unpredictable and in spring, large areas in the alpine region are in a critical situation with conflicts between safety and economic activities. There is a lack of knowledge of the internal layered structure of snow and of the structural changes triggering the avalanche. This is due to the lack of effective tools for sub-surface sensing. Optical tools for monitoring snow in alpine areas are limited by the poor visibility, quite common in those regions in the season of maximum avalanche risk. Finally, there is a lack of knowledge of the dynamic process of avalanche. As a result there is no optimal use of tools (recently introduced) to artificially trigger avalanches in sensitive areas when the risk is supposed to be high – on the basis of the actual forecasting system. Another effect can be the inappropriate use of such a system with potentially serious consequences.

The aim of the proposed activity is to implement an imaging system to monitor snow conditions. The approach uses Interferometric Synthetic Aperture Radar (InSAR). The multi-frequency polarimetric radar is coupled to a software imaging system. It is based on the linear portable SAR system (LISA) with some software developed earlier to give 2D and 3D imaging capabilities. The use of different frequencies provides a means to build a digital elevation model of the upper snow surface and to monitor the internal structure of snow to the underlying ground surface. The system complements existing tools for avalanche forecasting by providing missing information on the internal snow structure and being radar based is able to work in adverse weather conditions. Using a mobile ground-based platform in the sensitive area allows coverage of the all region of interest and maximises flexibility in terms of spatial resolution and temporal coverage. The first measurements with a practical application are planned to be taken in the Austrian Tyrol region at the end of 1999 until April 2000, allowing significant experience to be gained.

Contact: Dario Tarchi

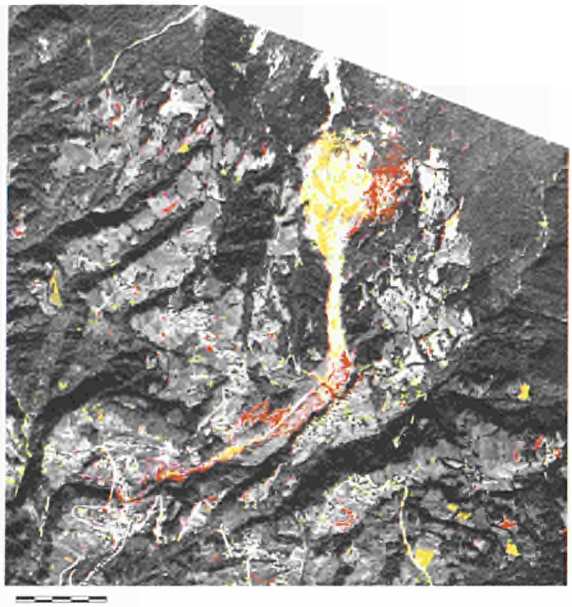
Landslides Monitoring by Radar Interferometry

Synthetic Aperture Radar Differential Interferometry (DInSAR), first used in space applications, is a proven tool for the identification and characterisation of ground displacement fields on wide areas, for example urban areas and post-seismic subsidence, volcano dynamics, and landslides. The contribution of the TDP Unit to the natural hazards project of the Fifth Framework Programme is focused on the use of interferometric radar data as a tool for monitoring landslides. The work is examining the potential of applying spaceborne DInSAR data as an early warning system of large-scale terrain movements, which could result in landslides. Many landslides become visible and recognisable only in the critical phase with serious impacts on both citizens' security and the economy. There are many potential and developing landslides which need to be continuously monitored. However current spaceborne interferometric missions generally present limitations in the monitoring of smaller scale landslides due to spatial resolution and revisit time.

Replacing or complementing space systems by ground based SAR systems could provide more flexibility in terms of spatial resolution, temporal coverage, viewing geometry, frequency of observation and polarimetric capabilities. A ground-based portable SAR system (LISA) has been developed and implemented by the Team of the European Microwave Signature Laboratory (EMSL). This instrument is able to perform measurements on areas extending from few metres to few kilometres thus providing close-up view of portions of particular interest. The frequency of observation can be in the range of 500 MHz to 26 GHz with fully polarimetric capabilities. The resolution can be selected in the range from tenths of centimetres to few metres.

At the end of 1999 LISA was being used in two experimental campaigns to monitor landslide phenomena. The first project concerned the landslide menacing the village of Airolo, Switzerland. The work was done with the Scuola Universitaria Professionale della Svizzera Italiana. SAR images were acquired at six-month intervals to map the progressive deformation of the area of interest by the landslide. An operating frequency of 18 GHz was used allowing a terrain displacement to be measured to about 1 mm, with a spatial resolution of 5 x 5 m. The data will help validate and refine a numerical model of the landslide evolution – essential information to predict where a detachment event could occur and thus what could be its significance for the village of Airolo. The second experimental activity concerns the landslides menacing the town of Schwaz near Innsbruck. A series of critical events had produced a fast movement of the whole slope leading to the evacuation of more than 50 houses. Subsequently the construction of protection dams was initiated in order to protect the town from future possible catastrophic events. The first series of Interferometric SAR measurements were performed at the beginning of October for a period of one week. The preliminary results are very positive and an area of movement was clearly identified. Follow-up work will establish the trends on this unstable area.

Contact: Dario Tarchi



Automatic change detection analysis on simulated IKONOS satellite multitemporal panchromatic imagery of Veneto, Italy. Areas in red represent changes often associated with landslide reactivation. Areas in yellow, in turn, appear mostly associated with soil moisture increase and vegetation growth.

Activities on Mass Movements

Assessment and prevention of the ever-increasing hazard and risk from mass movements in Europe, especially in the Alpine and Mediterranean countries, requires accurate and up-to-date mapping and monitoring as well as determining their key triggering factors. Activities concentrated on the development of GIS methods and advanced satellite image visualisation techniques for mass movement hazard assessment and illustration, and on monitoring landslide activity using high spatial resolution optical imagery. A GIS indexing approach has been implemented to assess the hazard from major landslides at medium scales. The method involved the application of multicriteria evaluation techniques to relevant terrain parameter and class weightings to obtain a hazard index. Multitemporal Landsat TM imagery was used to derive the land use change parameter. The method has proved to be a valid alternative to direct hazard mapping approaches based on information derived mainly from extensive field surveys and aerial photointerpretation, in areas where no geotechnical and precise groundwater data are available or whenever it is not feasible to undertake hazard statistical analysis.

Advanced three-dimensional visualisation techniques using suitably merged Landsat TM and KVR-1000 data together with high-resolution DEMs were successfully applied in the Grand Canary Island to help delineating landslide features in a complex geomorphological setting and to illustrate the risk from mass movements to local population. An experiment on monitoring landslide activity from simulated IKONOS satellite 1 m-resolution panchromatic data was carried out using multidate digital aerial photographs over an Alpine area of the Veneto region, Italy. Automatic change detection techniques were applied, depicting areas generally affected by the ground-monitored reactivation of a major landslide.

Some of these activities were undertaken in collaboration with other European laboratories, including ITC (NL), Universities of Las Palmas and Alcalá (E), University of Ferrara and CNR-IRPI of Padua (I) and UCL and Brunel University (GB). A new EU FP5 competitive project in partnership with other European laboratories has been recently awarded. It aims at improving the capabilities for assessing and monitoring hazards from landslides and other ground movements in Alpine and Mediterranean regions, using mainly earth observation data.

Contact: Javier Hervás

Selected Further Reading

Barredo, J.I., Benavides, A., Hervás, J., and Van Westen, C.J. (1999) Comparing Heuristic Landslide Hazard Assessment Techniques Using GIS in the Tirajana Basin, Gran Canaria Island, Spain. International Journal of Applied Earth Observation and Geoinformation. In press.

Barredo, J.I., Hervás, J., Lomoschitz, A., Benavides, A., and Van Westen, C.J. (1999) Landslide Hazard Assessment Using GIS and Multicriteria Evaluation Techniques in the Tirajana Basin, Gran Canaria Island. Proc. 5th EC GIS Workshop, Stresa, Italy, 28-30 June. European Commission. In press.

Hervás, J., Barredo, J.I., and Lomoschitz, A. (1999) Use of Landsat TM Imagery for Investigation of Landslide Hazard from Human Activities in the Barranco de Tirajana Area, Gran Canaria Island. Geophysical Research Abstracts, Vol. 1, No 4, 836.

EURO-LANDSCAPE: Geo-Information for Development and Environmental Monitoring

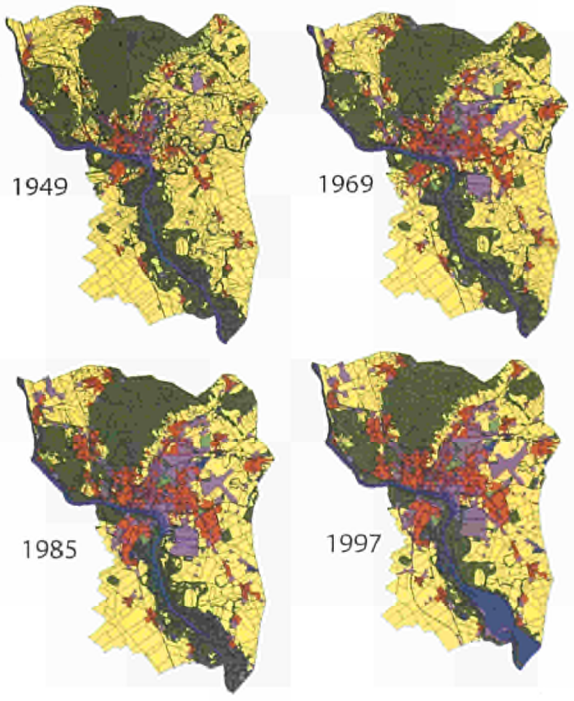
Project Co-ordinator:
Sten Folving

The EURO-LANDSCAPE project (Geo-Information for Development and Environmental Monitoring) embraces most aspects of the Pan-European landscape; it builds upon a sound technical foundation formed by many successful studies undertaken under the Fourth Framework Programme. In particular, existing networks, expertise and experience established in the past 4 years serve as a basis on which tasks, especially those contributing to Commission requirements or specific user requests, are continued. New customer-driven research and application studies have been integrated to build a frontline project to support decision-making and to monitor the implementation of EU policies. The main objective is to develop the application of Earth observation data and Geographical Information (GI) for assessing, mapping and monitoring the European landscape with special emphasis on the development of criteria and indicators for sustainable development, environmental conditions and bio-diversity. The project aims to assist the Commission in collecting and providing the information required for the formulation of new strategies and policies for both urban areas and rural lands; to facilitate timely access to the information to monitor the environment, and to answer questions which may arise from the implementation of EU policies and their impact on environmental resources; to perform historical trend analyses for understanding impacts at regional levels of the transport network and of the structural and cohesion policies; to develop remote sensing and GIS-based cost-effective methods for the management of less favoured areas and renewable resources within the Pan-European area. It links closely to the EU regulations and agendas on environment conservation, rural development, transport corridors and urban areas, forestry, desertification and biodiversity. The project has, for practical reasons, been organised into three sub-projects: MOLAND focusing on spatial development, ENVIP focusing on environmental indicators for environmental protection, and RDE focusing on monitoring rural development and the environment. Each sub-project deals with a specific aspect of the Pan-European landscape. Earth observation data, Geographical Information Systems and process models are used to analyse the different components of the European landscape and the complex interactions found both within and between these components.

EURO-LANDSCAPE: Geo-Information for Development and Environmental Monitoring

Spatial Development (MOLAND)

MOLAND aims to define and validate a method for supporting some important European sectorial policies, such as Regional Development and Trans-European Network (TEN), with territorial and environmental impacts. The reference framework for MOLAND is set by the European Spatial Development Perspective (ESDP) and the Strategic Environmental Assessment (SEA) of the Trans-European Network. MOLAND uses space-borne remote sensing as a measurement procedure that can provide a synoptic view. Indeed, data and images collected from sensors and instruments on board satellites are independent of physical, administrative and political borders and furnish homogeneity and consistency well suited for continental studies. MOLAND monitors the dynamics of Europe's settlements by developing urban and environmental indicators, which facilitate the understanding, the dynamics and the impact of cities on the environment; and by elaborating scenarios of urban growth at yearly intervals.



Bratislava: database of historical land use data.

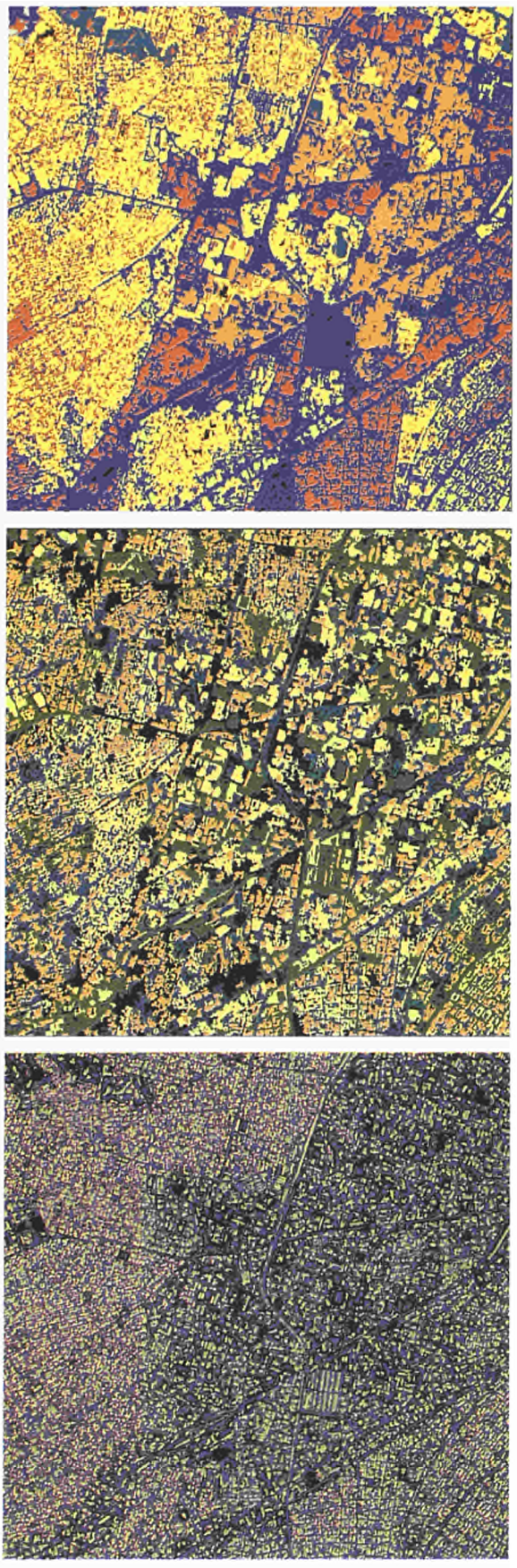
MOLAND aims at characterising European urban areas, highlighting their strengths and weaknesses, by quantifying and monitoring trends in the urban development. The resulting environmental pressures, and the impact of transport networks, infrastructures and build-up areas on the landscape are further supported issues. Another objective of the project is to assess the medium and long-term impacts of policies through scenarios. The development of scenarios of growth will serve as a major input for formulating and evaluating long term strategies for sustainable development. Finally MOLAND concentrates primarily on areas experiencing highly dynamic land use changes within the European Union, but it also includes areas outside the EU, mainly areas that are benefiting from EU economical aids, especially in Central and Eastern Europe.

The first part of the project consists of the development of multi-date land use databases. The databases are used to measure the changes in land use, which have occurred during the last 50 years. Up to now, MOLAND has been focusing on urban and peri-urban areas by integrating the databases developed within an earlier project, MURBANDY. Specific work is carried out on Advanced Spatial Analysis techniques. For each area a reference and three historical land use data sets are produced. The reference land use data set is derived from very high-resolution satellite imagery (IRS1-C, 5.7 metre/pixel), typically for the years 1997 or 1998. The historical data sets are derived using data from time windows in the mid-50's, end-60's, and 80's. Aerial photos and other ancillary data are used for the compilation of the historical data sets. The database allows the production of maps at a scale of 1:25 000. The minimum mapping unit is 1 ha for the artificial surfaces and 3 ha for non-artificial surfaces. The CORINE land cover legend is used within the sub-project. However, for artificial surfaces a more detailed level has been added. The transport network (roads, motorways, railways and river channels) is also produced for each area and each dataset. Once completed, the land use database is ready to be integrated with statistical and economical data sets from the European Statistical Office (EUROSTAT) and from the local and regional administrations. Extracts from the land use database have been integrated in the final version of the European Spatial Development Perspective and in the report Environment in the European Union at the turn of the Century by the European Environment Agency.

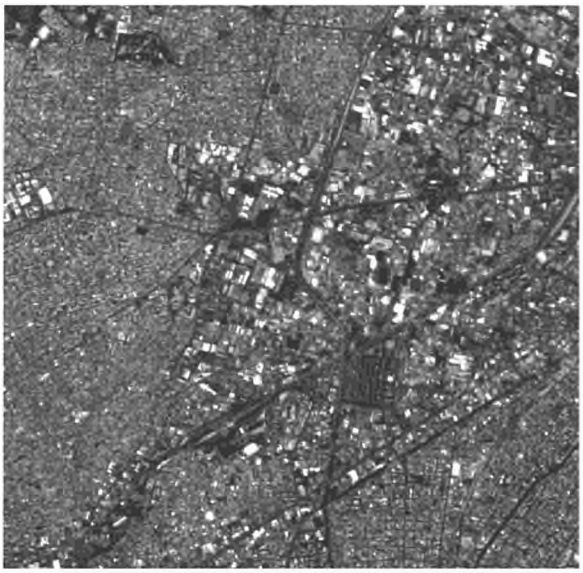
The MOLAND database directly allows calculation of environmental indicators based on territorial parameters. Socio-economic information is collected for the selected areas with the participation of local authorities. The data are included in a Geographic Information System, and disaggregated into a spatial format. In this way socio-economic data can be associated with the different categories used in the MOLAND land cover data set. This provides the basis for developing more complex indicators. A further task consists in developing scenarios of the evolution of the areas. The scenarios will serve as a major input for formulating and evaluating long term strategies for sustainable development. This task is based on the implementation of an integrated regional spatial dynamics model, consisting of a cellular automaton-based model of land use linked to both a geographic information system and regional economic and demographic data. The model allows to modify the input parameters (e.g. the transport network) in order to quantitatively and qualitatively simulate the temporal evolution of the land use.

The model is based on 24-cell states, each representing a land use class. Six of the classes (road and rail networks, airports, mineral extraction sites, dump sites, artificial non-agricultural vegetated areas, and water bodies) represent fixed features in the model; eight (arable land, permanent crops, pastures, heterogeneous agricultural areas, forests, shrub, sparsely vegetated areas, and wetlands) are passive functions – that is, their dynamics are not driven by an exogenous demand for land; they appear or disappear in response to land being taken or abandoned by the active functions. The latter, being the urban land uses (residential dense, medium dense, continuous, and discontinuous sparse; industrial areas; commercial areas; public and private services; port areas; and abandoned land), are forced by demands for land generated exogenously to the cellular automaton, in response to the growth of the urban area. Construction site represents a transitional state between one function and another. The transition potentials (one potential for each function) are calculated for each cell from the suitability, accessibility, zoning, and neighbourhood effects. Currently the model is being tested and calibrated against the available reference and historical database. In practice, the reference land use database is reconstructed from a past date.

The work on advanced spatial analysis techniques is focused on the fine, objective, spatially coherent and wide-area-coverage detection of the built-up environment and its dynamics. Spatially coherent means independent from administrative/national local conventions, same detection criteria for the entire area, independent from administrative boundaries. The aim is to demonstrate that with the current sensor technology (spatial resolution) it is possible to have satellite-derived mapping tools more integrated with the territorial planning activity, both for the built-up environment

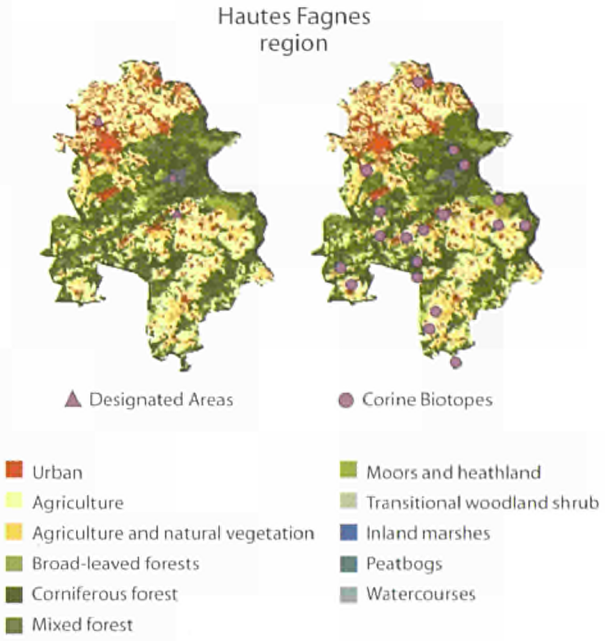


Morphological segmentation with different degrees of simplification.



IRS-1C Panchromatic imagery (© ANTRIX, SIE, Euromap Neustrelitz).

description and design. Within this context, one of the targets is to have accurate-and-large-scale representation of relevant parts of the European built-up environment. A further objective is to demonstrate the usefulness of very high-resolution satellite imagery, as a reliable source for the extraction of relevant statistical and environmental indicators such as: housing density, proportion of terrain covered by building structures, vegetation coverage indices (direct), energy consumption indices, transportation volume indices, pollutant release indicators (indirectly derivable). That is to extract indicators that describe the state and the dynamics of the built-up environment and can be potentially applied at European level, with homogeneous semantics. A further objective is to experiment with new-generation satellite data of 1-metre resolution for the accurate rendering and virtual (dynamic 3-dimensional) exploration of the built-up environment.



Updated CORINE Land Cover maps with location of centre point of various types of protected areas.

The detection methodology is fully automatic and object-oriented rather than region-oriented. In other words, the minimal mapping unit is an object and not an area. The areas corresponding to different settlement patterns are locally characteristic spatial patterns of detected objects. This is followed by a phase of human interaction validating the automatic recognition output. The recognition of different objects is based on their physical and morphological structure, and not on their social use. This approach is adopted for both technical and economical reasons. Satellite sensors capture information about physical characteristics and not (or only indirectly) about social use. The re-use and the fast changing of the use of the same buildings connote the European contemporary city. To map separately physical objects and land uses protect the mapping investment from rapid obsolescence. The automatic recognition process is based on textural and morphological pattern recognition procedures. The input remotely sensed imagery is 5-metre resolution panchromatic satellite imagery (IRS-1C PAN sensor).

Contact: Carlo Lavalle, Ioannis Kannelopoulos

Environmental Indicators for Environmental Protection (ENVIP)

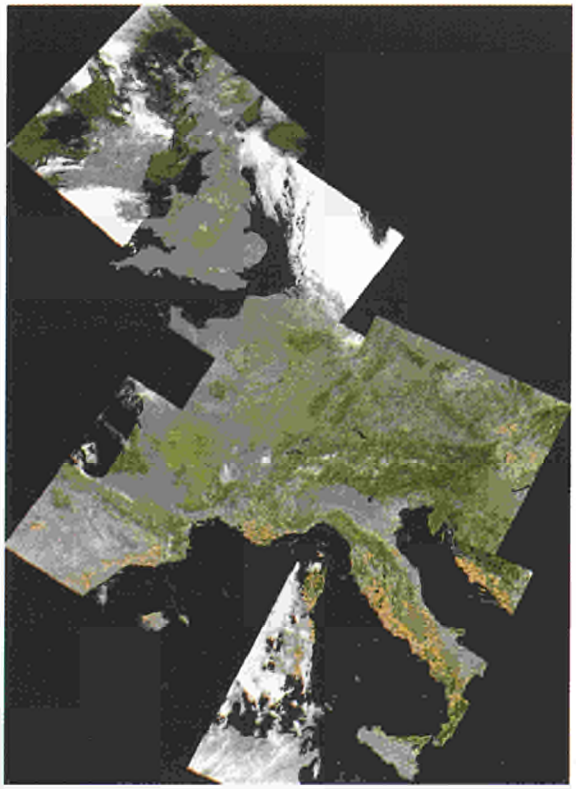
ENVIP is focusing on the provision of harmonised information for defining, implementing and monitoring environmental protection in terms of bio-diversity of natural and semi-natural areas as well as of the mitigation of land degradation and desertification. ENVIP aims at covering the Pan-European area. ENVIP aims at the development and provision of methods and indicators for the status assessment, long-term monitoring and protection of environmentally sensitive areas. This is achieved by investigating their structure, function and change, and connecting them within ecological networks. Thus ENVIP will contribute to the provision of harmonised data on environmental conditions and dynamics.

Coarse regional scale indicators are used to identify areas in Europe where more detailed analysis are needed. This comprises physical and ecological indicators but also socio-economic information. Regional indicators by themselves provide only a general overview. They are therefore seen as the outer shell for a nested approach for determining environmental problems and to define environmental protection initiatives. As the scale changes, the dominant controlling factors and related indicators also change. The scientific rationale at these widely different scales should remain compatible, from regional indicator models to detailed catchment or plot models in the nested approach. Consequently ENVIP promotes an Earth observation and GIS-based method to link from bottom up multi-spectral remote sensing with ground physical and ecological parameters as well as with spatial information layers (maps) in order to obtain spatial information on ecological conditions and their behaviour over time. Remote sensing is identified as a key tool since capable of providing, at regularly basis, synoptic and spatially consistent information, which will be required to establish a Pan-European ecological network.

Research on the integration and operationalisation of new information sources, particularly new spaceborne remote sensing systems such as SPOT VEGETATION, ENVISAT and airborne imaging spectrometry is an important complementary part of the work. All indicator definitions, remote sensing research and modelling are grouped around two major case studies. In 1999 significant progress was made through the establishment of the two regional scale demonstration studies, which are designed to test and apply the aforementioned concepts under specific thematic aspects. These two studies are ENVIP-DEMONETand ENVIP-Nature.

ENVIP-DEMONET was initiated upon the basis of the experience gained in the context of interdisciplinary land degradation and desertification research projects such as MEDALUS (Mediterranean Desertification and Land Use). The basic idea is to demonstrate the concept for a remote sensing based land degradation monitoring system applicable at European level. A network of 7 monitoring sites throughout the Mediterranean region has been established, each covering an area of approximately 4000 km². The available test sites are considered to represent the most critical land degradation processes, such as degradation of semi-natural vegetation, soil erosion, salinisation, and soil contamination, resulting from combinations of natural hazards, for instance those driven by physiography and climate change, and socio-economic factors driving the degradation, for instance land use change, grazing pressure, urbanisation and mining. Tackling the regional aspect in this context implies mainly a harmonised definition, development and implementation of the required processing chains, data exploitation methods, data management systems and products at al test sites.

For each test site a 15 to 20 year time series of georeferenced and fully radiometrically corrected Landsat data (MSS and TM) was prepared. On these time series environmental change is determined in terms of soil degradation levels, loss of semi-natural vegetation cover and land use pattern by applying spectral mixture analysis and change vector modelling. In support to the identification, analysis and interpretation of long-term trends of degradation, stability or restoration, a GIS has already been established to relate remotely sensed change to local statistical records and spatial data sets

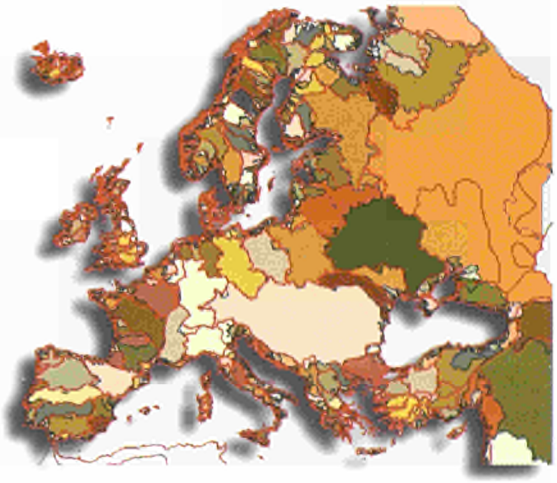


Forest area and area of other wooded land derived from medium resolution satellite data (IRS-WiFS).

such as CORINE Land Cover, soil maps, and administrative regions. At the coarse (1 km grid) regional scale, one approach is to apply a Regional Degradation Index (RDI), from a physically-based model combining climate, soil and erosion processes with actual vegetation cover derived from NOAA-AVHRR and SPOT VEGETATION images. Combining climate scenarios with satellite monitoring of vegetation cover has the potential to give an early warning of change, but the system requires links to be made with ground-based observations and medium resolution remote sensing data (e.g. Landsat TM, SPOT, IRS) that have to be improved for the purpose of calibration and validation. The model provides a rationally based method for estimating not only current relative levels of land degradation but also the sensitivity to changes in land use or climate. In the year 2000 an extension of the system is planned, which will incorporate test sites in Central and Eastern European countries. In addition, the RDI modelling is envisaged to be extended towards the North in close collaboration with the CCM activities of the RDE subproject.

The framework of ENVIP-Nature is set by the European Biodiversity Strategy (1998), the EC Habitats Directive and the Pan-European Biological and Landscape Diversity Strategy (1995) with respect to the integration of biodiversity into sectoral policies, the harmonisation of the Member States reporting and the development of a Pan-European Ecological Network. The activity is achieved in close contact with the European Environment Agency. ENVIP-Nature addresses the definition and provision of a standard set of indicators and integrated methods for the characterisation, assessment and monitoring of natural and semi-natural landscapes with respect to bio-diversity and nature protection. It makes use of Earth observation data, other geo-information and Geographic Information Systems. It is based upon an integrated landscape-ecology approach, the relationship between the landscape composition and structure and the flora and wildlife species diversity. It applies the ecological network concept which consists of core areas for conserving ecosystems, habitats, species and landscapes; biological corridors for improving the coherence of natural systems; restoration areas for repairing or restoring damaged elements; and buffer zones for supporting and protecting the network from adverse external influences.

ENVIP-Nature accommodates representative areas in the Member States and in the accession countries, in different bio-geographic regions, with different vegetation types and patterns, and with varying degrees of human influence in terms of land use practices and socio-economic development. The pilot areas illustrate the ecological network concept with natural and semi-natural landscapes, habitats and species of European importance. They include biotopes sites, legally protected sites and candidate sites for NATURA 2000. The activity addresses chronologically the three following issues at both landscape and regional scales: review of scientific literature, existing initiatives and international agreements concerning nature protection and biodiversity assessment in order to identify criteria for which indicators could be assessed through the combination of Earth observation and Geographic Information System; production of a harmonised and tailored landscape typology and database for the characterisation of areas with respect to bio-diversity assessment; elaboration of harmonised and spatially referenced indicators for the assessment and monitoring of those areas.



Major European Catchments derived from a DEM with 1 km grid cell size.

In 1999, the activity started to address the three above aspects for the regional level. A report untitled "Nature protection and implementation of the Pan-European Ecological Network: Overview and perspectives" was produced. The use of CORINE Land Cover (CLC), CORINE Biotopes sites, NATURA2000 candidate sites and other designated protected areas were investigated by NUTS regions that reflect the decision making process in terms of nature protection and regional planning activities. The CORINE Land Cover derived nomenclature that was used consisted in one artificial class, one agricultural class, one class "agriculture with significant areas of natural vegetation" and the natural and semi-natural classes of CLC level 3. Metrics related to the landscape composition and structure was tested and their translation into indicators to characterise adopted cri-

teria like naturalness, diversity, level of threat will be further elaborated in 2000. The modified CORINE Land Cover database and derived metrics appear to be suitable for delineating areas of importance for biodiversity within a grid cell size of 25 ha, for identifying weaknesses and strengths in the distribution and ecological coherence of protected sites network, then for setting priorities areas of natural value which lack protection or which are "threatened" by the land cover type and structure in their surroundings. The elaboration of the above approach by biogeographic regions for the characterisation of the ecological coherence and the level of threat towards the NATURA2000 network will play a major role in the research and development in 2000.

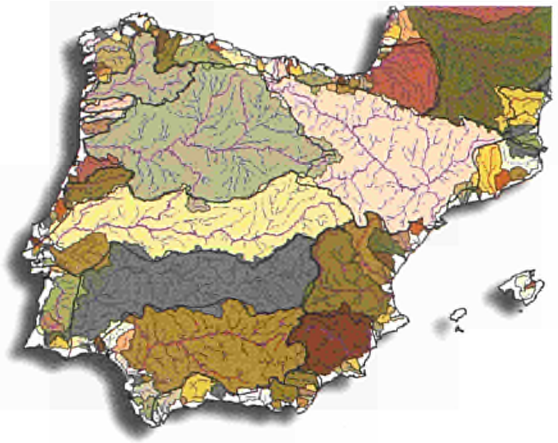
At the end of 1999, a one-year feasibility study started to address the same three issues at the local landscape scale and to investigate the use of high-resolution data acquired by satellites such as SPOT, IRS 1C together with other geo-information. A representative set of pilot areas was selected within the European Union. The feasibility to define a tailored and harmonised landscape typology and measurable indicators would enable to further develop a nested top-down approach by combining the local landscape and regional levels, towards a common European strategy for nature protection and biodiversity.

Contact: Stefan Sommer, Christine Estreguil

Monitoring Rural Development and the Environment (RDE)

The single objective of the RDE element of the EURO-LANDSCAPE project is the development of methods for assessing and monitoring Europe's rural environment. Three major aims have been defined: mapping of the forest and grassland resources in the Pan-European area; Catchment Characterization and Modelling (CCM) of run-off in relation to changes in land cover, to evaluate soil erosion risks and the needs for environmental protection; development of models integrating biophysical, social and economic factors to assess the environmental impact of EU policies related to the rural environment. The following outlines the developments that have taken place within these three thematic areas.

Much of the work related to European forestry which has been undertaken this year relates to the completion of a number of studies initiated within the framework of the FIRS (Forest Information from Remote Sensing) project. The results from these studies form the technical foundation of the research and development, which is now being continued within the RDE component of the EURO-LANDSCAPE project, and contribute to the European Forest Information and Communication System (EFICS). Emphasis has been placed on the development of methods for the provision of geo-referenced information related to the distribution of



Major Iberian Catchments derived from a DEM with 1 km grid cell size.

forests, forest types and above-ground biomass derived from EO data, for large regions of Europe, or for the entire Pan-European area. The products and significant developments that have been obtained in 1999 are a 1 km forest probability database for the entire Pan-European area derived from NOAA-AVHRR data; a thorough evaluation of the use of high spatial resolution (SPOT, Landsat-TM) satellite data for distinguishing forest types and other wooded land in Europe; a 200 m database of broad forest types derived from IRS-WiFS data. This is currently available for two large regions of Europe; an evaluation of techniques to derive above-ground biomass and volume of forested land in Mediterranean and Boreal ecosystems, using Landsat-TM and IRS-WiFS data; and the development of methods to study changes in forest cover and to assess and monitor the structural diversity of forested land at the landscape level.

All the products now available will be placed in a database, which will form part of a European Forest Information System being developed as direct support to EFICS and the Forest and Environment Division of DG Agriculture. The work undertaken for this study will constitute a major step forward towards cost-effective means of deriving and disseminating information on the forests and other wooded lands of the European continent. The study will aim at increasing the amount of information which is easily accessible (by establishing Internet links to existing meta-data catalogues) and, at the same time try to improve the comparability and integration of data from different sources and of different formats. The medium resolution (200 m) mapping exercise will be continued to cover the entire territory of the EU, thus completing the provision of geo-referenced forest information for Europe at two resolutions (1 km and 200 m). Work will also continue with the development of methods and tools for monitoring forest diversity as a contribution to sustainable forest management in Europe. This work will contribute to long-term Commis-

sion forestry strategies and the recently prepared biodiversity strategy of the European Community. The study will serve to support other European Commission Services, in particular, those of DG Agriculture, DG Environment, the European Environment Agency and the Commission's commitment to supporting the European Working Group on Research and Biodiversity (EWGRB). Emphasis will, therefore, be placed on the identification of key-indicators of forest diversity, which can be monitored in an operational way throughout the Pan-European area. An expert meeting, hosted by DG AGRI, will be held in March 2000. It will be the task of the invited experts to review the requirements of international policies affecting the bio-diversity of European forests, and to identify key indicators which could be derived using EO and GIS techniques in an operational and harmonized way across the Pan-European area.

Sub-Catchment of the Anapo river in Sicily.

Preliminary analyses of the Level-I database of the EU and ICP Forests, which deals with assessing crown condition across a 16 km x 16 km grid over the forested land in Europe, was undertaken in 1999. This study will be intensified next year to investigate the spatial patterns of forest condition in relation to extreme climatic events and ozone (O_3) concentration. This work will contribute to the definition of a proposal for an extension to Council Regulation on the Protection of Forests against Atmospheric Pollution, which is due to expire in 2001. Studies related to the mapping and monitoring of European grasslands and to the assessment of above-ground biomass of both forest and grassland ecosystems will be initiated in 2000 and 2001, respectively.

Catchments are an important functional entity for hydrological and landscape processes. It is, therefore, of importance to develop a comprehensive database of catchment boundaries and characteristics in Europe and to further develop relevant models to assess the risk of environmental degradation and to evaluate likely changes in the European landscape and their environmental impact. The CCM activity makes extensive use of both Geographic Information Systems and Earth Observation data to achieve these goals at the Pan-European scale. In 1999 the activity started with first tests to derive and characterise catchments from Digital Elevation Models with varying grid cell sizes. In July, the activity further held an expert meeting in order to discuss current scientific and operational needs in Europe. The meeting resulted in recommendations for the future work and the proposal of a network of catchments for detailed process studies. Following the recommendations, the activity has been organised in four main directions: (1) Catchment Mapping, (2) Catchment Characterisation, (3) Catchment Classification, and (4) Process Modelling. These tasks will be achieved in close contact with the European Environment Agency (EEA), EUROSTAT, and DG Environment and in collaboration with a network of experts.

The development of models integrating biophysical, social and economic factors is essential in order to assess the environmental impact of EU policies related to the rural environment. The work being carried out under this theme aims at contributing to the wide topic of integrated assessment and monitoring of the impact of EU policies on the rural environment. The tasks will consist in setting up an expert network for assisting in the development of methods and models for policy impact assessment at regional levels. Demonstration case studies will be used for the method development. Regional differences in the rural development could follow as an effect of Community policy and thereby lead to an increasing need for convergence in the spatial dimension of the common policies and derived actions. In this context, a study was launched in 1999 on the analysis of EU policies related to the rural environment and their requirement for a spatially integrated assessment. The results from this study will form the baseline for activities to be initiated next year, including an inter-regional study on the impact of policies on land use changes.

Contact: Pam Kennedy, Jürgen Vogt

The three main components of the EURO-LANDSCAPE project

Sub-project	Subject Matter
MOLAND Spatial Development	• Monitoring land use and land cover dynamics • Modelling past, present and future trends in European urban agglomerations and transport networks
ENVIP Protecting the Landscape	• Establishing environmental indicators for environmental protection • Updating spatial indicators integrating physical, ecological and socio-economic information at local to continental scales
RDE Monitoring Rural Development and the Environment	• Long term monitoring of policy impact on sustainable management of natural resources (soil, forest, land cover) • Catchment mapping and characterisation • Mapping of forest, grassland and natural vegetation in Europe.

Selected Further Reading

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Vogt, J.V., Viau, A.A., Beaudin, I., Niemeyer, S., and Somma, F. (1998) Drought Monitoring from Space Using Empirical Indices and Physical Indicators. Proc. Int. Symp. on Satellite-Based Observation: A Tool for the Study of the Mediterranean Basin, Tunis, Tunisia, 23-27 November.

Highlights

- 1-3 March 1999 – Workshop entitled "Drought and Drought Mitigation in Europe".
- April – CAMELEO workshop on Satellite Image Processing for Long-term Change Detection, Florence.
- June – IUFRO conference on Remote Sensing and Forest Monitoring, Rogow.
- September – Workshop on European Watershed Management, Ispra.
- September – International workshop on Applications of Remote Sensing to the Management of River Catchment Areas and their Coastal Margins in the Mediterranean and Black Sea, Ispra.
- October – Workshop on Criteria and Indicators for Sustainable Forest Management and Bio-diversity, University of Reading, UK.


http://www.me.sai.jrc.it/

Coastal Monitoring and Management

Project Co-ordinator:
Nicolas Hœpffner

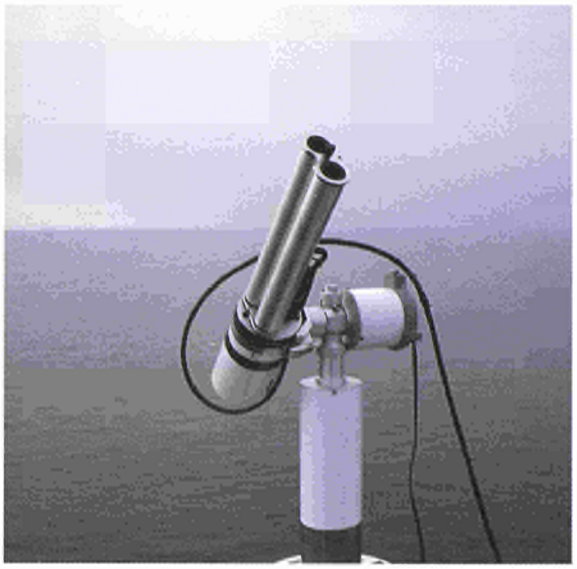
The need for an EU strategy on an integrated planning and management of the coastal zone has been identified as a priority issue by several communications of the Commission Directives and Programmes. This is in response to an increasing public concern about citizen's health, preservation of natural resources and biodiversity, as well as protection against natural disasters and/or anthropogenic damages along the shoreline. These Directives and Programmes, e.g. the Fifth EC Environmental Action programme, the implementation of Agenda 21 in the EC, the Demonstration programme on Integrated Management of the Coastal Zone (DG Environment) provide an excellent opportunity for the Marine Environment unit of SAI to support the Community Services through the provision of reliable and comparable data sets, statistics and indicators, and their subsequent integration into a sound scientific information at various geographical scales. Accordingly, the objective of the COAST project is to demonstrate an end-to-end utilisation of Earth observation data from satellite in an operational context for the management of the coastal zones in support to directives of the Commission on water quality policy and pollution control; and to decision-making processes regarding scientific understanding, deployment of infrastructure and sustainable management of the marine resources. The benefits of the project will emerge from focusing on a full system approach, an innovative enhancement of selected components, and pursuit of a long-term perspective. Key activities of the system are the establishment of a major database and exploitation programme for the assessment of algorithms and operational use of satellite imagery in coastal/shelf waters; a continuous identification and extraction of information relevant to oil spills and pollutant detection in marine waters; the provision of reliable, easy-to-integrate, spatial data on the state of the upper ocean for further applications in fisheries information system; a demonstration of an integrated coastal information system using data and data management tools currently available.

Coastal Monitoring and Management (COAST)

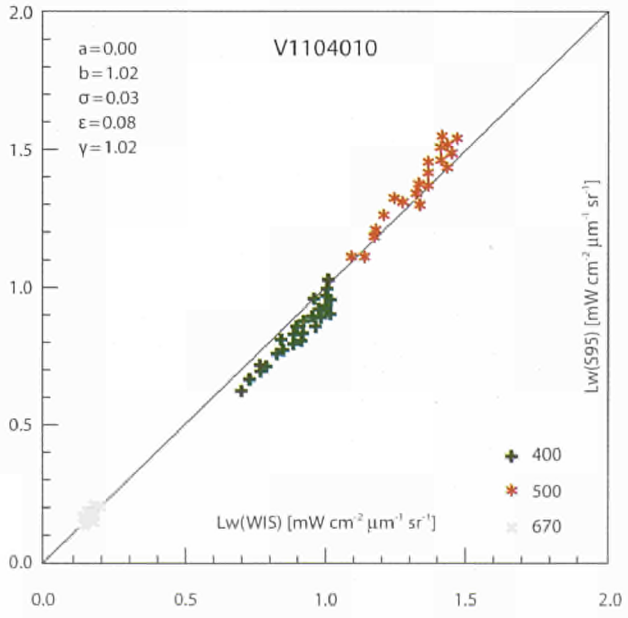
European Network for Coastal Water Monitoring and Bio-indicators

The validation of satellite derived products requires extensive field measurements. Because of this, networks of automatic instruments ensuring autonomous measurements at different sites, are now considered target systems supporting the operational use of Earth observation data. In the framework of the collaboration between SAI and NASA for supporting SeaWiFS calibration and validation activities, a new measurement concept has been developed for autonomous sun-irradiance, sky radiance and water leaving radiance measurements. A prototype measurement system (Permanent Radiometer System – PRS), based on the adaptation of an already existing instrument, has been developed and successfully tested in various field campaigns performed onboard the Acqua Alta Oceanographic Tower in the North Adriatic Sea. The measurement protocol has been implemented in order to collect sun-irradiance, sky radiance in the sun plane and in the almucantar, and the above water radiance at given viewing and azimuth angles with respect to the sun. The removal of sky glint effects in water leaving radiance, is ensured by sky radiance measurements taken at angles specular to those used to collect the above water radiance.

Contact: Giuseppe Zibordi



Permanent Radiometer System PRS – manufactured by CIMEL, Paris.



Intercomparison between subsurface up-welling radiances computed from in-water optical profile data collected with the WiSPER (Wire Stabilized Profiling Environmental Radiometer System) and the above water data collected with the PRS.

Operational Processing Tool for the Generation of Water Quality Parameters and Bio-optical Indices

The quantitative use of Earth observation data taken in the visible and near infrared over the sea requires the removal of the absorbing and scattering effects of the atmosphere. The methods applied for the atmospheric correction of remote sensing data can be in general divided into two groups based on the use of: approximate and numerical (exact) models for the simulation of the radiative transfer processes in the atmosphere and sea. In the retrieval of water quality parameters (i.e. pigments and detritus concentrations) from remote sensing data, the approximate methods are usually applied on a pixel-by-pixel basis, while the numerical methods, requiring a higher computational time, can only be used in forward simulations to generate extensive look-up-tables later applied into the atmospheric correction. An approximate method has been implemented to routinely process satellite data from SeaWiFS and MOS data. The code accuracy has been evaluated making use of a match-up data set (in situ data collected at the same time of the satellite imagery) and of the FEM (Bulgarelli et al. 1999) exact numerical code.

Bio-optical Indices

The analysis of a 3-year (1996-1998) time-series of atmospheric and marine measurements was completed for the northern Adriatic Sea site ("Acqua Alta" oceanographic tower). Quality control procedures have been developed and applied to the initial dataset. The analysis led to the assessment of the variability at different time scales of the optical properties and of the related main optical components of the water. Seasonal cycles can be well identified for most components, nevertheless in some occasions the daily variability can be of the same order as the annual variability. Empirical relationships between marine reflectance ratios and bio-geochemical indices of interest (concentrations of Chlorophyll a, Total Suspended Matter, dissolved organic matter) have been elaborated for the site. They explain from 80% (Chlorophyll a) to 60% (dissolved matter) of the variance of the concentrations. Their use as algorithms for satellite colour data interpretation in the northern Adriatic Sea is in the validation phase using the new in situ data collected during the year 1999. They are also being tested on a selection of SeaWiFS Adriatic scenes.

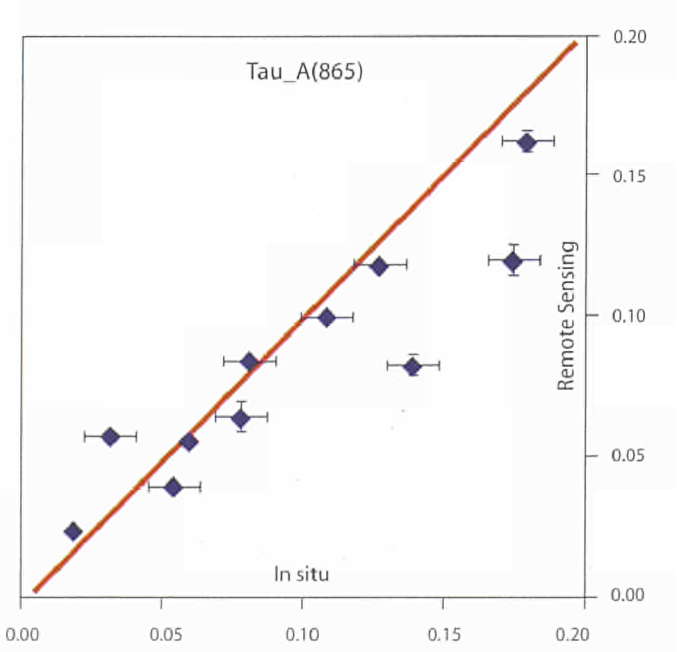
The possibility of inferring from marine reflectance another index of ecological importance, the occurrence of "mucilage" matter in the northern Adriatic Sea (thought to be related to the eutrophication of the basin), has also been investigated. Benefit was taken from a unique set of optical measurements performed on the tower during a mucilage event in Summer '97. When the mucilage is concentrated in vertically narrow subsurface layers, it can not be distinguished from non-mucilage situations. On the contrary when the mucilage is more homogeneously distributed throughout the water column and in particular approaching the surface, there is a detectable difference with respect to non-mucilage water (Berthon et al., 1999).

Contact: Jean-François Berthon, Giuseppe Zibordi

Oil Spills and Pollutant Detection in Marine Waters

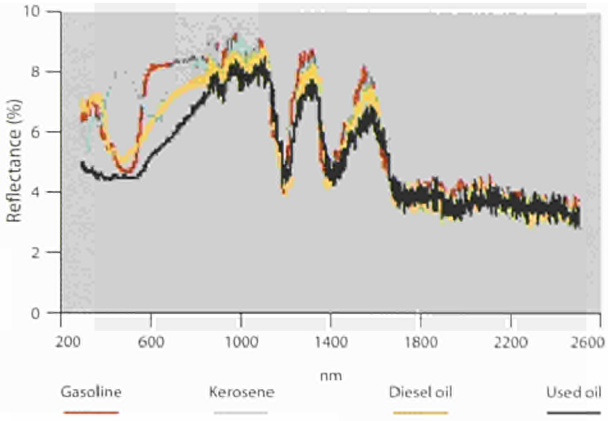
The European Goniometer (EGO) and the radiometry laboratory have been used in experiments to differentiate the spectral signatures of various pollutants in marine waters in the optical and infrared wavebands. A series of test measurements in the laboratory were performed to examine the feasibility of the methods employed. The first series of measurements were performed on four test samples of hydrocarbons using a high-resolution spectrophotometer in both reflectance and transmittance modes. Samples of crude oil have not yet been procured since this requires more time and information regarding suitable providers of crude oil samples. A second series of test measurements was performed in the EGO using a high resolution CCD camera to characterise the dispersion of the four test samples of hydrocarbons on a small reference surface of seawater. For this, it was necessary to modify the light source and to employ diffuse light to avoid specular reflectance. A third series of test measurements was then performed in the EGO using a thermal infrared imaging system. The dispersion of some hydrocarbon samples on water was measured in the thermal infrared range using this system at one angle of observation only. A fourth series of test measurements was performed using a spectroradiometer operating in the 400-1100 nm band on the same samples and at various angles of observation. A preliminary analysis of the test measurements made has been performed and a technical note on the results of the experiments is being produced. An analysis of eventual modifications and/or additions required to existing measurement facilities is also in progress. More research on the current situation with regard to the measurement of spectral signatures of marine pollutants in general will contribute to a better understanding of the phenomena involved.

Contact: Brian Hosgood, Giovanni Andreoli



Intercomparison between aerosol optical thickness obtained from in situ measurements and SeaWiFS imagery of the North Adriatic Sea.

Samples of gasoline, kerosene, diesel oil and used oil employed in the experiment.

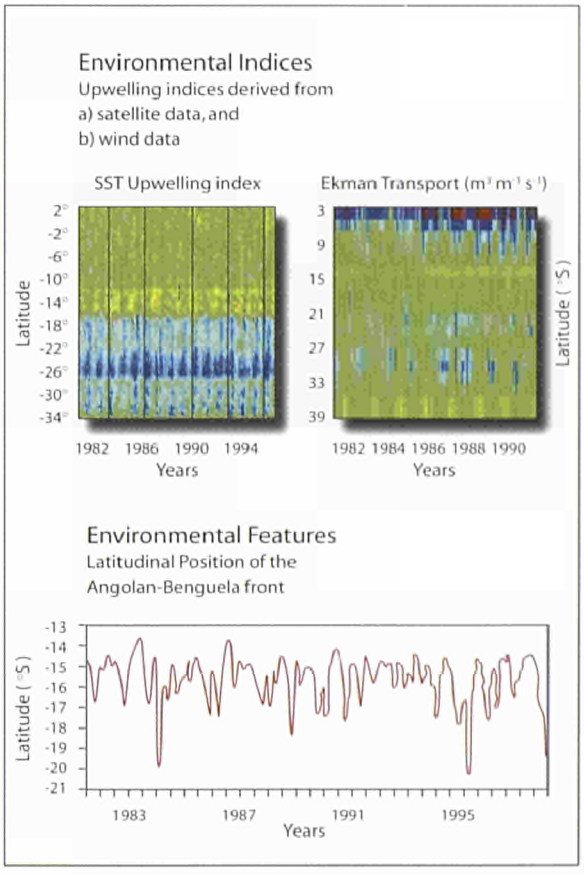


Reflectance measurements of hydrocarbons.

Coastal Fisheries and Aquaculture

The main goal is to supply and analyse environmental data including spatial data in support to the management of living marine resources, especially fisheries. To add to the previous AVHRR derived SST archived in the Unit by the project CORSA (Cloud and Ocean Remote Sensing around Africa), the years 1994 to 1997 were processed. An algorithm, developed in house, was established and used to process all satellite passes. The individual satellite passes, once processed onto level two products, were then combined into weekly and monthly sea surface temperature composite maps. The archive thus now covers the 1981-1997 period. The years 1998 and 1999 have now been acquired and it is envisaged the data will be processed next year. The Unit also augmented its environmental archive by acquiring meteorological data from The European Centre for Medium Range Weather Forecast (ECMWF). As a case study, environmental patterns and features have been derived from satellite imagery and are being analysed along the African West Coast. Environmental indices and features have to be resolved, in order to have comparable series, at the same time and spatial scales as the biological data available. Automatic procedures for the identification of oceanographic meso-scale features like surface thermal fronts, eddies position and displacements, thermal signatures, and indices, like upwelling indices, have been developed. Temporal appearances and persistence of all the above oceanographic features and indices have also been characterised.

Contact: Leo Nykjaer, Carlos Villacastin

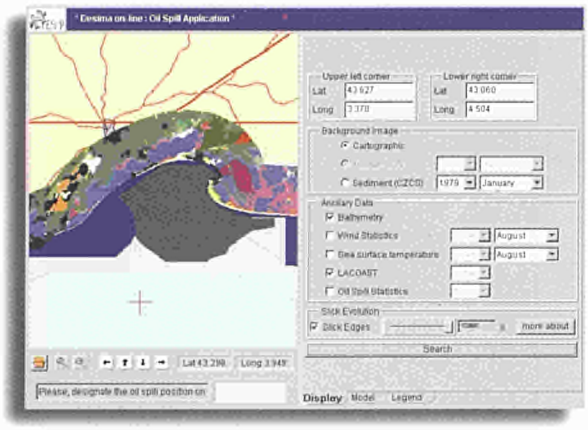


Oceanographic indices and features obtained from the analysis of environmental data.

Integrated Management of Coastal Areas

The objective is to prepare basic elements needed to design and implement a distributed information system for the support of coastal zone monitoring, assessment and management. The system should allow to access and use remote data repositories and remote processing leading to cost and time savings for the user. Developments are following the system architecture used in the DESIMA Project (started in the Fourth Framework Program and continued in COAST). A system demonstrator developed under contract by MATRA Systems & Information has been updated and verified for the two scenarios implemented.

One scenario is addressing oil spill. The system allows a first assessment of an oil spill event in the Golf de Lyon (Mediterranean Sea) using oil spill characteristics and meteorological data to predict the oil spill evolution at different times and to evaluate its impact on the coastal environment. LACOAST data and ocean colour data (CZCS) sets are accessible by the system for this scenario. The second scenario is dedicated to sea defence problems. The scenario is illustrating the interaction between data, process models and the identification of preferred management strategy for West Bay on the south coast of England. Using a series of predefined approaches, the sea defence problems at West Bay clearly demonstrates how the DESIMA methodology can be applied to support coastal managers. The demonstrator has been made accessible to potential users in the fields of coastal monitoring, assessment and management. A tutorial has been written and implemented to guide an inexperienced user through the two scenarios. Information on the developments can be found on the Internet Web site http://desima.jrc.it. Requests for a user-id and password to run the demonstrator should be sent to desima@jrc.it.



Example of Graphical User Interface (GUI) for the DESIMA oil spill scenario.

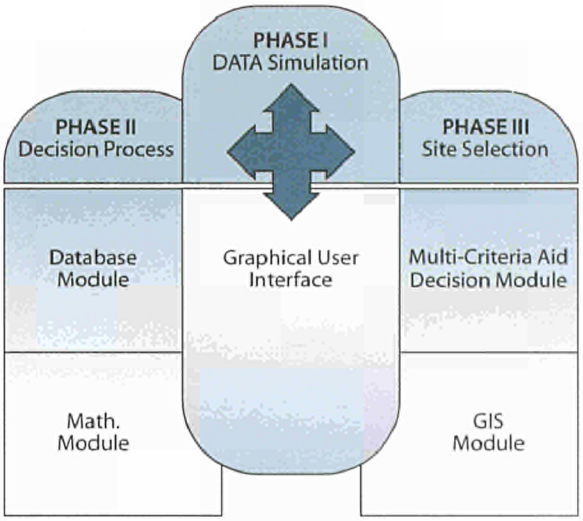
Contact: Wolfram Schrimpf, Ardy Siegert

Aquaculture Information System

From the results obtained by a Feasibility Study on Decision Support for Coastal Areas Management in Thailand and considering the activities to support developing countries (e.g. ACP countries), the ME Unit has used its expertise to design and develop a prototype of an Aquaculture Information System (AIS). The complexity of decision making for an aquaculture facility suggests the need for analytical tools that are able to integrate various components of the knowledge base required to arrive at a decision. Such tools, termed decision support systems, integrate knowledge in the form of quantitative mathematical algorithm models, rule-based (expert) systems, and/or databases into user-friendly software focused on developing, analysing and optimising management strategies. In this context a prototype version of a decision support system (AIS) has been designed and developed in order to provide decision makers and aquaculture managers with a computer based simulation tools to rapidly exploring the environmental and socio-economic impacts of aquaculture

by the use of simulation models; to evaluate the implications of management practices; to resolve conflicts (such as site selection conflicts) by the use of Multi-Criteria Analysis tools; and to use GIS tools and techniques to help the decision makers to explore and analyse the input and output data (to and from the AIS system). AIS is an analytical tool developed for generating information in support of strategic planning decisions for coastal aquaculture management. AIS comprises the following three modules which can be used separately: a Data Simulation module; a Decision Process module; and Site Selection module. AIS operates under Microsoft Windows environment and requires approximately 20 MB of available hard disk space and a minimum of 16 MB RAM.

Contact: Lyes Terfai, Wolfram Schrimpf



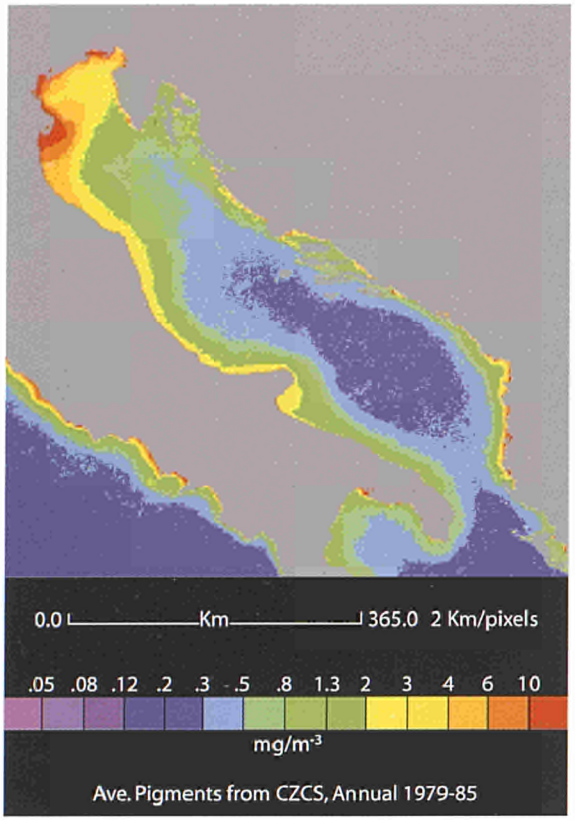
The concept of AIS System.

Phytoplankton Dynamics and Eutrophication in the Adriatic Sea

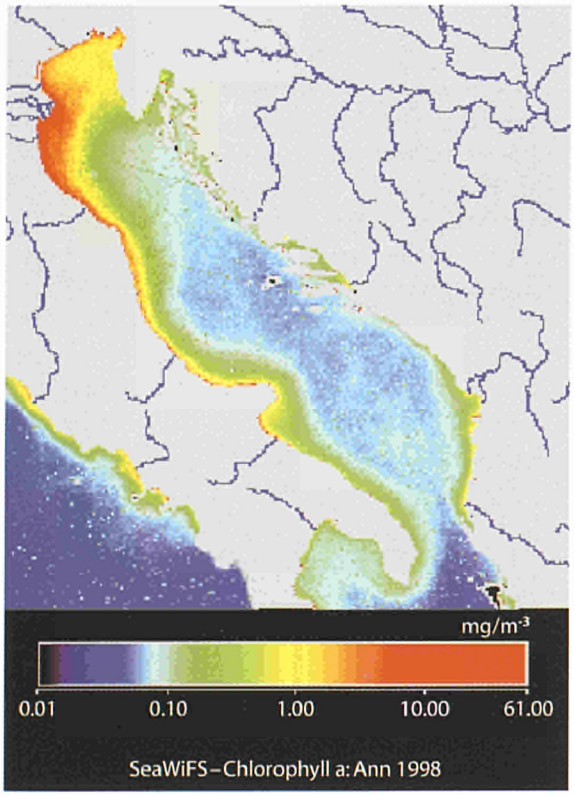
A statistical assessment of phytoplankton dynamics in the Adriatic Sea started, based on the integration of geographical and environmental data derived from remote sensing campaigns, using data sets collected by the Coastal Zone Colour Scanner (CZCS) in 1979-1985, and by the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) in 1998. The raw satellite data were processed to apply sensor calibration, correct for atmospheric contamination, and derive chlorophyll-like pigment concentration – later used as an index of phytoplankton abundance (Sturm et al., 1999). Individual images were generated for each available day, co-registered using the same geographic equal-area projection and resolution, and then averaged pixel by pixel, to compute monthly and annual composites. A GIS-like integration of the composite images was performed, so as to obtain geographically coherent data sets, remapped over a standard geographical grid, covering an area of 700 x 700 km^2, using an equal-area (Alber's) projection, and constant resolution, with a pixel size of 1 x 1 km^2.

A preliminary analysis of these data sets has shown that main geographical features appearing in the integrated imagery include near-coastal areas under the direct influence of major river plumes (e.g. that of the Po in the Northern Adriatic), or other intense coastal interactions such as minor river discharges and non-point sources of runoff, along both the Italian and Albanian coastlines. The high concentration of pigments (1.0 to 10.0 mg m^{-3}, and higher, on average) suggests that such areas are those where the potential to develop eutrophic phenomena is greatest, while the interior of the basin appears to have quasi-oceanic levels of phytoplankton (0.01 to 1.0 mg m^{-3}, on average). The comparison of and current data (SeaWiFS) with the historical record (CZCS) confirms that the observed patterns appear to be regular features of the region. The results obtained so far point to coastal zones as critical areas where key processes occur, capable of influencing the ecological dynamics of the entire basin. Future developments in the analysis of the same data sets (augmented by new SeaWiFS imagery currently being processed) include the compilation of monthly averaged values of pigment concentration, in order to evaluate trends in the time domain.

Contact: Vittorio Barale, Wolfram Schrimpf



Mean chlorophyll-like pigment concentration [mg m^{-3}] in the Adriatic Sea, derived from (above) the CZCS 1979-1985 data set and (below) the SeaWiFS 1998 data set.



Selected Further Reading

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Schrimpf, W., Iovanovitch, P., and Schlittenhardt, P. (1999) DESIMA. Ports of Europe 1999. McMillan-Scott Plc Publishers.

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Schrimpf, W., and Siegert, A. (1999) More Efficient Coastal Zone Management through Application of Distributed Information Systems (DESIMA Project). Proceedings of the National Forum on Support of Remote Sensing to Planning and Decision Making Processes for Sustainable Development, Malta, 6 July 1999.

Barale, V., Larkin, D., Fusco, L., Melinotte, J.-M., and Pitella, G. (1999) OCEAN Project: the European Archive of CZCS Historical data. Int. J. Remote Sens. 20:1201-1218.

http://www.me.sai.jrc.it/

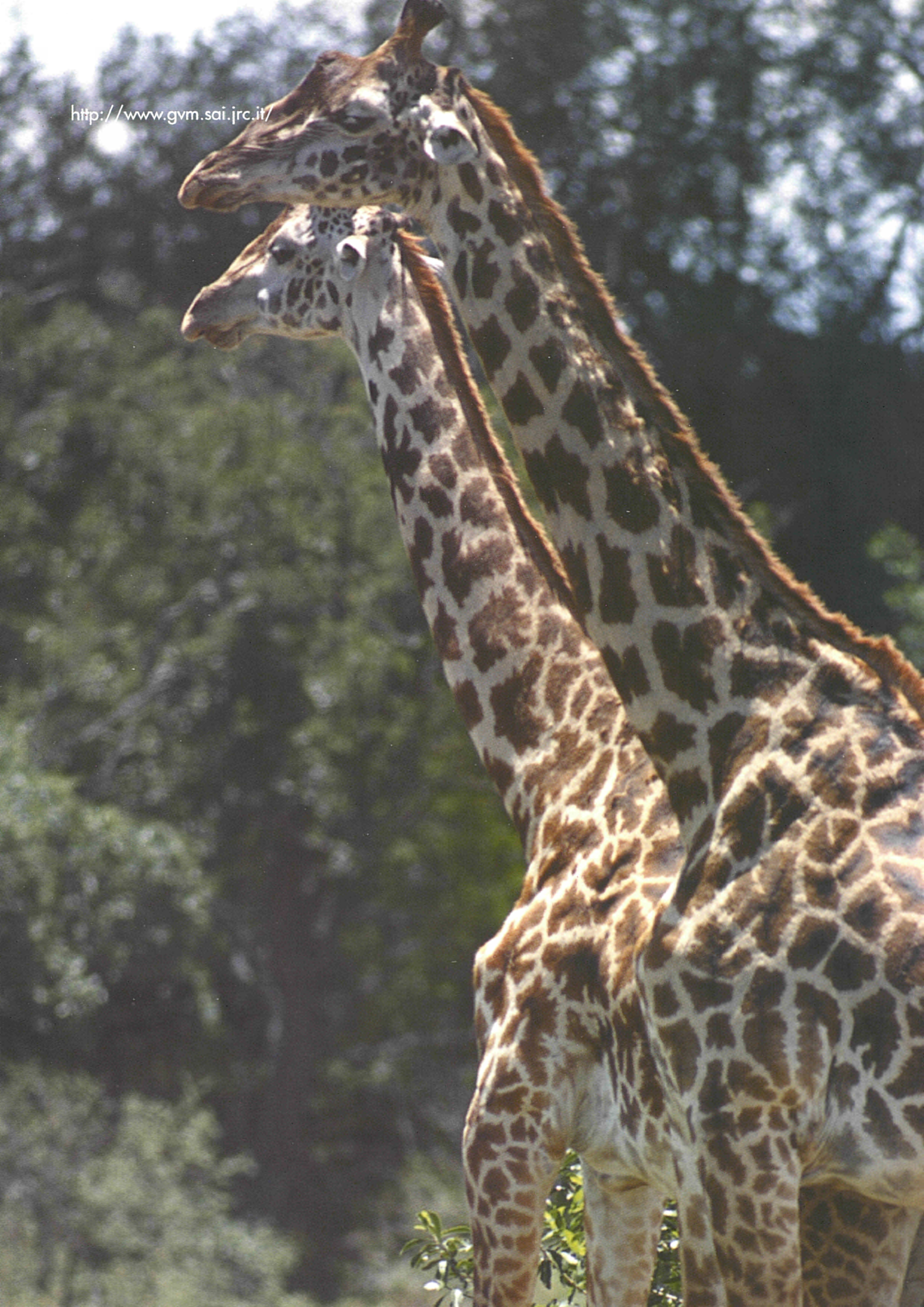
http://www.desima.jrc.it/

Highlights

- Satellite Observing Techniques as an Additional Research and Assessment Tool for Marine Inter-Regional Conventions, Workshop. Ispra, 18 January 1999.
- Programma Pilota ICM, Sisyema Informativo Distribuito per Il Mare Adriatica, Workshop. Ispra, 15 March 1999.
- Case 2 Water Workshop: Ocean Colour Algorithm in Turbid Waters. Ispra, 14-18 June 1999, in the frame of IOCCG (International Ocean Colour Coordinating Group).
- HELCOM Meeting of Working Group of Monitoring and Assessment (EC/MON), Gothenburg, Sweden, 21 April 1999.
- Working Group "Coastal and Sea Space Development". Maritime Industries Forum Panel. Brussels (DG III), 19 March and 18 May 1999.

Information Dissemination

- DESIMA Demonstrator accessible via Internet.


http://www.gvm.sai.jrc.it/

Global Environmental Information Systems

Project Co-ordinator:
Jean-Marie Grégoire

EC Services have a growing demand for global environmental information, notably concerning the state of the world's forest and marine resources. Collectively these services call for global-scale monitoring of change in the world's vegetation and marine production to support policy formulation and to assess policy impact, in the framework of existing international conventions (Framework Convention on Climate Change, Convention to Combat Desertification, Convention on Biological Diversity) and of conventions under preparation (International Forest Convention). The importance of the global perspective gained new significance in December 1997 when the EU signed the Kyoto Protocol to the UN framework convention on climate change. Spaceborne systems provide a reliable, consistent and timely means of obtaining such information. The Global Environmental Information Systems project (GEIS) was launched to satisfy these worldwide environmental information requirements focusing on three actions, namely the development of methods to reduce uncertainties in inventory, mapping and monitoring of global land cover types, especially forest resources; the development and testing of methods to identify significant events heralding land cover change, such as fires and short term climatic variations, and determine their impact; and the development and testing of methods to identify oceanic sinks and reservoirs of greenhouse gases.

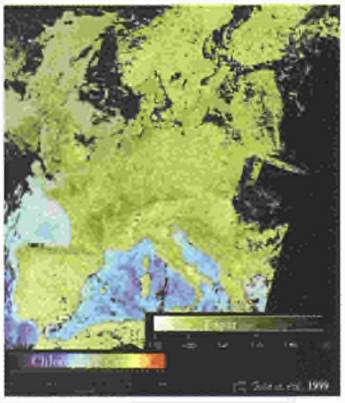
The GEIS project activities during the Fifth Framework Programme cover four major aspects of the global environmental issue. The first concerns the state and evolution of the global vegetation cover. This project is analysing 16 years of global Earth observation data (from 1982 to 1998) at medium to coarse resolution to determine broad changes in vegetation cover and seasonality, and changes in global fire activity. This will provide global context for the Kyoto reference year of 1990 and show the impact of short-term climatic variations such as El Niño/La Niña. The second issue is related to current global forest resources. Methods are being developed for inventory, mapping and monitoring of global forest resources. Refining methods previously developed in tropical ecosystems, adapting these to other ecosystems, provide quantitative information on current global forest resources. Particular emphasis is given to the boreal ecosystems. Deforestation risk models will be developed to predict changes. A third issue relates to the disturbances, due to fire, to the state of the vegetation cover. The project is developing detection procedures to identify significant events, such as forest fires, which are indicators of land use change and are sources of greenhouse gases. The World Fire Web (WFW) network, initiated in FP-IV, is being refined and extended to provide maps of global fire activity. Another significant issue examined is the ocean primary production. On the basis of multi-annual patterns of ocean colour and sea surface temperature, derived from EO, specific algorithms are developed to improve estimates of marine productivity. This will be significant in terms of understanding the carbon cycle and in support of sustainable fishing practices.

Global Environmental Information Systems (GEIS)

Geophysical Products from Optical Sensors

The production and delivery of pre-operational geophysical products, derived from Earth observation data, is a key component of the GEIS project applied research. The METEOSAT albedo project has evolved considerably in 1999. The final operational modules to compute the radiative properties of the land surface and the overlying atmosphere on the basis of half-hourly METEOSAT data have been delivered to EUMETSAT and integrated into their reprocessing environment. As a full-scale case study, EUMETSAT reanalysed the entire year 1996, and generated both the scheduled standard products. A detailed analysis of these files is underway. It is expected that once we have evaluated the standard products internally, they will be made available to a limited number of so-called "beta-testers", scientists and organisations who will be asked to evaluate the usefulness of these products for their own purposes. These include major weather and operational centres in Europe, as well as scientists involved in climate and global change research. Then the products will be made generally available to all users, as part of the set of products and services provided by EUMETSAT.

A vegetation index, optimised to estimate the Fraction of Absorbed Photosynthetically Active Radiation (FAPAR) on the basis of SeaWiFS data, has been designed and evaluated. Specifically, the software code to compute the index has been delivered to the Marine Environment unit of SAI, and implemented in their processing environment. The ME unit has been able to use these codes to generate a 10-day composite map of Western Europe of FAPAR from a set of daily images at full resolution. It is envisaged that this collaboration may lead in the future to the generation of global products (both over the oceans and the continents) of information critical to assess the primary production of the biosphere.



Estimation of the Fraction of Absorbed Photosynthetically Active Radiation (FAPAR), a major measurable biophysical quantity which controls the primary productivity of the biosphere (and thus also of agriculture), for the Western European sub-continent, derived from SeaWiFS data for 21-30 Sep-1997.

In the framework of the ENAMORS project, two major conferences have been organised: the Second International Workshop on Multi-angular Measurements and Models (IWMMM-2) was held in Ispra, September 15 to 17, and assembled over 100 participants from all over the world. The International Workshop on Satellite Remote Sensing and Climate Simulations: Synergies and Limitations took place in Les Diablerets, Switzerland, on 20-24 September. This meeting focused on the exploitation of remote sensing data in weather and climate applications.

Contact: Michel Verstraete, Bernard Pinty, Nadine Gobron

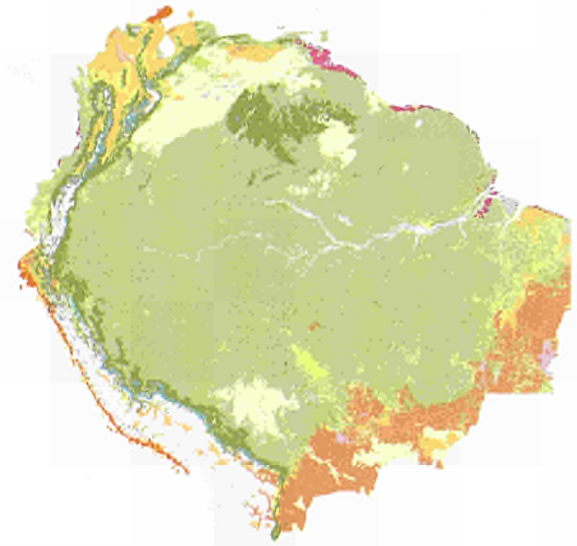
Tropical Forest Mapping and Monitoring

Activities reported here have been executed in the framework of the TREES-II competitive project funded by DG Environment. The TREES II project continued the development of a prototype information system for monitoring tropical forests at a pan-tropical scale. The work is being specifically tuned to the needs of the Global Environment unit of DG Environment though the concept is progressively being adapted to meet the growing forest related information needs of other Directorates General. For example during this execution period particular effort was made with respect to DG Development funded ECOFAC regional project in Central Africa. During 1999 the project analysed over two thousand scenes acquired from the ATSR sensor on ESA's ERS-2 satellite. The initial evaluation of these data show encouraging results for the updating of existing vegetation maps, for identifying active deforestation areas and for modelling of deforestation risks. The interface between fire and vegetation cover maps has provided unique views on the coincident distribution of those ecosystems characteristic, in particular in Southern Brazil and Indonesia.

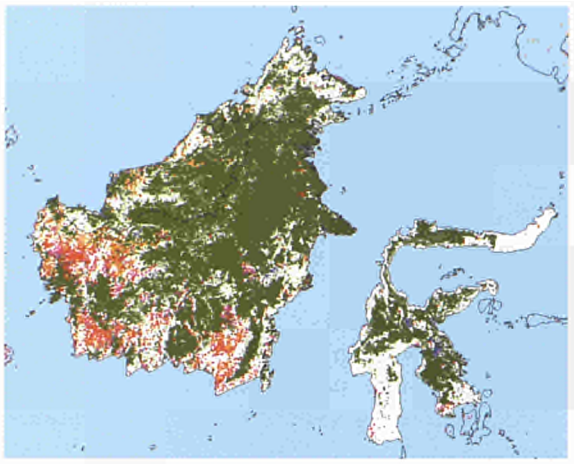
However the measurement of forest area change in the tropics during the 1992-1997 period calls for the use of much higher resolution data sets: the so-called "high-resolution satellite data exercise". Using a statistically conditioned sample of 95 sites, around 300 high-resolution images from the Landsat and SPOT satellites were acquired during the course of the last two years. A large number of local partners in South America, Africa and Southeast Asia (26 in total) have been selected for the detailed interpretation of the high resolution images in order to benefit from local field knowledge and forestry expertise. Copies of the high-resolution images were distributed to them and analysis work is progressing well. Most of the results should be made available to the JRC in early 2000. A new multi-sensor approach has been successfully initiated. Mosaics of L-band radar

data has been tested for forest change detection in lowland tropical forests of Brazil. The project continued to release new tropical forest maps. After the publication of the continental vegetation map of Central Africa in 1998 the continental vegetation map of South America at 1:5,000,000 scale was published in 1999. Regional maps of tropical forests have been elaborated (Madagascar and Kalimantan) using recent satellite imagery (SPOT-Vegetation and ERS-ATSR of 1998 and 1999). As well as up-to-date maps, the TREES project provides access to the information in digital form via a bespoke GIS, the Tropical Forest Information System (TFIS). TFIS allows users to analyse the tropical forest maps in conjunction with other spatial data sets such as elevation, and non-spatial data. A dedicated TFIS has been installed for the Central African ECOFAC project. As in previous years, the project supported an on-site TFIS within DG Environment in Brussels. A strategy is being developed to provide an interface available to a wider number of partners. The TFIS manager is closely involved in the International Consultation on Research and Information Systems in Forestry (ICRIS) and is contributing to an international effort on the Global Forest Information Service (GFIS).

Contact: Frédéric Achard (Co-ordinator), Hugh Eva (S. America), Philippe Mayaux (Africa), Hans-Jürgen Stibig (SE Asia), Tim Richards (TFIS), Pascale Janvier (Cartographic products)



Vegetation map of Tropical South America at 1:5,000,000.



TREES forest cover of Borneo and Sulawesi classified from ERS-ATSR images of 1998 and WFW active fires in summer 1999 (World Fire Web): forest (dark green), non-forest (beige), lakes (dark blue), sea (light blue), clouds/no data (white), fires 22-31 July (orange), fires 1-13 August (red), fires 14-31 August (red-violet).

Mapping Boreal Ecosystems of Siberia

The activities planned for mapping boreal ecosystems over Siberia started. Collaboration started with the International Forest Institute, Moscow, and Russia. A strategy to map vegetation and to monitor forest fires at continental scale in Siberia has been put in place using a combination of SPOT-VEGETATION and NOAA-AVHRR data.

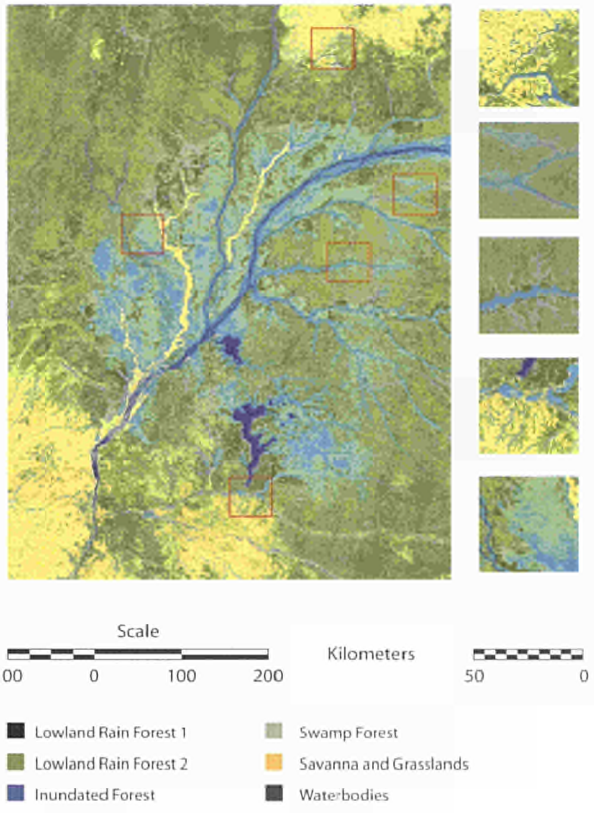
Contact: Frédéric Achard

Mapping Swamp and Lowland Rainforest for Africa

This activity was part of the Global Rain Forest Mapping project (GRFM), an international collaborative effort initiated and managed by the National Space Development Agency of Japan NASDA. Main goal of the project is to produce a high-resolution wall-to-wall map of the entire tropical rain forest domain in four continents using the L-band SAR on board the JERS-1 spacecraft. The SAI GVM unit is principal investigator and main processing node for part of the project related to Central, West Africa and Madagascar. During 1999 the project entered a second phase where the focus was on geophysical parameters retrieval and in general on automatic thematic information extraction to supplement information to the TREES vegetation databases on the Africa tropical ecosystems, especially related to biomes like the swamp forests in the Congo floodplain, that are so far not well documented at continental scale. In this direction the first attempts using simple supervised classification techniques have produced very promising results. A thematic map of the swamp and lowland rain forest in the entire Congo River basin at 200-m pixel size was produced. Validation of the classification accuracy was carried out using local area ground data and high-resolution optical remote sensing data. Stability of the classification was checked by correlating the high resolution radar map with coarse resolution but large scale classification products (generated by historical ground surveys and global remote sensing data sets, e.g. in our case the UNESCO/AETFAT/UNSO Vegetation Map of Africa and the Phytogeographical map of Congo).

The GRFM Africa data set represents a milestone in wide area radar mapping of the Earth ecosys-tems. However at this stage it is a foundation whose value will be fully exploited only if the science community at large will build over it geo science applications for providing adequate information on local and global environmental issues to the policy and decision makers. In this perspective the availability of the GRFM present and future products, will be a key asset. In response to these requirements, a CD-ROM set with the GRFM Africa baseline products was com-piled by SAI GVM and is already available for distribution to interested parties.

Contact: Gianfranco De Grandi



Classification map of the entire Congo River floodplain, derived from L-band radar imagery provided by the JERS-1 spacecraft. The map was generated from the GRFM Africa high water data set at 200-m pixel size using a maximum likelihood classifier and by stratification with the TREES project GIS data.

Land Cover Mapping at Global Level

This action responds to a range of needs including production of per-country statistics for international conventions (climate change, desertification), the characterisation and monitoring of inter-annual changes. The emphasis has been put in 1999 on two aspects: an improved access to the imagery provided by the VEGETATION instrument onboard the SPOT-4 satellite, and a range of preparatory actions for the global mapping of land cover from the same Earth observation system. As a partner of the VEGETATION programme, the GVM unit was given the responsibility, together with the ARIS unit; to develop a PC-based software package ("SPACE-VEGETATION") to be used by local receiving stations for the pre-processing of VEGETATION data. The software was delivered to GVM by mid-October. The package will be ready for distribution in the first weeks of 2000. This will allow users who have specific requests or constraints that do not allow them to acquire the standard products directly from the global archive in the central processing facility to operate their own receiving system locally. Still in the field of an improved access to VEGETATION data, a series of automated telecommunication procedures have been tested to facilitate data delivery to these partners for which data delivery speed is critical for their applications. This activity is done in connection with DG Development, and together with operational partners such as FAO (Rome, Asmara, harare), IRSA (Beijing), the AGRHYMET centre (Niamey), or the Met. Office in Ouagadougou, the operations have started as soon as data became available.

The activity on land cover mapping started in the second semester of 1999, when sufficient data had been acquired. In a first stage the data quality was assessed on a series of different environments, and synthetic images, representative of main seasonal situations, were built. Classification tests were then carried out on specific features such as forests or water and humid biotopes. Tests were started to combine spatial information on land cover types and their temporal behaviour, both in a perspective of real time monitoring and early warning, and for a better description of the seasonal behaviour of these units. A dedicated tool, called Cellular automates for change detection, has been developed to measure inter-annual changes from remote sensing time series. These changes are expressed not only in terms of changes in the amplitude and the shift of the seasonal growing cycle, but also in terms of vegetation or land cover change. A first test has been carried out on two year of AVHRR GAC data: 1984 and 1990, which is the reference year for the Kyoto protocol. Although the system was able to detect changes between these years, further work needs to be carried out to validate them with ground reference material.

Contact: Etienne Bartholomé

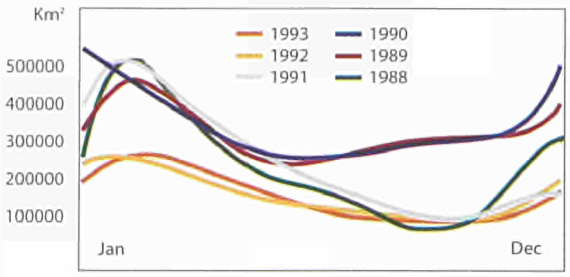
Global Scale Monitoring of Vegetation Fires

Activities have focused on two major aspects: the assessment of burnt areas and the near-real-time monitoring of fire occurrence, for the provision of quantitative information relevant to the carbon budget and to the emissions of greenhouse gases issues. A global assessment of burnt areas at very coarse resolution (8 km) has been completed for the 6-year period from 1988 to 1993. The broad changes in overall burning activity and in seasonality have been determined and analysed in comparison to the burning activity observed in 1990, which is the reference year of the Kyoto Protocol to the United Nations Convention on Climate Change. The analysis, which shows clearly the inter-annual changes of burning activity at global level, provides a spatial and temporal context for the Kyoto reference year and provides highly relevant information for the assessment of greenhouse gases emissions and of the carbon budget.

It also relates the intensity of fire activity to climatic events as "El Niño Southern Oscillations" (ENSO). Seven more years (1981 to 1987) are currently being analysed, to complete this trend analysis.

An important experimental campaign has been performed in Australia, in collaboration with the CSIRO Earth observation Centre, and with European Partners (Lisbon University, CNES, and ESA-ESRIN), to support the development of tools for burnt area detection and mapping based on the SPOT-VEGETATION and ERS-ATSR systems. The importance and success of this collaboration has been noted by the EC Delegation to Australia and New Zealand (Canberra), which reported it in the June/July 1999 issue of the European Union News. The activity dealing with the real-time monitoring of fire occurrence at global level has been further developed in the framework of the World-Fire-Web network (launched in 1998). Three new regional nodes have been successfully implemented in Dakar/Senegal, Bangkok/Thailand and Caracas/Venezuela. Moreover, technical tests have been done to prepare the implementation, at the end of 1999 and beginning of 2000, of six additional nodes: Argentina, Canada, Central African Republic, Botswana, Western Russia and Siberia. Global coverage by the network will be achieved by the end of 2000. The first operational version of the software, which has been under test at the European node (JRC-Ispra) since January 1999, is now available. A set of algorithms are being tested to develop a prototype burnt area module, which should be ready for implementation in the World-Fire-Web system during the first half of 2000; it will complement the existing module dedicated to the detection of fire occurrence.

A web front-end to the fire product database has been implemented. It provides users with an easy to use web-browser type interface to the fire maps, which are now accessible on-line at http://www.gvm.sai.jrc.it/projects/fire/home.html. The World Fire Web network has been reported on the CNN web site on 27 September 1999, as being an important activity co-ordinated by the "European Commission Global Vegetation Monitoring Unit to assess fire's role in global warming": http://www.cnn.com/NATURE/9909/27/global.fire.enn/.



Seasonal distribution of burnt areas, at global level, for the 1988-1993 period: daily global NOAA-AVHRR-GAC imagery at 8 km resolution have been processed to burnt areas to analyse the inter-annual changes in burning activity, before and after the year 1990 (Reference year for the Kyoto Protocol to the Convention on Climate Change). Quite large inter-annual differences are observed, in terms of burning activity: while 1989 shows a dynamics very similar to the one of 1990, the other 4 years deviate significantly from the 1990 situation.

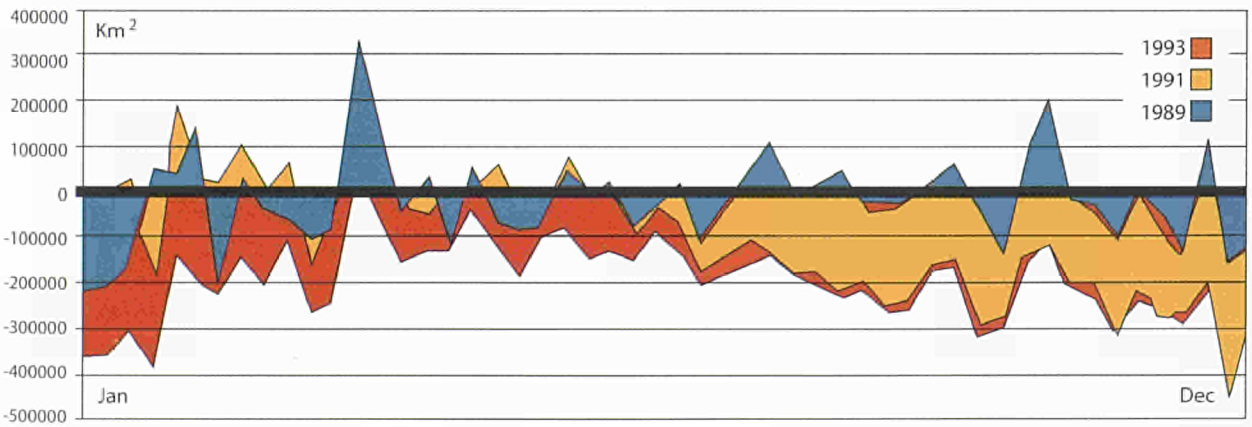
The feasibility study for mapping burnt areas at high resolution using the FUEGO system has been initiated, using airborne data over the Mediterranean region.

Contact: Jean-Marie Grégoire (co-ordinator), Simon Pinnock (World Fire Web network), César Carmona-Moreno (Historical analysis, FUEGO)

Global Monitoring of Marine Resources

The Global Monitoring of Marine Resources activity (GOMOR) aims at improving our understanding of the role of the ocean in a global environmental system. Research includes three key objectives. First of all the provision of seasonal global maps of marine environmental parameters with focus on Net Primary Production to be used for applications such as global change and fisheries. A further objective aims at assessing innovative tools/algorithms in their potential to supply additional information on potential missing sinks of organic and inorganic carbon in the marine biosphere (with particular attention being place on the global coastal zones). The GOMOR will also address the methodologies to implement the assimilation of the derived satellite products in models to ultimately assess the fluxes of carbon in the ocean and at the interface with land and atmosphere.

A core element in the GOMOR activity is the calculation of primary production in order to constitute a global inter-annual archive. The approach adopted so far for the operational processing has been to use an existing peer reviewed algorithm, known as the B&F algorithm, to compute global primary production. The implementation of this algorithm using publicly available satellite dataset has constituted a fundamental part of the un-



Deviation, from the 1990 situation (Kyoto reference year), of the area burnt globally in 1989, 1991 and 1993, as derived from NOAA-AVHRR-GAC time series at 8 km resolution. Burning activity in 1993 is systematically lower than in 1990. The situation in 1991 deviates from the 1990 reference during the second half of the year, which indicates a lower burning activity in the Southern Hemisphere; while 1989 slows minor deviations from 1990.

dertaken work in this first year of the activity. Marine Primary Production in general can be considered as in the case of the B&F algorithm (PP=f(CHL, PAR, SST)). Where CHL represented chlorophyll "a" concentration and acts as a proxy for the concentration of photosynthetically active biomass. PAR is the calculated Photosynthetically Active Radiation impinging on the sea surface and SST is the proxy identified by different authors in describing the spatial variability of parameters related to the quantum yield of photosynthesis. The parameterisation of such a relationship using available satellite products has been accomplished as follows. The concen-tration of chlorophyll "a" has been taken from the monthly-binned products from the SeaWiFS sensor (in orbit since September 1997). PAR has been calculated using a clear sky irradiance model corrected for clouds and parameterised using freely available meteorological products on the Internet (the implementation of the model has been undertaken at the JRC). Finally the dataset used for SST is the MCSST dataset publicly available from the Jet Propulsion Laboratory (NASA). The first results, obtained for the month of July 1998, are quite promising. The global variability of primary production is shown to be representative in the range of acceptable values for different geographic regions.

The archive of monthly products derived from the data on global primary production from the beginning of the SeaWiFS sensors lifetime (contemporary dataset) will be compared to a climatology of global primary production calculated using the same algorithm with data from average over the period of the CZCS sensor (1979-1986). This climatology may be considered as a baseline to which the contemporary archive may be compared and will be important when evaluating possible decadal change in carbon sinks and sources at global scale.

Ongoing work includes attempts to validate the derived products as well as to improve the adopted algorithms in areas known to be critical in estimates of global carbon estimates. Specifically attention will be placed on more accurately determining primary production in the global coastal zone where it is known that present estimates may be wrong by a factor of two or more. Also ongoing work will consider the development of combined global biosphere products, combining both land and sea. This type of study is now possible as present ocean colour sensors have both the sensitivity and the dynamic range to consider both of these environments objectively.

A further activity in the GOMOR contribution is in EO data assimilation and Marine processes modelling. The methodologies used are based on minimising the misfit between satellite data and mathematical ocean models forced by real meteorology to provide the best simulations in agreement with satellite observation. A sophisticated tool was developed for sea surface temperatures forecasting in upwelling areas, and elaborated to produce high level information by assimilation of remote sensed data in ocean circulation models. Remote sensed sea surface temperatures are assimilated on a large-scale basin covering the North Atlantic Ocean to produce a continuous – in time and space – realistic surface and subsurface simulations of the oceanic physical parameters.

The Ispramix ocean model used for satellite data assimilation was coupled to a three-component biological model. Assimilation tools for biological observation were developed and first experiments are made assimilating Chlorophyll observation derived from SeaWiFS data. The combined bio-physical assimilation is an innovative and appropriate way to better conduct global change studies (map globally parameters for primary production and for marine carbon cycle investigation), and to derive the relevant parameters for coastal zones studies (bio-indicators, biological activity, physical parameters for sediment transport, etc.).

Contact: Mark Dowell, Mohamed Ouberdous

Selected Further Reading

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Global Scale Monitoring of Vegetation Fires	http://www.gvm.sai.jrc.it/projects/fire/home.html
WFW Reported on CNN (27 Sep 1999)	http://www.cnn.com/NATURE/9909/27/global.fire.enn/
Geophysical Products from Optical Sensors	http://www.enamors.org/
Tropical Forest Mapping and Monitoring	http://www.trees.gvm.sai.jrc.it/
Land Cover Mapping	http://www.gvm.sai.jrc.it/projects/LC/home.html
Global Monitoring of Marine Resources	http://www.me.sai.jrc.it/

Highlights

- Second International Workshop on Multiangular Measurements and Models (IWMMM-2). JRC/SAI, Ispra, Italy, 15-17 September 1999.
- The "Forest Fire Monitoring and Mapping" Workshop for the Global Observation of Forest Cover (GOFC) Project. JRC/SAI, Ispra, Italy, 3-5 November 1999.

Press

- **WFW on CNN.** The World Fire Web network was reported on the CNN web site on 27 Sep 1999, as being an important activity coordinated by the "European Commission Global Vegetation Monitoring Unit to assess fire's role in global warming".
- **GVM CSIRO on EU News.** The success of the joint GVM CSIRO scientific collaboration on monitoring biomass burning was reported in the June/July 1999 issue of the European Union News, edited by the European Commission Delegation to Australia and New Zealand.

Information Dissemination

- **27** articles in refereed journals and books; **2** publications of the European Commission; **15** articles in conference proceedings.
- Tropical Forest Information System (TFIS); World Fire Web Information System (WFW).
- **DG External Relations:** Participation to the EU-ASEAN meeting in Bangkok in May 1999: ongoing and potential regional co-operation between the EU and the ASEAN.
- **DG Development:** Installation of the Tropical Information System (TFIS) in 2 sites of the DG Development funded ECOFAC project (Gabon); A proposal has been submitted and accepted by DG Development for geographical data archiving and analysis.
- **DG Environment:** Final report of the 3rd year and interim report of the 4th year of the administrative arrangement between DG Environment and DG JRC, sent in March and September 1999; Interservice meetings: participation to the "forest interservice meeting".
- **CD-ROM:** "The JERS Central Africa radar mosaics at 100 m resolution"; "Les feux de végétation dans le monde".
- "The Vegetation Map of South America, Scale 1/5M".
- "The Vegetation Map of Africa, Scale 1/5M".

Air Quality Monitoring Using Space Techniques

Project Co-ordinator:
Jean Verdebout

This research project aims at evaluating, testing, demonstrating and improving the emerging capabilities of Earth observation from space to provide information on air quality in support to the EU policies in this domain, in particular those stemming from the new air quality framework directive (96/62/EC). For the first time, the new generation of environmental satellites will allow to probe the composition of the lower atmosphere. First results have been obtained for nitrogen dioxide and sulphur dioxide. Sophisticated retrieval methods to estimate near surface ozone concentrations are being devised using data assimilation techniques in atmospheric models and the temperature dependence of the ozone optical absorption. Standard aerosol products are also under development, which will include information on the aerosol type and vertical distribution, allowing in principle the identification of particulate matter (PM). With respect to these external developments, the project assesses the applicability of the results for supporting air quality policies. For this purpose, it will organise demonstrations and comparisons with ground measurements and modelling results. For PM detection and quantification, it also intends to adapt the techniques and products to better meet the specific requirements stemming from the preparation and implementation of the European legislation. Apart from direct detection of atmospheric pollution, space Earth observation can also provide input data to air pollution models. The project will develop space-derived information on the radiation (actinic flux) as an input to photochemical models.

Air Quality Monitoring Using Space Techniques

Particulate Matter

With regard to Particulate Matter (PM), the first action was to comprehensively assess the capabilities of space sensors to quantify and characterise the atmospheric aerosols. The work was undertaken with the Université du Littoral-Côte d'Opale and the Freie Universität Berlin. Firstly the study identifies, through documents published by the European Commission, the applications that could potentially benefit from an evaluation of the aerosol load from space. The most obvious would be the support to the implementation of the European air quality directives, which define concentrations of PM10 (particles with a diameter less than 10 µm), not to be exceeded in the Union. The directives also recognise modelling as an indispensable tool for assessing the air quality for regulatory purposes. In this regard, space remote sensing of aerosols can play an indirect role by providing additional or better input data. In addition, the study briefly describes the main aerosol optical parameters that are used in the interpretation of space remote sensing data. The basic principles of aerosol remote sensing over land are then introduced. The difficulties of the task are outlined, mainly the high contribution of the ground in the signal observed by the sensor above land. In fact, most of the aerosol remote sensing techniques now available consist in reducing, as strongly as possible, the ground contribution.

The main body of the study is an extensive review of the space missions from which an aerosol product is actually or potentially available. They are classified according to the spectral, directional and polarisation measurement capabilities of the sensor. Some alternative techniques are also presented, such as the use of the backscattered UV radiation by TOMS or the use of the blurring effect of aerosol on image acquired with high spatial resolution sensors. The performance of the algorithms in terms of nature of the retrieved information, accuracy, applicability are reported as found in the literature. The conclusion of this review is that the most robust parameter retrieved is the aerosol optical thickness and that more detailed information may be obtained only with some assumptions or a priori knowledge from climatological or ground truth measurements.

In order to better illustrate the difficulties to fulfil the requirements associated with PM quantification, an error analysis is conducted based on the MERIS instrument which will be launched onboard ENVISAT in 2000. The MERIS sensor was chosen for this analysis because it is representative of a whole class of optical sensors. This study concludes that the fine particles density and, to a lesser extent UV ground fluxes, are poorly characterised from the remotely sensed data alone. This is not astonishing since, for the most part, past and present missions have been dedicated to surface studies. The review is complemented by examples of typical projects involving EO data, ground measurements and modelling. They represent the trend in the approach of local and regional studies concerning atmospheric particles and more generally air quality. This study (Characterisation of Aerosols over Land with Space Sensors) and its accompanying bibliography are publicly available on INFEO (http://infeo.ceo.org).

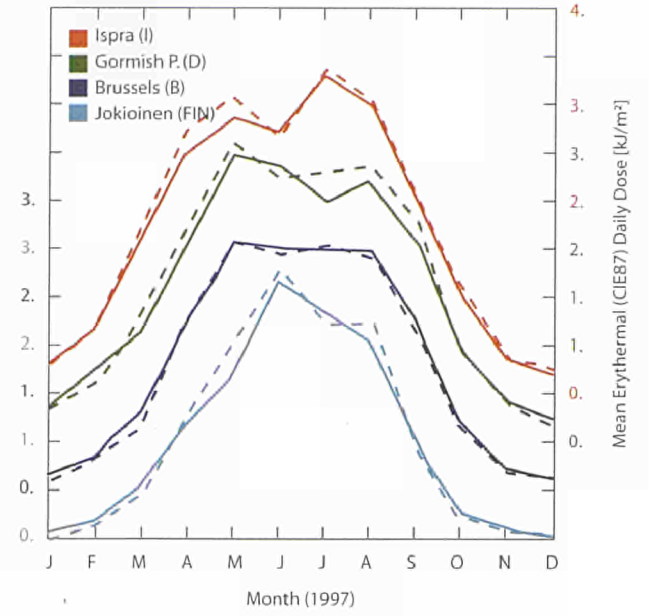
Surface UV Radiation and Actinic Flux

Most of the work in 1999 was dedicated to the consolidation and extensive testing of a method to map the surface or near surface ultraviolet radiation, using space-derived information. The method will later be adapted to generate information on the actinic flux and photo-dissociation rates, to serve as an input to the photochemical module of pollution models (such as the one used by the JRC Environment Institute). This activity was largely conducted in the framework of the MAUVE project (supported by the Environment and Climate Programme of DG Research). The project develops several methods to map the surface radiation at various scales and for different applications (climate research, human health, and environmental impact). The other partners developing these methods are the Belgian Institute for Space Aeoronomy, the National Institute for Public Health and the Environment (RIVM, NL) and the German Space Centre (DLR). The project also exploits databases of ground UV measurements set-up by two other European projects (SUVDAMA and UVRAPPF). The Finnish Meteorological Institute, the Fraunhofer Institute for Atmospheric Environmental Research and the Norwegian Institute for Air Research are particularly in charge of this validation work.

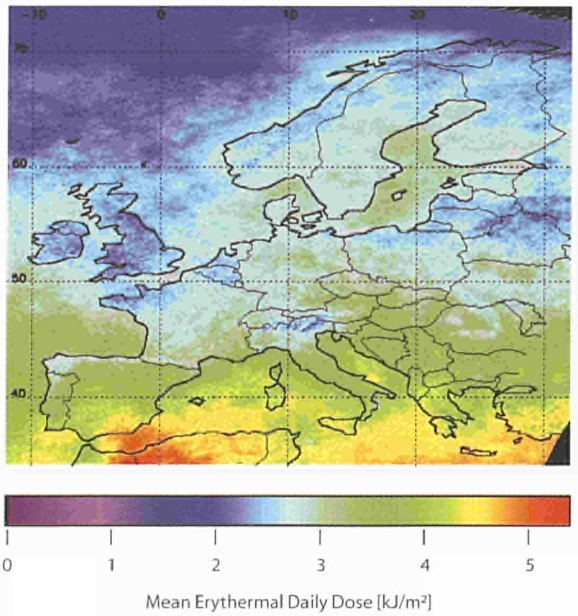
The method developed at SAI generates UV radiation maps over Europe, with a spatial resolution of 0.05 deg., and potentially on a half-hour basis. The UV irradiance is obtained by interpolation in a look-up table (LUT), the entries of which are solar zenith angle, total column ozone amount, cloud liquid water thickness, near surface horizontal visibility, surface elevation and UV albedo. Both satellite (METEOSAT, GOME) and non-satellite (synoptic observations, meteorological model results, digital elevation model) data are exploited to assign values to the influencing factors. With the help of another LUT simulating the visible signal, METEOSAT data are processed to retrieve the cloud liquid water thickness. The radiative transfer calculations are performed with the UVspec code. A preliminary step consists in generating an effective surface METEOSAT albedo map from a series of ten consecutive days. The

effective albedo map is then used as a baseline to estimate the cloud liquid water thickness. The UV surface albedo is assigned uniform values for land and sea/ocean, except in the presence of snow (identified with the help of HIRLAM data). The total column ozone is extracted from the level 3 GOME products. The aerosol optical thickness is mapped by gridding the daily measurements performed by about 1,000 ground stations. The digital elevation model is the GTOPO30 data set from United States Geological Survey (USGS).

The algorithm was first tested on limited areas around the validation test sites and during a 31 days period in spring 1997. It was later adapted and consolidated to be applicable over the whole of Western Europe and during the full year. The results are quite encouraging and the method constitutes a sound basis to develop a similar procedure to generate vertically resolved information on the actinic flux, as required by the air pollution models.



Monthly means of the ultraviolet erythermal (CIE87) radiation: comparison between the satellite derived values (dotted lines) and the measurements at four validation sites (solid lines). For clarity, the curves at the four sites have been vertically shifted.



UV radiation over Europe: map of the ultraviolet erythermal (CIE87) radiation mean daily dose in June 1997.

Selected Further Reading

Kalliskota, S., Arola, A., Hansen, G., Martin, T., Matthijsen, J., Meerkoetter, R., Peeters, P., Seckmeyer, G., Simon, P., Slaper, H., Taalas, P., Verdebout, J. (1999) Mapping of UV by Europe: Four Spaceborne UV Retrieval Methods and Their Preliminary Validation against Ground Based UV Measurements. XXIV General Assembly of the European Geophysical Society, The Hague, The Netherlands, 19-23 April.

Verdebout, J. A Method to Generate Surface UV Radiation Maps over Europe Using GOME, METEOSAT and Ancillary Geophysical Data. Journal of Geophysical Research – Atmospheres. In press.

Verdebout, J. (1999) Mapping Surface UV Irradiance Using GOME, METEOSAT and Meteorological Data. XXIV General Assembly of the European Geophysical Society, The Hague, The Netherlands, 19-23 April.

Verdebout, J. (1999) Mapping Surface UV Radiation over Europe, Using GOME and METEOSAT Data. European Symposium on Atmospheric Measurements from Space (ESAMS99), ESA-ESTEC, Noordwijk, The Netherlands, 18-22 January.

Verdebout, J. (1999) A Method to Map Surface UV Radiation, Using METEOSAT, GOME and Other Data. 1999 EUMETSAT Meteorological Satellite Data Users' Conference, Copenhagen, Danmark, 6-10 September.


http://mars.aris.sai.jrc.it/

Monitoring Agriculture with Remote Sensing

Project Co-ordinator:
Olivier Léo

In 1999, the MARS project became 11 years old and its continuation in the Fifth Framework Program, indicates its successful balance between applied research, development of methods and close technical support to DG Agriculture, for the implementation and management of European policies. A two-day conference was held in Brussels in April with the general subject "MARS Project, 10 Years of Demand-Driven Support". The life of any project in such a general context, implicates the maturity of some products (some activities, reaching an operational stage, have to be transferred to an external production environment), but also permanent innovation and developments, which are both customer-driven (requests and new regulations, sometimes defined with our support); and technical-driven (present important developments in the field of geomatics, photogrammetry and arrival of very-high-resolution satellites). MARS now consists of eight main workpackages or subprojects, and regroups the two previous groups of activities, namely MARS STAT for agricultural statistics and MARS PAC for the management of the Common Agricultural Policy.

In the field of agricultural statistics, there are two workpackages. Following the successful development and operational transfer of some products, the European area estimates activity will now focus, during the Fifth Framework Programme, on new research issues. Regarding the yield forecasting systems activity, the agro-meteorological MARS Bulletin is foreseen to be transferred in an operational phase with a co-funding by DG Agriculture. On the other hand, similar approaches will be tested and developed to cover extra European regions, in a general concern of food security.

Directly related to fight against fraud are the following workpackages: control with remote sensing, land parcel identification systems, olive tree and vineyard registers, and management of agri-environmental measures and subsidies. The OLISTAT and OLIAREA activities launched in 1998 by DG Agriculture with the support of MARS present overlaps between the STAT and PAC activities. Their aim is indeed to produce objective statistical estimates of the number of olive trees and areas under olive tree cultivation. But these projects were defined for a direct and short-term support for the policy definition (current reform of the Common Market Organisation on Oil). Moreover, the technical approach developed by the MARS project for OLIAREA, will be directly re-utilised by the Member States for the implementation of their future olive tree GIS. Last but not least, the new sensors and methods activity is carried out as a horizontal support to the other activities.

Monitoring Agriculture with Remote Sensing (MARS)

The MARS Bulletin.

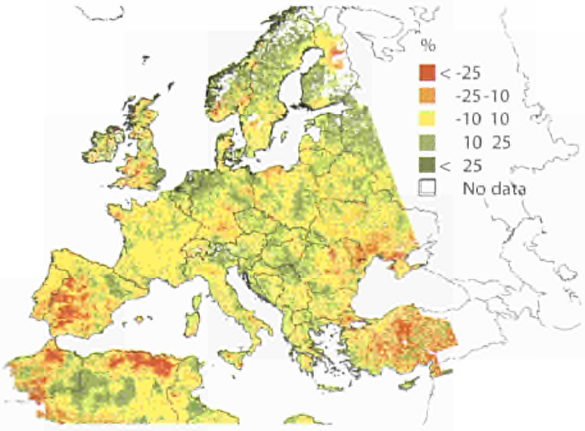
Crop Yield Forecasting System

The 1999 crop yield forecasting system was based on:

- meteorological analyses;
- agro-meteorological simulated crop growth indicators;
- low resolution satellite based information (NOAA and VEGETATION);
- statistical analyses of data produced and crop yield forecasting at EU level;
- publishing of a bulletin containing analysis, forecasts and thematic maps on crop yield expectations.

The MARS bulletin is published nearly on a monthly basis and is publicly available on the Internet. An average of 300 copies per issue were distributed to those directly interested in the information, with DG Agriculture being the main client. The MARS bulletin analysis also incorporates Central and Eastern European countries. In particular, for these countries the crop growth simulations were extended to maize and barley in 1999. The analysis based on the output of the agro-meteorological model (the Crop Growth Simulation System) was reinforced by the results of an application that integrates CORINE Land Cover data with Normalised Difference Vegetation Index Profiles (CNDVI).

Contact: Giampiero Genovese



Integration of CORINE Land Cover data with Normalised Difference Vegetation Index Profiles (CNDVI).

Crop Area Change Estimate from a Scattered Sample of Mini-sites

Following the re-engineering of "Activity B" (Rapid Area Estimates at a European Level), a pilot project was launched to use a different sampling approach with the goal to measure crop area changes from one year to the other and to derive final national rapid estimates. The test area includes Italy and Benelux. The key elements of the project, which also constitute the main differences with the previous Activity B, are the following:

- The site size is 6×6 km²
- The sample sites are defined according to a systematic-random sampling (50 km grid corresponding to CGMS)
- A post-stratification on the mini-sites is applied using the CORINE Land Cover information on arable land class
- Remote sensing data are acquired on the mini sites 3 times during the year
- A ground survey on the mini-sites is included during the campaign.

The first year of experience of this pilot project was a set-up year. Ground surveys were carried out on the mini-sites. High-resolution imagery was acquired on 95 mini-sites in Italy (average rate of success 87%) and on 23 mini-sites in the BENELUX area (rate of success of 85%). Next year the final area changes estimates on the target crops will be produced.

Contact: Giampiero Genovese

Statistical estimates on Olive Trees: OLISTAT and OLIAREA

The aim of the OLISTAT project was to estimate the number of olive trees in five Member States (Spain, France, Italy, Greece and Portugal), using computer-aided photointerpretation of aerial photos on a sample unit and statistical estimators for extrapolation at national level. DG Agriculture requested the JRC to produce national estimates of areas covered by Olive trees. The target of accuracy was the double of the results obtained within the OLISTAT project (i.e. 8% for a 95% confidence interval, instead of 4%). This area estimate was the main goal of the OLIAREA project (task 1), completed with: (a) an estimate of number of maintained trees (task 2), using a field/agronomic definition and in-

	Abundance Index (pre-OLISTAT figure)	OLISTAT Results (total number in 97/98)	OLIAREA Results (total number in 98/99)	OLIAREA Maintained Trees 98/99	DG Agri Reference for Productive Trees 97/98
Spain	209.9	299.5	308.9	278.5	195
Italy	169.1	224.7	236.6	229.2	136.3
Greece	153.9	155.9	162.1	152.1	148
Portugal	44.8	71.1	71.8	63.4	37
France	2.8	5.7	6.5	4.3	2.3

Olive trees number (millions of).

	98 national statistics areas	OLIAREA total area	EUROSTAT 97 areas
Spain	2.30	2.42	2.24
Italy	1.30	1.43	1.15
Greece	0.9	1.03	0.73
Portugal	0.34	0.53	0.32
France	0.01	0.04	0.01

Olive tree area (millions of ha).

cluding a comparison between trees found and the olive trees registers (or other data); and (b) an analysis of the large differences that were found between pre- and post-OLISTAT figures for tree populations (task 3).

The project started in November 1998 and was concluded in June 1999, tasks 2 and 3 being carried out by the OLISTAT contractors while task 1 was completed by the JRC; the latter being deeply involved in project coordination and quality assurance. Taking into account the olive tree sector regulation adopted between OLISTAT and OLIAREA (R2366/98), which defines olive tree parcels according to tree position, the JRC proposed a method based on a GIS modelling approach to complete task 1. A specific algorithm was developed and was applied at the sample unit level to each tree stored in the OLISTAT database. This GIS solution was implemented within the ArcView environment.

The OLIAREA application defines whether a tree is scattered or belongs to an olive tree parcel, according to distance between trees. A tree is defined as being scattered if there is no other tree within 20 m and an area of 100 m² is attributed to the scattered tree (Regulation statement). The olive tree parcel areas are calculated by generating a virtual network between the grouped trees and buffering the network, considering different buffering parameters for internal and external parcel boundaries. The final parcel area is divided in Voronoi polygons, meaning that its surrounding area is attributed to each single tree, allowing straightforward density calculations.

The JRC applied the developed tool on the revised field survey database provided by contractors (as task 2 subproduct, task 2 being a field work survey where tree position was requested to be accurately detailed). The final results obtained were communicated to DG Agriculture in June 1999 and are summarised in the enclosed tables. Briefly the main results of this project showed that discrepancies between pre- and post-OLISTAT figures in terms of number of trees are mainly due to the fact that Member States only had information regarding the actual declared olive trees. Areas are comparable with national area frame surveys, validating the OLIAREA model for olive tree area calculation. The slightly higher results obtained from the OLIAREA project are partly explained by the fact that areas were taking into account also in case of mixed crops, where in other surveys they may have been attributed to different classes. These results have the advantage that they provide an objective estimate obtained in a standardised manner, covering olive growing areas of Europe.

Contact: Laurence Bories

Control with Remote Sensing of Area-based Subsidies

The Control with Remote Sensing programme, using both satellite images and aerial photographs, is the largest civilian application of remote sensing in Europe. Following the end of co-financing in 1998, the Commission has only financed image acquisition in 99 and has continued to provide satellite images free of charge to the Member States. The latter remain responsible for the administration and control of farmers' aid applications.

In fact, all Member States but Luxembourg participated in the programme this year. In 1999, about 250,000 applications were controlled with the use of remote sensing. For the more than 100 control sites to be checked, the Commission purchased more than 700 satellite images from four image providers. These images were then delivered to some 17 main contractors in the Member States for analysis and interpretation.

In September 1998 DG Agriculture transferred to the JRC the responsibility for providing technical support to the Member States. As a consequence, the JRC has fostered a team to guarantee this service: publication of a common Call for Tender with Technical Specifications; technical support to site selection and real time management of image acquisition; quality control; and follow-up of national contractors. Moreover, the team is exploring the use of SAR data as a complementary tool for monitoring crop declarations; developing database applications for handling satellite image ordering and delivery; publishing a newsletter; and creating web pages for posting technical documents and disseminating techniques and examples from the national contractors' reports.

Since 1995, quality control has been performed under the supervision of the JRC. From the list of sites proposed by the National Administrations for checks, the JRC has selected a sub-sample of six sites for a complete quality control this year. The purpose of this activity is, by applying a series of well-defined checks, to assess the work carried out and appraise the specific results achieved by the national contractors. Specifically, the consistency of the delivered data, the application of diagnostic rules and the photo-interpretation results have been checked. The JRC distributes its quality control reports both to the National Administrations and within the Commission.

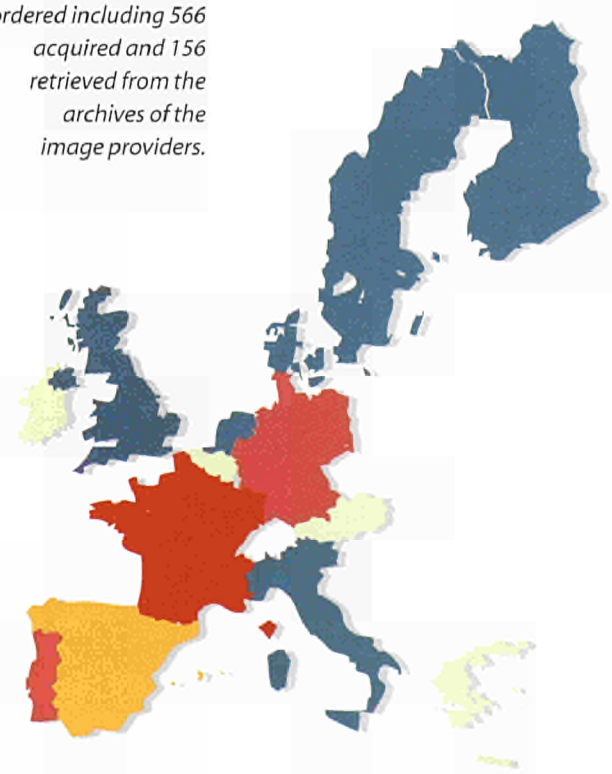
Contact: Tore Tollefsen

Land Parcel Identification Systems

The land parcel Identification systems are defined by the regulations (3508/92 and 3887/92) as the key element of the IACS (Integrated Administrative Control System), for the administration and crosschecks of all the area based subsidies. Since 1993, a number of Member States have already introduced ortho-imagery in their IACS, and/or have developed dedicated GIS to manage the identification of the agricultural parcels declared every year by the farmers. Most of them are providing maps or image extract to help farmers register their area aid applications in a straightforward and unambiguous way. The most advanced projects include the use of Internet for this purpose. This can be shown to have advantages both in the accuracy and speed of registration.

The MARS project has provided technical support to DG Agriculture and the Member States for the implementation of their LPIS. It has been directly involved in follow up and the evaluation of the systems, the definition of technical specifications and the quality checks of the orthophotos funded by the DG Agriculture. The success of the approach combining GIS and orthophotos has led DG Agriculture to propose amendments for the regulations 3508/92 and 3887/92. The new regulation, currently in discussion, may introduce the compulsory use of graphical database systems and ortho-imagery in the IACS. This will probably reinforce the role

Satellite optical images acquired during the campaign in the different Member States for the control with remote sensing of area-based subsidies programme supported by the Commission. Colours indicate a value ranging from less than 25 images (blue and green) to an average of 50 (orange and pink), to more than 100 (red). In total, 722 images were ordered including 566 acquired and 156 retrieved from the archives of the image providers.



	1992	1993	1994	1995	1996	1997	1998	1999
No. Member States	11	11	10	13	13	12	13	14
No. Sites	30	44	56	86	90	78	104	113

Number of participating Member States and sites controlled with satellite imagery.

	1992	1993	1994	1995	1996	1997	1998	1999
Landsat TM	88	63	90	155	127	139	166	151
SPOT PAN	10	40	50	53	60	53	54	64
SPOT XS/XI	100	122	232	287	330	242	309	343
IRS PAN	-	-	-	-	-	12	13	1
IRS LISS III	-	-	-	-	-	33	36	47
ERS SAR	-	-	7	6	33	111	106	104
Radarsat SAR	-	-	-	-	-	4	41	12
Total	**198**	**225**	**379**	**501**	**550**	**594**	**725**	**722**

Number of satellite images acquired for the programme from 1992 to 1999.

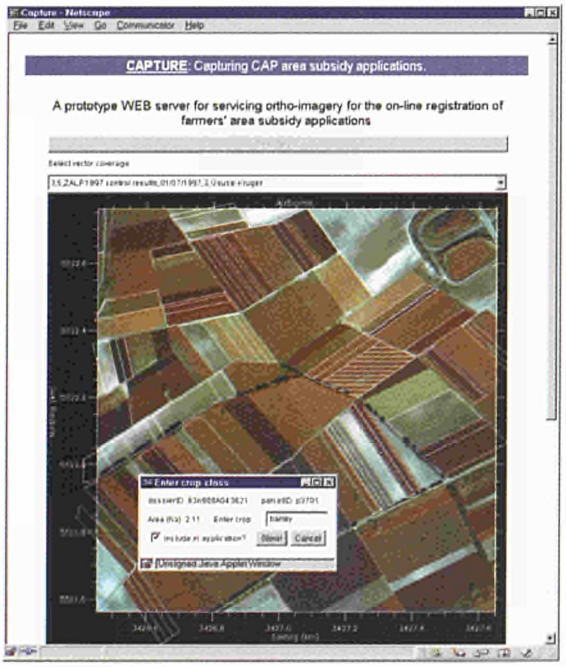
Cost (KEURO)	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Satellite images	1,184	1,300	1,410	1,255	1,588	1,736
Control with RS	8,586	9,925	11,585	10,385	11,617	not available
JRC Support & Quality control	200	300	500	500	500	800
Total	**10,070**	**11,525**	**13,495**	**12,140**	**13,705**	**not available**
Co-funded by the Commission	*10,070 (100%)*	*6,565 (57%)*	*7700 (58%)*	*7,825 (58%)*	*7,895 (58%)*	*1,736 (≈15%)*

Costs and co-funding for sites including satellite data. Since 1997, total costs, including sites with aerial photos only, have been between 20-25 MEURO. Satellite image purchases are still completely funded by the Commission.

of the MARS project in supporting the countries concerned and checking the appropriate use of the Funds from the Commission.

Internet is more and more expected to service functionality: the explosion in relevant functionality that is becoming available in the Java programming language allows the deployment of tailor-made highly sophisticated tools for such applications, at relatively low cost. Simple prototypes for vector editing against queried high-resolution image background have been demonstrated in 99 and more complete prototypes will be tested in 2000, A very important aspect, in this respect, is the analysis of the uptake of these applications by the farmer communities in the various Member States. This requires, amongst others, socio-economic studies on the information collection and dissemination techniques used in this context. Last but not least, in the frame of the preparation of the adhesion of new members, the MARS project has established in 99 contacts with the candidate countries. Exchanges, pilot studies and transfer of know-how will be developed in 2000 in the field of parcel identification systems.

Contact: Guido Lemoine



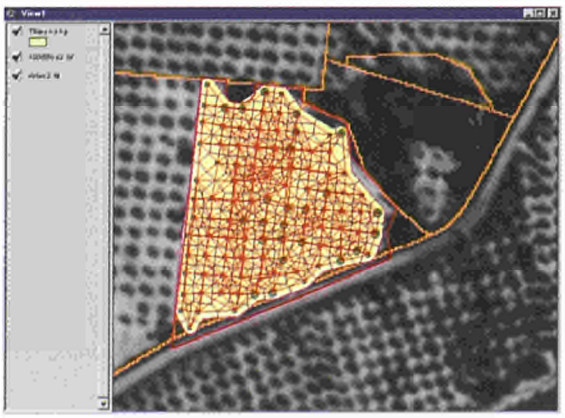
Building on prototype software developed in 1998, it was possible to demonstrate the potential use of Java-based Internet technology to serve high-resolution ortho-image data sets combined with digital cadastre data for the registration of area-based subsidy applications. The interest in such applications is widespread amongst EU Member State organisations that are involved in land parcel information systems for registration and control of agricultural support measures.

Olive Tree and Vineyard Registers

Under European Community legislation (R2366/98), Member States with olive cultivation (ES, IT, FR, PT, EL) are required to implement by the end of 2001 a Geographic Information System for management of crop declarations and aid applications, this being fully funded by the Commission. A specific requirement within the regulations is the establishment of a comprehensive database, including digital orthophotographs, land parcel boundaries and the location of individual olive trees. The JRC is involved in technical support to DG Agriculture and national Administrations. Activities are focused on geomatic topics and administrative issues.

In the field of geomatics, wide-scale orthophoto coverages are being acquired requiring technical co-ordination and quality control: this year 33,000 km² in France, 107,000 km² in Spain, 50,000 km² in Greece, 80,000 km² in Portugal (in this case this has been integrated with Portugal's Integrated Administration Control System). Moreover there are several administrative aspects, such as technical specifications for international ITTs, and technical aspects related to GIS implementation and data management. In support of the Member States who are faced with these tasks, the JRC has proposed the "OLICOUNT2000" tool, offering olive tree identification and olive area calculation tools. Technical aspects of computer-assisted olive tree identification from digital orthophotographs, resulting in OLICOUNT – a tool implemented in C++ and delivered with an ArcView interface – have previously been investigated through the OLISTAT project. Areas under olive cultivation calculation are based on the OLIAREA project concepts (see figures), redefined at the parcel level instead of at the OLIAREA sample unit level. OLICOUNT 2000 is a project offering CAPI/area calculations capabilities integrated in a simplified declarative-check environment compatible with the national Parcel Identification System. The French, Spanish and Portuguese administrations are already implementing part or the all of the OLICOUNT 2000 concepts in their national GIS. Activities regarding vineyards sector management should increase in the coming campaign, considering the new regulation in preparation, which should be adopted in springtime 2000.

Contact: Laurence Bories



Olive tree parcel area calculation in OLICOUNT 2000: in orange, LPIS boundaries, in red declared parcel boundaries, with tree identification (green points), network (red) and total olive tree parcel area calculation (light yellow), divided into Voronoi polygons (cf. OLIAREA project).

Management of Agri-environmental Measures and Subsidies

A series of regulations outline the EU Agri-environmental Policy. This starts from the definition of the Less Favoured Areas in 1975 and the Objectives 1, 5a, 5b areas in 1988, passing through the milestone IACS (Reg. 3508/92, and 3887/92), reaching the more aimed Regulations 2078/92 on Agri-Environmental Measures (AEM), 2080/92 on afforestation, Agenda 2000, and finally 1257/99, and 1750/99 on support to Rural Development. The last two state that AEMs are required as compulsory part of all Rural Development Programmes submitted to the EC. This means that the Common Agricultural Policy (CAP) is taking another step towards sustainable agriculture, where goals are to turn European agriculture competitive but at the same time environmentally friendly. With the experience in support to DG Agriculture in implementing the CAP, the MARS project has introduced a workpackage to follow the Agri-Environmental Measures throughout the Fifth Framework Programme aiming at providing expertise for their definition, targeting, monitoring, management, control and evaluation. This entails managing agri-environmental subsidies in a system similar to the IACS, homogenising their implementation, and their management at regional, national, and EU level. The aim is to solve this by innovative use of geomatics, and electronic information services. The workpackage will test methods in a real environment through pilot projects and organise workshops, and training sessions to allow Member States Administrations, experts in remote sensing and the environment, and Commission representatives to meet, present, and discuss Agri-Environmental Measures and Subsidies.

The main achievements in 1999 included starting the work to establish good contacts with Member States Administrations, and DG Agriculture; profiling as a main horizontal activity in the JRC Agri-environmental cluster; organisation of the 1st in a series of workshops on the Management and Monitoring of Agri-Environment Schemes; start of definition of three pilot projects where key agri-environmental issues will be studied in a real environment during the growing season of the year 2000. The first of these pilot projects will be in Italy within the MARS test site on Lago di Garda, where a GIS system will be set-up containing a time-series of data (potentially including the use of IKONOS data) for the monitoring of chosen AEMs of the Lombardy Italian region (e.g. intensive arable to grassland, to extensive pasture, or to extensive farming practice; landscape features; set aside etc.). The second will continue in the year 2000 to follow up the French CNASEA's achievements with remotely sensed imagery for AEM Monitoring. Four sites were already included in the 1999 Control with Remote Sensing Campaign. The third pilot project will be a study in the UK, aiming at the identification of selected aspects of land management controlled under agri-environmental schemes where there is potential to develop the operational use of remotely-sensed, and GIS data. Of special interest for the study are small-scale landscape features, specific features of arable land, farm management practices, and nutrient status in arable and grassland systems.

Landsat Thematic Mapper satellite image of Wharfedale

This satellite image was acquired on the 28th June 1995, ten days before the permitted tier 1 cutting date of the 8th July. The image wavebands have been selected such that uncut areas of agricultural grassland appear bright blue, with cut fields appearing bright yellow. By overlaying agreement boundaries – as defined by the shaded red polygon – on the image, it is possible to identify any fields where cutting appears to have occurred prior to that allowed under ESA regulations. This demonstrates the valuable contribution satellite imagery can make to conservation management and environmental monitoring. Artificially bare surfaces – for example quarries and residential areas – appear in orange tones. Yellow tones are generally indicative of sparsely vegetated surfaces; in lowland agricultural areas these are cut fields as evidenced by the regular field pattern whereas in upland areas they are likely to be sparsely vegetated semi-natural surfaces such as limestone pavement. Areas of dwarf shrub appear in brown tones and have an almost 3-dimensional appearance with semi-natural grassland appearing in light blue tones. Forestry and water appear in black and dark tones.

Contact: Pär Åstrand

New Sensors and Methods

The most important new sensor event in 1999 was, at least from our perspective, the successful launch of the IKONOS satellite. After years of promises, repeated postponements and a number of spectacular failures,

the operational availability of 1-m spaceborne remote sensing data can definitely be a major impulse for new applications. In our case, the LPIS, control and agri-environment management and monitoring activities are likely candidates for the use of such data. Not that the use of 1-m resolution data is new. We have been actively using such data in activities such as OLISTAT, OLISIG and LPIS before. For this reason, the MARS project discussed with the European distributor of IKONOS data the possibilities of testing the data in typical MARS applications. The fact that these data are now available from space will allow different experimental set-ups (e.g. control of small areas, focussing in on specific measures, quality checking of LPIS).

LANDSAT-7 is certainly another milestone. Again, postponements and failure had plagued the LANDSAT programme, making availability of Thematic Mapper products increasingly uncertain. The ETM+ sensor, which includes a 15-m PAN mode, is reported to provide excellent data. First example data has been reviewed mainly on spectral characteristics. Furthermore, the new pricing policy is likely to be a catalyst for the wide-spread acceptance of high resolution remote sensing data in a range of applications. The MARS project has been approached to use ETM+ data in benchmark test, for a selection of control sites. From spring 2000 onwards, we hope to integrate the data in the control programme.

SAR activities within the MARS project have focused on the continuation of the analysis of wide-area ERS SAR data for cereal area estimation. Data fusion with optical imagery and error propagation analysis with the help of image simulation techniques are part of this work. In the control programme, RADARSAT was used for the first time in Ireland in a fully operational way producing encouraging results. The PAAGE and SAAGE projects were successfully completed in 1999. These shared cost actions under the Environment and Climate programme of the Fourth Framework Programme aimed at the evaluation of the technical and economical feasibility of a proposed super-spectral mission. The MARS project was involved in the evaluation of the requirements for typical applications for national government organisations. Special interest was paid to applications that are related to the implementation of agri-environmental measures.

Contact: Guido Lemoine

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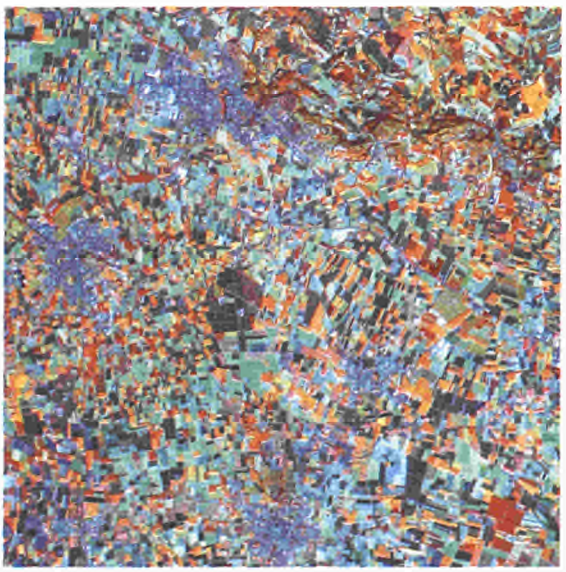
Highlights

1999

- Successful 1st year of the technical support on the Controls with Remote Sensing (fully transferred from DG AGRI to DG JRC).
- Start of the activity on Management of Agri-environment Measures and 1st conference in Ispra, 23-24 November.
- April Conference on "MARS, 10 years of demand driven support" in Brussels.
- July Presentation and validation by DG AGRI of the final results of OLI AREA and OLISTAT projects.
- 25- 26 November: 5th Stresa conference on Control with Remote Sensing of Area-based subsidies.
- ITT and preparation of new framework contract with image providers.

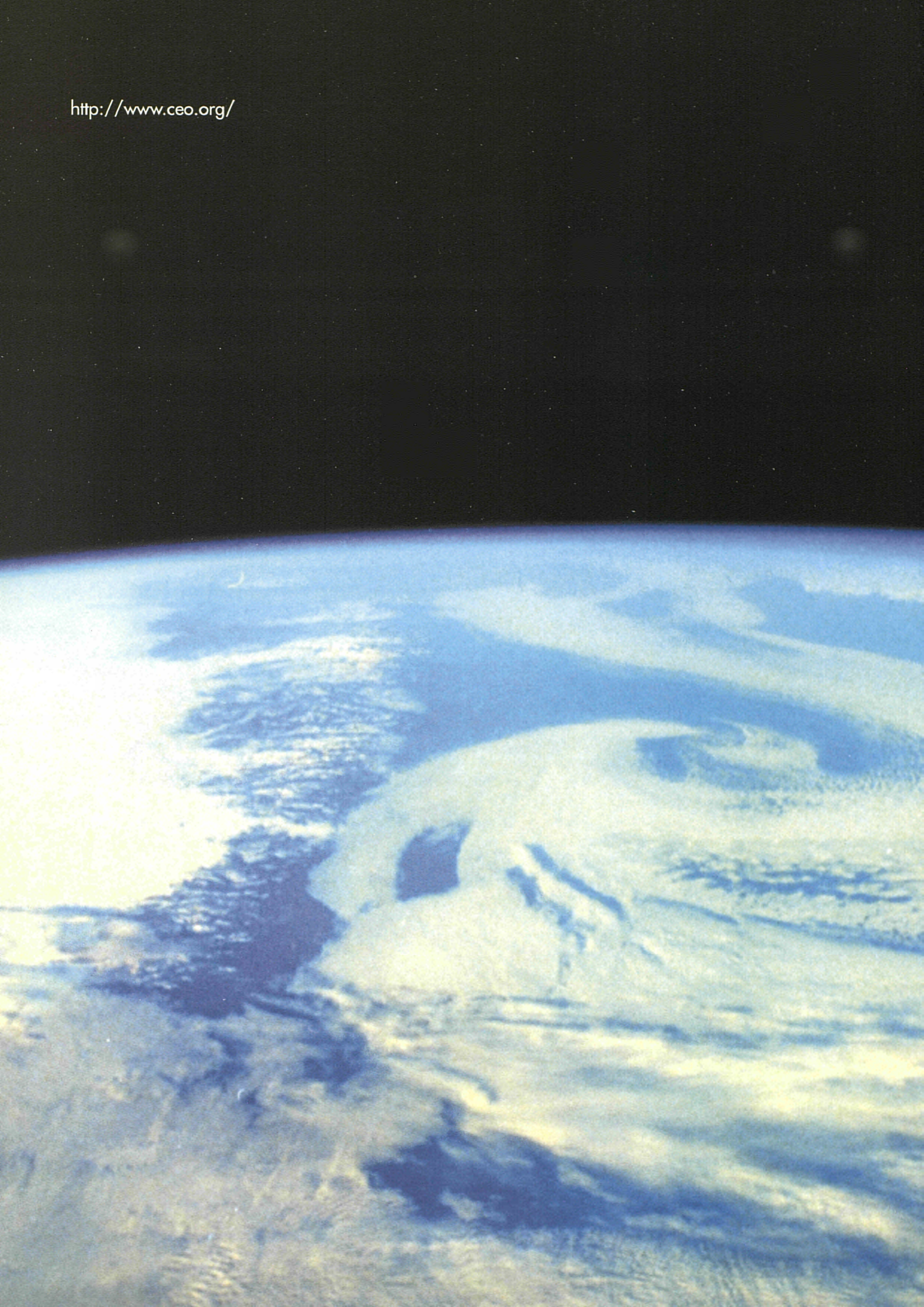
2000

- Operational transfer of the Crop Growth Monitoring System (1st phase of a 3-years program, co-funded by DG AGRI).
- Initial development of agro-meteorological systems for food security monitoring outside Europe.
- Semi-operational use and evaluation of IKONOS data for remote sensing controls and development of Land Parcel Identification Systems (LPIS).
- Technical visits and pilot project with candidate countries on remote sensing controls and implementation of Land Parcel identification systems (LPIS).
- Possible development of the activity on LPIS and Registers, and of applications using Internet for farmers' declarations.

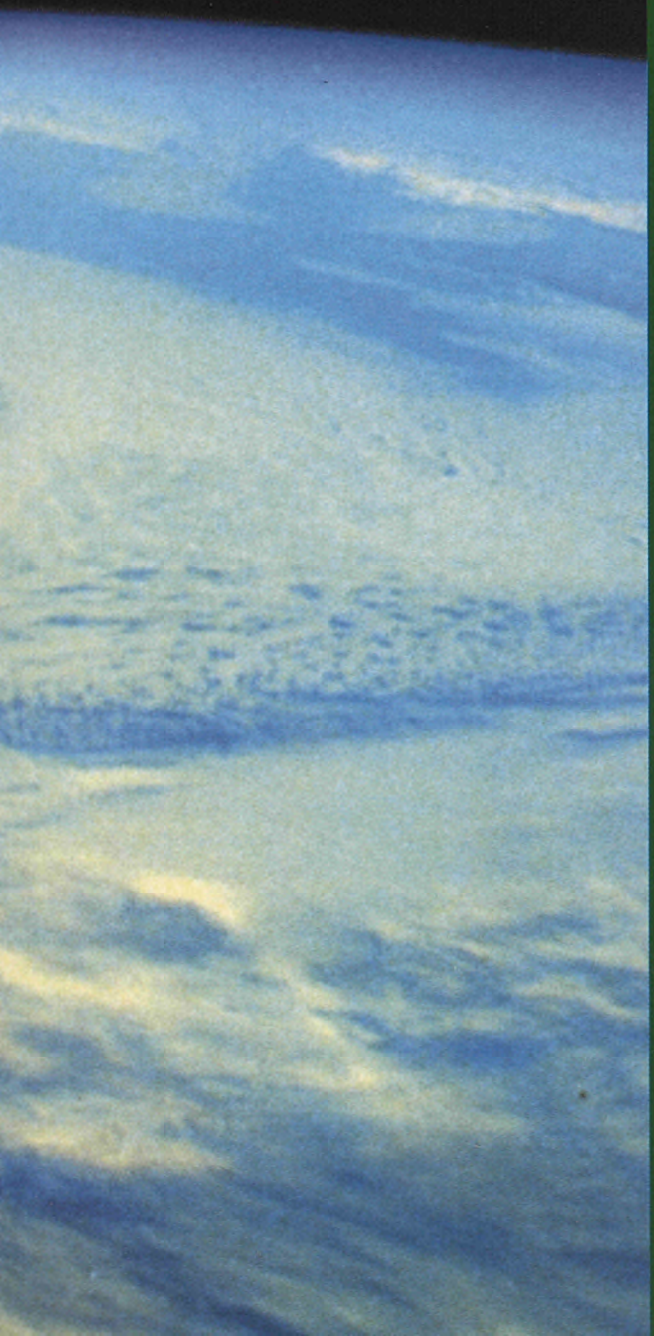


Landsat Enhanced Thematic Mapper false colour composite 453 fused with the panchromatic band. Courtesy of EURIMAGE S.c.r.l. © ESA (1999).

http://www.ceo.org/



Project Co-ordinator:
Peter N. Churchill



The driving force for the CEO project is to aid the development of an operational, sustainable and competitive Earth observation capability in Europe based upon the requirements of EU policies. The project's work builds upon the results of the CEO in the 4th Framework Programme, and is also influenced by the Global Monitoring for Environment and Security (GMES) initiative. The work seeks to ensure that the needs of EU policies for spatial information will be met. These needs are used to stimulate the associated industry to provide information on an operational basis, and to raise European competitiveness in this field. Of particular note is the work to support the global monitoring aspects. Activities have been undertaken to stimulate the use of spatial information within the Services of the Commission. This requires innovation and demonstration; in short, using new ideas and technology to show what can be provided to meet the identified needs. Research is being carried out to develop information extraction techniques from current and future sensors. These same skills are used to evaluate if or how the identified needs of EU policies will be met by proposed future missions, and where appropriate, technical recommendations will be made for fine-tuning technology to requirements. Finally, none of this can happen if the relevant data, information and services are not available to the operational organisations that require them. To address this requires an on-line infrastructure to facilitate the necessary access. This infrastructure should be interoperable to obtain relevant information from other appropriate information systems. This issue has been addressed by the development and implementation of an interoperable data and information system, based on international standards developed by the CEO project, called INFEO.

Centre for Earth Observation (CEO)

Earth Observation Market Development

The CEO Programme hosted a final workshop on 21-22 April 1999, to bring its activities in the 4th Framework Programme to a close. The results of the CEO's Market snapshot and Impact assessment studies were presented, and presentations from industry and the EC addressed the question "Has EO found its customers?".

Based on the CEO projects carried out in the 4th Framework Programme, the commercial sectors showing the greatest potential for increased use of EO data in the next five years are the agri-industry, insurance, software, travel/tourism/leisure, and intergovernmental bodies. Some key words emerged from the workshop for building European competitiveness. These included terms such as new business concepts, strategic drivers and product innovation. Opinion was split on whether Earth observation services within Europe should be business-driven, driven by strategic considerations of governments or elements of both of these.

A new publication describing the breadth and scope of the past activities of the CEO Programme was published in 1999, under the title "EO for better Information – CEO Programme 1996-1998". It gives a synopsis of the over 100 projects that the CEO Programme supported during its Design and Implementation phase (1996-1998). It also describes the various initiatives, which formed the framework for these projects, and includes a number of project examples. Also, contact details are given for each project such that further information regarding the project can be obtained directly from the project co-ordinator.

Through the launch of an Invitation to Tender for the "Integration of EO into information services" in August 1999, the CEO builds upon previous activities aimed at developing the market for EO derived products or information. One objective of these projects is to introduce EO into new markets for information services, for example geographical information services, or tourist information services. On the other hand, it also aims to support companies within the EO industry to analyse and assess the business case for their proposed products or services. This includes the consideration of the risks and ways to minimise these, involving other partners, development of a market entry strategy, and where appropriate, avenues for seeking further investment.

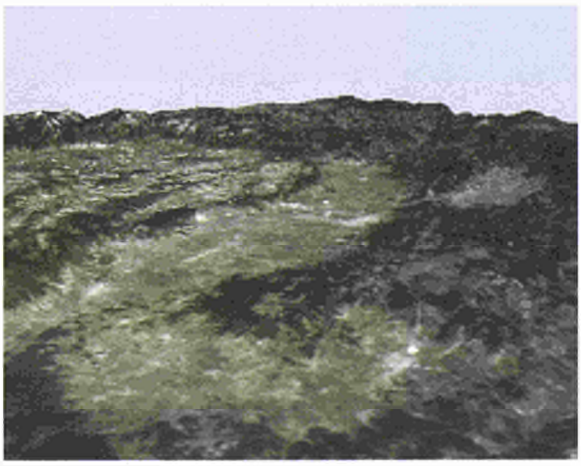
Contact: Neil Hubbard

Innovation and Demonstration

Significant work has been undertaken this year for the European Commission Humanitarian Aid Organisation (ECHO) and DG External Relations with particular emphasis on Humanitarian Aid. Discussions were held to determine where spatial information could play a role in humanitarian activities, and specifically, what products or services could be beneficial to ECHO. The work involved providing technical interpretation to ECHO about what space-based information could provide, such as level of detail, timeliness, and accuracy.

On this basis, a prototype information system for Kosovo is being developed that aims at exploring the potential of the information technology in a crisis area. It will be used by field officials for navigating and collecting data in the field; and/or by humanitarian aid officials planning rehabilitation and reconstruction; and/or by decision makers monitoring progress towards reconstruction. The work is based on Kosovo but the concept may be adopted in the future on other parts of the world. Information technology that includes Earth observation, such as a data collection methodology, satellite navigation for positioning, satellite telecommunication and Internet for data transfer as well as a geographic information system for data storage management processing and visualisation will provide synthetic ready-to-use information for decision making.

Contact: Daniele Ehrlich



3D model, generated from a satellite image, of the Pristina valley as seen from the south.

Technical Support to Galileo

Another new initiative has begun to provide technical support to the Galileo project of DG Transport. Galileo is an initiative of the European Union and the European Space Agency to develop, implement and operate a state-of-the-art global navigation satellite system. Galileo will provide benefits to Europe in applications such as road, rail, sea and air transport together with a wide range of non-transport applications such as precision farming and geodesy. The performance of Galileo will be improved much beyond the current GPS standard positioning service. The Galileo project has now entered the Definition Phase, to prepare the technical information necessary for a decision on progression to the Development Phase. This decision will be taken late in 2000 by the Council of Transport Ministers and the ESA Council.

The Strategy and Systems for Space Applications (SSSA) Unit is providing technical support to the management by DG Transport on a number of large, industry-led studies. Key areas of work are requirements definition, system trade-offs and overall architecture design and in understanding market factors and the development of Public-Private Partnership (PPP) models for joint investment in an operational service. The ASTRON project will continue to provide support to the development and demonstration of applications. This work will extend throughout 2000, and dependant upon the decision on the Development Phase could continue much beyond this.

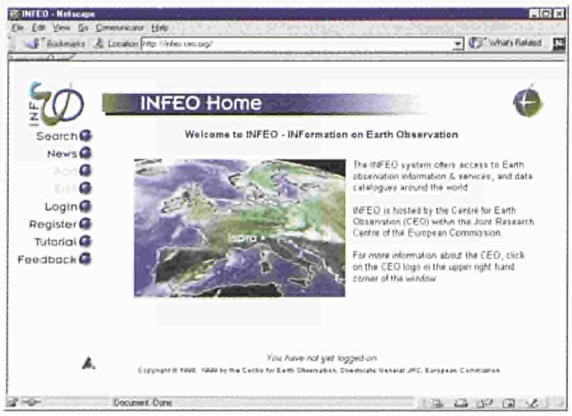
Contact: Neil Hubbard

Earth Observation Information Systems and Interoperability

After four years of successful operation, the CEO has replaced its on-line information service for Earth observation, the European Wide Service Exchange (EWSE), with a new system called INFEO (INFormation on Earth Observation). For the first time, users can now simultaneously search many data catalogues located across the world via a single user interface.

INFEO went live as planned on 10 September 1999. Release 1 of INFEO is now available at http://infeo.ceo.org/. Through the launch of INFEO, the CEO is closer to realising it's ideal of offering a one-stop shop for EO data and information. The CEO's first service, EWSE, was a huge success as reflected by its statistics. Before it was phased out, it had registrations for over 3700 users, 970 organisations and 665 EO products. All the information held within EWSE has been transferred to INFEO.

1999 was a year of intense activity in the final development phase of INFEO. Gateways, to talk to data catalogues, were installed around Europe and elsewhere in the world so that Earth observation data of interest are searchable, and an advertisement and announcement server to hold records from the EWSE was built. In addition, work to improve the user interface was carried out to make the INFEO catalogue search as simple as possible to use.

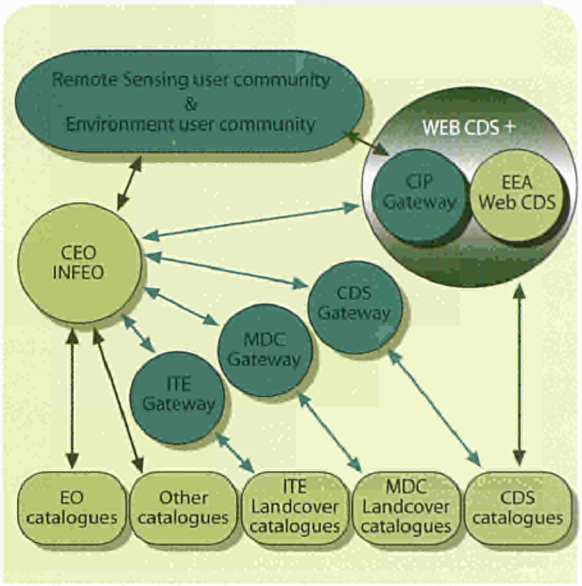


The on-line information system for Earth observation, INFEO, was launched in September 1999.

The catalogue search functionality of INFEO is due to its adoption of a communication protocol called Catalogue Interoperability Protocol (CIP). It should be noted that CIP, developed in an international partnership under the leadership of CEO, has now been formally adopted by the G7 initiative the Committee on Earth Observation Satellites (CEOS) as the international catalogue interoperability protocol. CIP has also been promoted in the wider geo-spatial field, with an adaptation of CIP being proposed to the OpenGIS consortium as its official interoperability protocol. The OpenGIS consortium is an international body seeking to put standards in place for the GIS world. Again this is being undertaken under the CEOS umbrella. CIP was selected for INFEO since it allows customers to search catalogues all over the world.

ARIS (Agriculture and Regional Information Systems) at the JRC	Italy
ISIS (Intelligent Satellite Information System) at DLR	Germany
EUROMAP at DLR	Germany
MARF at EUMETSAT	Germany
EURIMAGE	Italy
SPOTIMAGE	France
HEOC (Hatoyama Earth Observation Centre) at NASDA	Japan

Major satellite data catalogues searchable via INFEO on its launch.



Schematic diagram showing the interoperability between the INFEO system and the WebCDS system of the European Environmental Agency developed under the EEIS project.

A gateway was also installed to connect INFEO to NASA's IMS Gateway, which provides access to a further 800 datasets including all the American Data Active Archive Centres (DAAC), as well as to the Canada Centre for Remote Sensing. In addition to all these satellite or space catalogues, INFEO users can also search a selection of relevant non-space catalogues from the same single user interface. These include the land cover catalogues from ITE (Institute for Terrestrial Ecology), UK and MDC (Swedish Environmental Data Centre), Sweden. Access is also offered to a map catalogue at IGN (Institut Geographique National) in France, an atmospheric catalogue at BADC (British Atmospheric Data Centre).

Through a joint project undertaken by CEO and the European Environment Agency (EEA), the gap between the environment and Earth observation communities has been bridged by linking INFEO to the Catalogue of Data Sources (CDS) of the EEA. An environmental user will be thus able to easily find Earth observation data (e.g. satellite images) for their research and reports, and vice versa. It will be launched towards the end of 1999.

INFEO was developed in close co-operation with international partners to ensure coherence of approach, and to minimise development overlaps. This is mainly undertaken via the Committee on Earth observation Satellites (CEOS) Working Group on Information Systems and Services (WGISS). In the reporting period two CEOS-WGISS technical meetings have been attended, one in May and one in June. Participation in CEOS-WGISS has ensured that the INFEO development is coherent with other developments globally.

Contact: Michel Millot

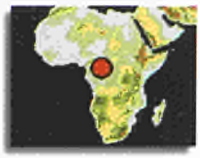
New Environmental Information Systems

Activities of the New Environmental Information Systems group range from local to global scales and use geographical information systems and the Internet. At the local scale the group has, in collaboration with the ECOFAC Programme, installed a geographical information system, including hardware, software and spatial data, in Libreville, Gabon, and in Odzala National Park, Congo, and provided an intensive training programme.

ECOFAC is a regional programme, funded by the European Development Fund, which aims to strengthen biodiversity conservation and the sustainable management of six national parks in Central Africa. The research activities of the programme have established a substantial knowledge base of the dynamics of flora, fauna and human activity within the parks. The data integrated into the system includes vegetation maps, airborne radar and videography, optical satellite imagery and data collected by forest patrols such as animal reports and photographs. With the geographical information system provided by the JRC the ECOFAC programme has been able for the first time to spatially visualise and analyse the field data collected by their forest rangers, in conjunction with digital maps and satellite imagery. Field observations are collected by patrols using a CyberTracker, a field computer combining a simple icon based user interface and an integrated Global Positioning System. These data are then downloaded directly into the geographical information system for analysis. The results are expected to reveal the inter-relationships and dynamics between animal and vegetation species and distributions.

At the global scale the group's activities include developing an Internet-based mapping system to provide the JRC global and regional satellite products to the Services of the Commission in Brussels, and close involvement in the development of a Global Forest Information Service on the internet.

The recent development of Internet mapping allows us to provide map data and information via the medium of the Internet. It is now feasible to serve very large global or regional datasets on the Internet - such as the results of the TREES, FIRE, GRFM and IGBP Land Cover projects. An integrated system is in development, which brings together these information products together with other spatial topographic data. Coordinated country based links are provided by active scripting technology directly to the relevant country pages of other data providers.



Another major activity is coordination of the technical sub-group of the IUFRO Task Force on the Global Forest Information Service – GFIS. GFIS has the ambitious aim to "develop a strategy for, and implement, an Internet-based metadata system that will provide coordinated world-wide access to forest information". The GFIS represents the facilitation of an action point of the Intergovernmental Panel on Forests. The group is working with many partners in the international forest community towards this end.

Contact: Tim Richards

Future Sensors

Part of the work of the CEO project is related to advanced research in remote sensing and to the exploitation of new and future instruments. A major activity that took place in this context was the organization of the RAdiation transfer Model Intercomparison (RAMI) activity. Remote sensing data obtained from imaging sensors on space platforms in the optical domain always is concerned with the measurement of bi-directional spectral reflectances. The quantitative interpretation of these measurements must rely on appropriate mathematical models that take the relevant physical processes into account.

The scientific community concerned with these problems has made significant progress over the last decades, and has reached a level of maturity sufficient to start evaluating the models and solutions available. The RAMI exercise is the first step of a long process of critically assessing all the bi-directional reflectance models published so far. This activity will lead to (a) the definition of quality standards and benchmarks, (b) the publication of evaluation results, (c) the improvement of existing models, (d) the definition of research priorities, and (e) a better long-term interaction between the modelling and observation communities, as the latest simulation results will inevitably lead to more stringent measurement requirements, while new observations will better constrain the models and help identify the best tools.

Research is actively pursued on the development of advanced models simulating the reflectance of continental surfaces and on the full exploitation of high performance methods of remote sensing data interpretation for practical applications. Work is on going to develop further the RAYTRAN Monte Carlo ray-tracer code that was developed earlier by this group, and to take advantage of this and other research tools in thematic applications. Two examples can be highlighted:

- It appears that new approaches, based on the exploitation of advanced models of radiation transfer, can be pursued to describe land cover and its changes in time. A publication has been submitted in the refereed literature to describe how innovative inversion methods based on Look-Up Tables (LUTs), built with physically-based reflectance models, can yield reliable information on the observed systems.

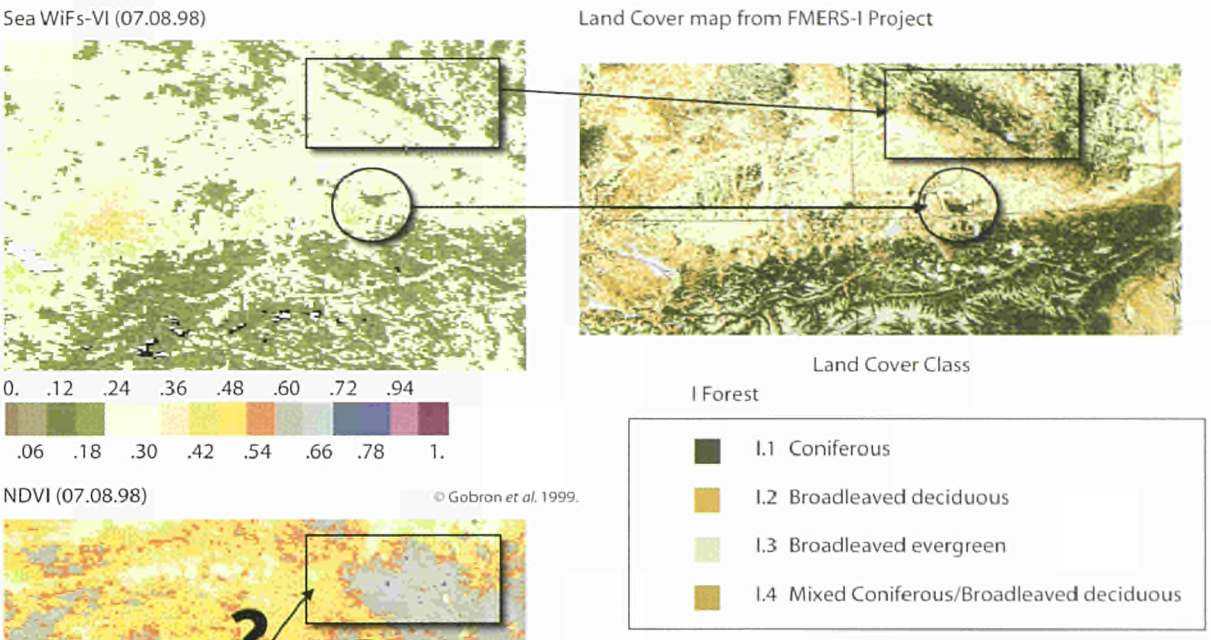
- Existing models of spectral and directional reflectance are being adapted to describe the measurements that can be obtained over burned areas. In parallel, measurements are being acquired in collaboration with the EGO of the TDP Unit (Technologies of Detection and Positioning; Anti-personnel Mines) of SAI to document the spectral and directional properties of bare soil, ashes, and stands of burned trunks.

Another major sector of activity in the context of the CEO-project is the support provided to national and international Space Agencies, either for the optimal exploitation of existing or near-future sensors, or for the design of the next generation of instruments. The following contributions have been made:

- Active participation in the drafting and revision of the MBWG (MSG Biospheric Applications Working Group) report on the exploitation of the Meteosat Second Generation (MSG) instrument in land applications. This report has now been published by EUMETSAT and widely distributed.

- Participation in the MERIS Scientific Advisory Group of ESA and definition of operational algorithms for the exploitation of that sensor over continents. For reference, an operational software code has been delivered and is being implemented in the ENVISAT ground segment, and a formal ATBD has been published. In addition, preliminary results have been obtained by applying this algorithm to MOS data, as this existing sensor has spectral characteristics similar to those of MERIS.

- Participation in the LSPIM (Land Surface Processes and Interactions Mission) Advisory Group of ESA. LSPIM is one of the 4 proposed Earth Explorer missions, and we have made a number of simulations to support the number and optimal angular position-



A set of three panels showing (top left) a SeaWiFS image for Central Europe analysed with the help of the SeaWiFS-VI (the vegetation index optimised to estimate FAPAR on the basis of SeaWiFS data), (top right) a land cover map for the same region derived from a combination of Landsat images and field observations, and (bottom left) the distribution of NDVI derived from the very same SeaWiFS image. These panels clearly demonstrate the superiority of the optimised indices to identify land cover structures.

ing of the directional measurements to be made by that instrument. A EUR report containing a detailed description of the models used and results obtained is under preparation.

- Links have been established with the NASA Langley DAAC for the acquisition of data when the MISR (Multi-angle Imaging SpectroRadiometer) instrument becomes operational, some time after launch currently scheduled for late November 1999. In parallel, data from the AirMISR instrument has been processed, and are preparations are underway to process MISR data by assembling full documentation on the HDF data format as well as the various public domain and commercial software available to manipulate these files.

- In the case of the VEGETATION instrument on the Spot platform, the software codes have been developed, tested and delivered together with the ATBD describing an operational way to assess FAPAR. In this case, on the basis of the few data sets available, a likely instrument calibration problem has been identified and reported to CNES.

- Contribution to the definition of advanced algorithms in the ADEOS-II/GLI ground segment is continuing. As for the other sensors mentioned above, this activity has resulted in the publication of a formal ATBD and the delivery of a software code to the Japanese Space Agency.

Contact: Michel Verstraete

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- A profile in Innovation and Technology Transfer – 5.98.
- Eye in the Sky in Euroabastracts, Vol. 37 – 2.99.
- Satellites bridge the application gap in VIPS – July1999.
- News from Europe in Backscatter – August 1999.


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Project Co-ordinator:
Michalis Ketselidis

ASTRON (Applications on the Synergy of satellite Telecommunications, eaRth Observation and Navigation) is a project that was initiated as a spin-off of a major activity of the EC in the Fourth Framework Programme, the Centre for Earth Observation (CEO) programme. ASTRON aims to investigate the synergies between the three space technologies with the aim to introduce innovative and sustainable services and applications based on the convergence of digital information from satellites. ASTRON was conceived and initiated based on the observation that a number of applications and user groups could benefit from the combined use of satellite technologies. As part of the EC RTD in the Fifth Framework Programme, the ASTRON project formally started in 1999. ASTRON is supported under line III.3 (Innovation and Technology Transfer) of the Fifth Framework Programme and aims therefore to underpin European competitiveness through the support of space industry by identification of new users and innovative applications. For the entire Fifth Framework Programme, the activities of ASTRON are co-ordinated and supported with the other relevant activities of the EC, namely Key Action 1 of Theme 2 (User-Friendly Information Society/Systems and Services for the Citizen) and Key Action 2 of Theme 3 (Promoting Competitive and Sustainable Growth/Sustainable Mobility and Intermodality).

Synergy of Earth Observation with Satellite Telecommunications and Navigation

Synergy of Earth Observation with Satellite Telecommunications and Navigation (ASTRON)

The Value of Spatial Information for the Information Society

Information rapidly becomes a tradable and strategic good. Societies, industry and business are developing from selling "physical goods" to selling "information". Personalised decision making systems require on-line access to information in order to reach their goal and support their owner. The highly personalised service requires not pre-compiled information, but information and databases to a degree where personal flavours can be included in the decision ("...I don't like to drive in highways"). These data need to be updated with actual status information ("There is traffic jam..."). Interaction with several services and databases might occur while the users (or better the decision-making system on behalf of them) are searching for alternatives. The access to information for personal decisions must be granted at all times and everywhere. Especially services such as communication and navigation require portable and mobile systems. These form a key to *Infomobility*.

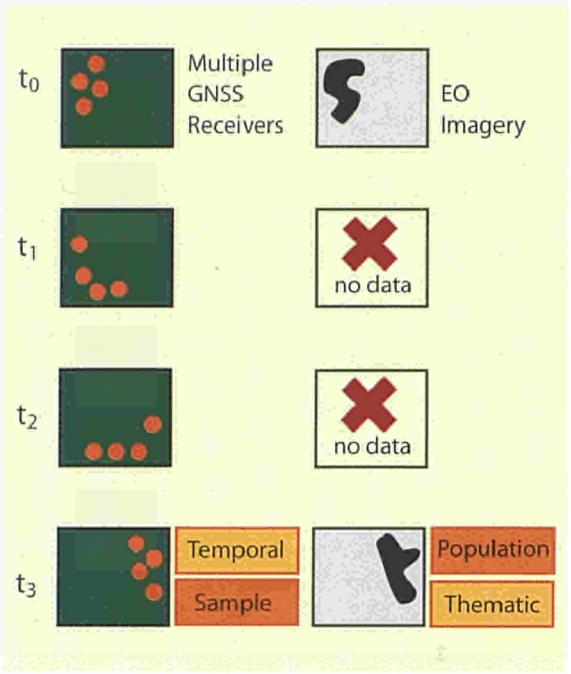
In the geographical information world, we are going through a transition period from traditional maps to digital spatial databases. Very soon most of the spatial applications will be handled by a normal PC, more difficult ones by a more powerful database management system while complicated applications will use the web for client-server interaction between the low-end user and the remote powerful GIS machine. Maps will very soon become much more than a traditional paper print of an area's snapshot at a given time. Within the next two to three years 'smart maps' will also be communication tools, control and display mechanisms, active messaging interfaces. They will need to be available anywhere and give recent/updated information about any place. They will also offer positioning information of different kinds ("Where am I? Where is my kid? Where is my fleet? Where is the closest restaurant? What is the menu today?"). Satellites are well positioned to provide both the information and the distribution services that are needed for such products.

Integrating Space Technologies into the Global Information Infrastructure

Earth observation is currently moving away from its science-based approach towards a more market driven tool for acquiring global geo-spatial data information products. With very high-resolution (1 m) satellite imagery already available, the remaining challenge for Earth observation is to demonstrate that it can supply reliable and cost-effective geographical information for commercial as well as environmental applications.

Satellite navigation services are starting to become widely available. Embedded navigation systems already feature as minor components of integrated circuit boards within mass-market products in hundreds of scientific, commercial and industrial applications. An example of this are passenger information systems increasingly being introduced for municipal buses and trains giving real arrival times of the next service at stations or bus stops. On 17 June 1999, Europe decided to proceed with defining Galileo as the European contribution to the Global Navigation Satellite System (GNSS). This important strategic decision will no doubt enhance the development of products and services derived from satellite navigation technology in Europe.

The communications demand is on a permanent state of growth. The rapid growth of information access and exchange in a global context as exemplified by the Internet, and the increasing trend towards mobility are opening up new prospects for the introduction of novel communication systems aiming at providing advanced multimedia services with world-wide coverage to fixed or mobile users. Satellites are ideally suited to linking organisations in rural or remote regions to the information highway. Satellite Technology provides the capability for fully mobile, personal broadband services.



Satellite navigation measurements can help to fill the gaps in an Earth observation data series through continuous remote data collection by dispersed inexpensive GNSS transmitters during a flood event.

Synergy of Space Technologies

While the satellite navigation signal is available to anyone, anywhere and anytime, it is simply a position sensor providing co-ordinates in space and time. These are difficult to interpret unless they are related to features on the ground. Earth observation, on the other hand, can provide this spatial detail for large areas anywhere in the world, but it is only available at fixed times depending on the frequency of the satellite overpass. In addition, cloud cover can render an optical image of the area of interest useless. It is in these aspects that the two satellite technologies can complement each other. The combination of Earth observation and satellite navigation can provide more complete and frequent observations, which are critical in disaster monitoring operations for example.

Synergistic use of space technologies is not a completely new concept. Satellite communications have been occasionally used in the past for the transfer of Earth observation data. ASTRON already in 1998 produced a first inventory of these projects. Also, signals intended for satellite communications and satellite navigation have been opportunistically exploited as a complement to Earth observation measurements. Most examples have used GPS signals for atmospheric sounding. There are also possibilities for using reflected signals from the sea surface for ocean monitoring and the radio-occultation of inter-satellite communication signals for atmospheric sounding.

Clearly the most obvious potential for synergy lies between space telecommunications and navigation, where the combination of the two technologies extends the question *"Where am I?"* to *"Where are they?"* with the accuracy of less than 10 metres. Today, operating navigation payloads are flown on geostationary satellites to augment the performance of GPS and GLONASS. There are already in the market combined user terminals capable to both receive positioning information and transmit this information through another satellite communications constellation.

Communications is the maturest service, followed by Navigation. Communication and Navigation could pull Earth observation in this new mass market. Commercially viable new services addressing market or quality of life needs based on the synergy of these technologies can provide an interesting new area of applications for market up-take by European industry. Opportunities will be found where:

- Earth observation and Navigation can be turned into tradable information and services, and Communications is used to acquire and distribute this information (towards personalised *infomobility*).
- Applications exist where space systems are a virtual monopoly for delivering a certain service or where synergies with ground and alternative systems can give unique advantages.
- Information and services from Earth observation, Navigation and Communication can turn into topics addressing the widest possible range of customers: every European citizen in the Information Society.

ASTRON Development Model

The aim of ASTRON is to improve benefits from the use of space technologies and services in Europe by assisting in their integration within emerging digital interactive services. Thus the key objectives of ASTRON are to investigate the synergy between satellite communications, satellite navigation and Earth observation in order to develop and demonstrate innovative and sustainable applications; to provide direct support to other EC services responding to their requirements in the areas of the project staff's competence; to contribute to the EC effort for the development of Galileo, and in particular the Galileo pilot projects.

These objectives will be met through four sequential activities: "communication" that leads to "monitoring and analysis" that leads to "development and demonstration" that leads to "user up-take"; this last activity eventually meeting the overlaying objective of the JRC action line "Underpinning European Competitiveness" under which ASTRON is supported. For each activity, the relevant stakeholders are identified and so do the rationale and expected results for Europe from the collaboration with the stakeholders.

The position of the ASTRON project in the context of the space activities of the Fifth Framework Programme.

• THEME 2: USER-FRIENDLY INFORMATION SOCIETY	
Key actions	
(i) Systems and services for the citizen	*collaborating*
(iv) Essential technologies and infrastructures	
• THEME 3: COMPETITIVE AND SUSTAINABLE GROWTH	
Key actions	
(ii) Sustainable mobility and intermodality	*collaborating*
(iii) Land transport and marine technologies	
(iv) New perspectives for aeronautics	
• THEME 4: ENERGY, ENVIRONMENT AND SUSTAINABLE DEVELOPMENT	
Key actions	
(ii) Global Change, Climate and Biodiversity	
Research and technological development activities of a generic nature	
(ii) Development of generic Earth observation technologies	
• DIRECT ACTIONS (JOINT RESEARCH CENTRE)	
Space Coordination Group	
Space Applications Institute	
(i) Serving the citizen	
(ii) Enhancing sustainability	
(iii) Underpinning European Competitiveness	*ASTRON*

Communication with stake-holders.

Stake-holder		Collaboration Scheme
EC Services	• DG Enterprises	Provision of technical support and coordination of work
	• DG Transport	Provision of technical support and coordination of work
	• DG Information Society	Provision of technical support and coordination of work
Space Agencies	• European Space Agency (ESA)	Coordination and collaboration with the ARTES programme
	• CNES (F)	Collaboration on synergistic use of space technologies in the Intelligent Transport Services sector
	• DLR (D)	New applications demonstrations and implementation of user services for satellite navigation
	• BNSC (UK)	National space applications programme
Space Segment Providers	• SES/ASTRA	Plans for joint undertakings for demonstration projects
EO data providers	• Space Imaging Europe	Plans for joint undertakings for demonstration projects
Other SAI Projects	• EURO-LANDSCAPE / MOLAND	
	• Natural Hazards	

Communication with Stake-holders

Within 1999, ASTRON established formal collaboration frames with the three relevant EC services: DG Enterprises, DG Transport and DG Information Society for provision of technical support and co-ordination of work (with particular emphasis on market studies and demonstration projects) in the timeframe 2000-2002.

Discussions for technical collaboration have proceeded very well with various space agencies. In particular, a plan for co-ordination of ongoing projects has been agreed for the ARTES programme of the European Space Agency (ESA). There is ongoing discussion with CNES, France, for collaboration on synergistic use of space technologies in the Intelligent Transport Services sector. With DLR, Germany an agreement will be soon established for the development of joint activities to demonstrate new applications and to implement user services for satellite navigation. Discussions with Italy started recently. Last but not least a close co-ordination is envisaged with BNSC, UK for the national space applications programme.

In June 1999, a two-day cloistered seminar was held in Ispra, with major European industry representatives. In parallel, discussions have proceeded with a number of European providers (SES/ASTRA, Space Imaging Europe) for joint undertakings towards demonstration projects. A workshop was held in Ispra in October 1999 with professors from universities in Germany, Spain, Greece, Italy and the UK, who had already expressed an interest in ASTRON. Following a review of opportunities and priority areas was done and it was agreed to establish and maintain a research network that will be open to all other interested institutions. This network will be of mutual benefit, including EC policy priorities to the research world while introducing innovation and successful research results to the ASTRON project. Moreover, collaboration frames were established between ASTRON and other SAI projects, namely *EUROLANDSCAPE/MOLAND* and *Natural Hazards*, that are working on relevant applications.

In January 1999, an information day on ASTRON was held in Ispra and was attended by 100 representatives from the EC, space agencies, industry and research. A call for ideas was published in the Official Journal of the EC in June 1999, requesting ideas from European organisations or citizens on areas and initiatives relevant to ASTRON, which the EC should undertake. A call for expression of interest was published in the Official Journal of the EC in April 1999 and will stay open until the end of 2000, for the creation of a short list of organisations interested to carry out future contracts for ASTRON with a value less than KEUR 130.

Monitoring and Analysis

Within the context of technology monitoring a number of reports were published: namely the Satellite Communications Survey 1999 (3rd release), the Satellite Navigation Survey 1999 (1st release), and the Earth observation handbook (1st release), including updated information with regard to the 1998 EO report. The Space Compendium 1998 was prepared for the EC Space Co-ordination Group presenting all space related projects that were funded by the European Commission in the Fourth Framework Programme. The Synopsis of the Satellite Navigation Market studies was prepared, consolidating information from all acknowledged relevant market studies. All aforementioned documentation as well as publications from past years are available and can be ordered by email from ssa.helpdesk@jrc.it.t.

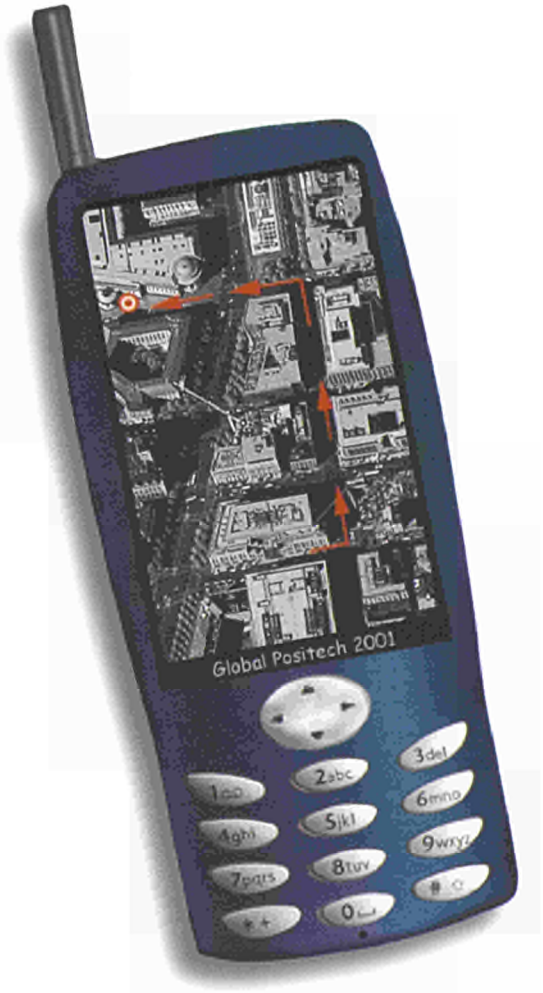
Four market studies were awarded and are expected to produce results by the end of the first semester of the year 2000. These studies will perform a market analysis and propose mini business plans for the following market segments:

- **Saving Resources:** Applications about quality of life and ecosystem preservation, i.e. wildlife preservation, natural and man-induced incidents, environmental monitoring, common and foreign security, anti-personnel mine detection, law enforcement, public security, including search and rescue operations.
- **Business I:** Emerging applications exploiting innovative technologies and addressing mass markets, i.e. Personalised Infomobility Services, Media, Interactive Games, Entertainment, Tourism, Leisure, Sports, Real Estate.
- **Business II:** Emerging applications relevant to the Olympic Games of Athens-2004, but also applicable to the other major sport, cultural or business events where high population densities are introduced in urban areas for limited periods of time.
- **Transport:** Applications in the transport section, such as those related to road, train, air, maritime, and intermodality.

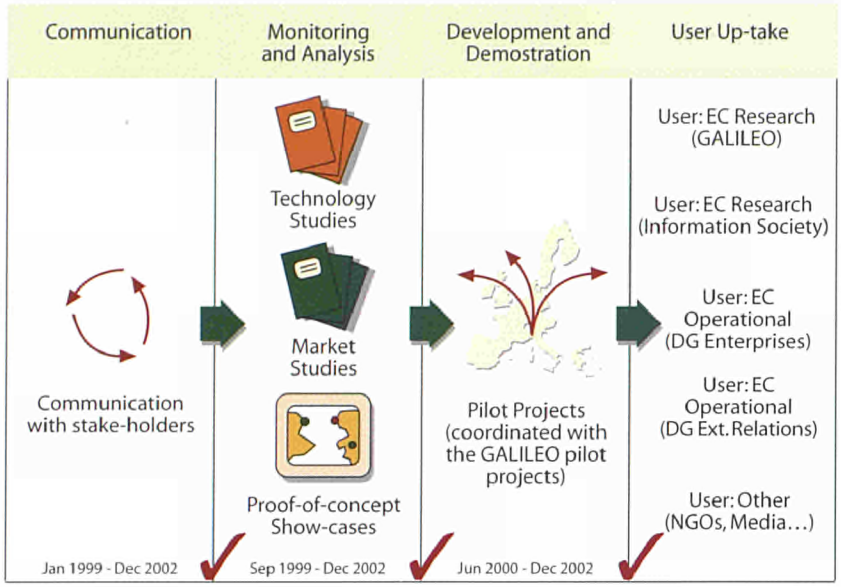
Development and Demonstration

The first demonstration projects were initiated and are expected to be ready in the year 2000. They are called 'proof-of-concept showcases', because they aim to demonstrate the vision and the opportunities arising from synergy of space technologies. They will focus on *environment and security* and *infomobility services*.

The first demonstration project targets personal infomobility and is entitled Personal Assistant (City Navigation). It aims at providing orientation in different areas and supporting users with information on demand. The demonstration visualises these capabilities using different space (EO, NAV, COM) and ground based technologies in a synergistic way. It is focused on personal guidance to people in unknown environments. This could either be an unknown city, where they need help to find the next subway station or a rural area, where backpackers search the nearest camping site. In a next step further projects directed to population security, hazards and search and rescue, will be developed. The development of these projects is based either on industrial work specified by ASTRON or by own work in collaboration with other SAI projects.



Personal Assistant, City Navigation (courtesy of OM&M).



The ASTRON Development Model.

Selected Further Reading

ASTRON Brief Presentation, 1999. Report SSSA/ASTRON /008.

ASTRON Information Day (19 January 1999): Workshop Proceedings. S.P.I. 99.22.

Combined Strengths: Synergy of Earth observation and Satellite Navigation. S.P.I. 99.190.

Overview of Current and Planned Spaceborne Earth Observation Systems; the Handbook – Scenarios of Integrated Space Applications (Satcoms and EO). Report EUR 18672 EN.

Satellite Communications Survey 1999 – Systems & Applications; Release 3. Report EUR 19006 EN.

Satellite Navigation Survey – Systems and Synergistic Applications. Report EUR 19013 EN.

Space Compendium '98. Report EUR 18971 EN.

Synopsis of the Satellite Navigation Market Studies. Report SSSA/ASTRON/014.

http://www.sai.jrc.it/astron/

http://www.sai.jrc.it/astron/documents.htm

Highlights

1999

- ASTRON Information Day, JRC, Ispra (19 January 1999).
- Agreement for Collaboration with DG Transport (19 January 1999).
- Agreement for Collaboration with DG Information Society (17 June 1999).
- ASTRON Industrial Cloistered Seminar (21-22 June 1999).
- Agreement for Collaboration with DG Enterprise (5 July 1999).
- Agreement for Collaboration with the Natural Hazards of SAI (30 September 1999).
- Agreement for Collaboration with the ARTES programme of ESA (18 October 1999)
- First meeting of the ASTRON Research Network on 'Scientific innovation and synergistic applications of satellite technologies' (27 October 1999).
- Agreement for Collaboration with the Eurolandscape/Moland project of SAI (12 November 1999).

2000

- Publication of Satellite Communications Survey 1999, 3rd edition (January 2000).
- Publication of Satellite Navigation Survey 1999, 1st edition (January 2000).
- Publication of EO Handbook, version 1.2 (January 2000).
- Publication of Space Compendium (January 2000).
- Initiation of four market studies and the first demonstration project (January 2000).
- 2nd Industrial Cloistered Seminar (April-May 2000).
- First Presentation of ASTRON results (GNSS 2000 conference, May 2000).
- First Demonstration projects available (May-December 2000).
- Invitation To Tender for industrial development of demonstration projects (May-June 2000).
- Closer Coordination with the Galileo Application projects of DG Transport and DG Information Society.

Project Co-ordinator:
Alessandro Annoni

The growing attention from both public and private organisations to aspects concerning Geographic Information (GI) is a logical consequence of the developments society has seen over the last three decades. With the risk of some over-simplification, these developments are characterised by strong individualisation (as a reaction to standardisation), globalisation (a continuation of standardisation in extremis), flexibility (fed by the wish to apply as cost-effectively as possible limited resources in a changing environment), the speed of innovation, and the increased care for nature, quality, and safety. These aspects affect directly and indirectly all GI communities, which share the great challenges of the information society, of which GI is an integral part. The use of GI in private sectors, where actors apply GI and GIS as powerful marketing and planning instruments, has created unprecedented opportunities.

Also in regional, national, and European policy making, measures are more and more tailored to local realities. GI concerns all major EU policies, directives and programmes, such as the Common Agricultural Policy (CAP), the European Spatial Development Perspective (ESDP), transport, environmental protection and sustainable development, having an increasing impact on the European territory. Planning and monitoring of these policies intensify the pressure for more timely, dependable and usable Geographic Information. At the same time, inappropriate territory management often causes an increase in natural disasters and detrimental consequences to the environment and to people. To reduce the probability and cost of natural disasters and better manage them should they occur, territory management must be monitored and improved. In other words spatial planning is necessary and hence GI since it constitutes an essential component. On the other hand, environmental phenomena are not limited to national boundaries. Thus there is a need to create and maintain coherent seamless databases describing fundamental geo-referenced information. Examples include administrative boundaries, soil type, meteorological information, land cover, demography, protected sites, and urban dynamics.

Territorial management is multi-disciplinary by its very nature. The sustainable development principles, agreed at Rio de Janeiro and Kyoto meetings, increase the need to combine information coming from different disciplines. Examples are agriculture, environment, transport, fisheries, land planning, geomarketing, geology, etc. The only way to succeed in combining data in a cost-effective fashion, and to keep coherence in the decision process, is by creating an infrastructure, making reference data and system available for all users, from all disciplines, regardless of the scope and reach of their work. The solution to meet the challenges is the set-up of a common framework called European Geographic Information Infrastructure (EGII). The operational use of GI requires that information should be interoperable and accessible to distributed users (interoperability). Furthermore, advances in information technologies have resulted in an explosion of GI databases, but the lack of appropriate tools for spatial analysis prevented a commensurate increase in knowledge.

The GI and GIS project aims at helping to pave the way both for private and public sectors in the EU to overcome the difficulties that hinder the development and application of GI. The specific objectives of the GI and GIS project are: 1) to conceive, create and harmonise pan-European databases relevant to support and monitor EU policies, mainly through the support and co-ordination of networks in various thematic fields, including the European Soil Bureau and the European Topic Centre on Land Cover; 2) to develop integrated spatial models and to improve the use of GI in statistics; 3) to assist the creation of EGII; 4) to develop a common European position on GI/GIS interoperability; and 5) to inform and educate European users operating as GI/GIS communications facility. The GI and GIS project can be seen as an integrating tool, a bridge between information technology and applications domains that have a direct impact on our life. In this chapter, some 1999 key activities will be highlighted. These are: Dissemination of information, the European Geographic Information Infrastructure, GI and GIS interoperability, Spatial analysis, Land-use and land-cover, European Soil Information System, GIS for NATURA 2000, and the Catchment Information System for the agri-environment.

GI and GIS: Harmonisation and Inter-operability

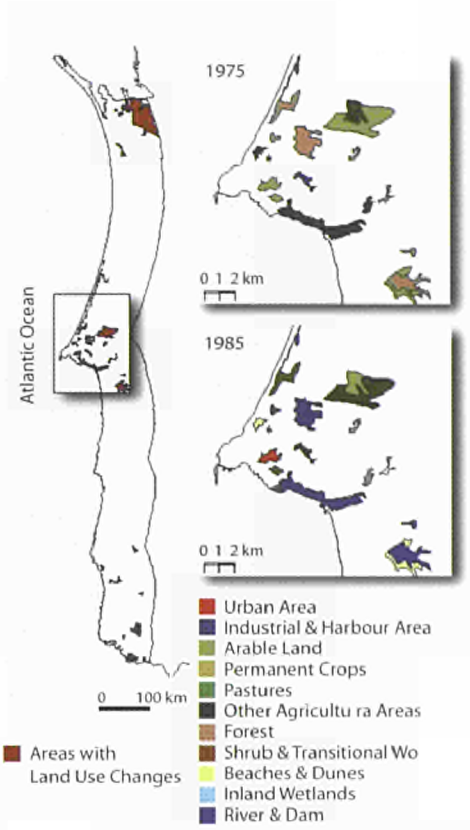
Dissemination of Information

Dissemination of information about GI data and GIS technology is a key element to improve the use of GI, to develop new market opportunities and to help in decision making. This is true both for activities that affect directly the European Commission (EC), and for those that relate to the use of GI in the European Union (EU) as a whole. Some topics that were identified for inclusion in the dissemination process are: "who does what?" on EC GI and GIS, the spatial dimension of EU policies, GI data policies, general repository of EC GIS related publications and workshop proceedings, EGII, EU sponsored projects, reviews of projects with an important technical component (e.g. metadata, reference data, catalogue services, interoperability, digital libraries), GI(S) research and development, and GI and Statistics. In 1999, major dissemination efforts were put in the use of Internet and the organisation of the annual EC-GIS workshop.

Over the past few years we have seen an increase in the interest and use of GI and related technologies within the EC services. In this context the EC acts both as a user and as an actor, which fuels the need for the dissemination of timely and accurate information from the EC to the European GI Community. Since Internet is the perfect medium for this purpose, an EC-GIS web portal has been designed that will focus on GI and GIS topics and activities within the EC Services and on GI and GIS related projects and technology funded by EU programmes. This site (http://www.ec-gis.org) will be hosted and maintained by the GI and GIS project in close collaboration with other EC services, improving the visibility and coherence between relevant GI and GIS activities.

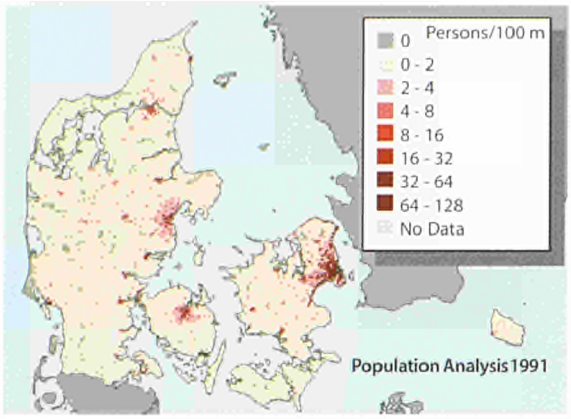
The 5th European Commission Geographic Information Systems (EC-GIS) workshop, entitled "GIS of Tomorrow" was hosted by SAI in Stresa, in June 1999. This meeting brought together researchers involved in EC sponsored projects, GIS Industry, data suppliers, and EC representatives to discuss the issues facing the European GI community. The main objectives of the EC-GIS workshop were: i) to provide information about projects financed by the EC relevant to GI and GIS; ii) to inform the European community on relevant European initiatives or organisations; iii) to discuss topics for the research agendas or for political issues on GI and GIS; iv) to give the opportunity to Industry, academia and data providers (private or public) to meet; v) to establish strategic partnerships and to identify European priorities in which EC initiative is required. The workshop focused on ESPRIT and INFO2000 projects but also included presentations from other programmes such as transport, environment and climate, INCO and telematics. The 1999 workshop saw a substantial increase in the number of participants, this higher attendance reflects:

- The growing importance of the workshop to the GI/GIS community
- The growing recognition of the importance of spatial information
- The improved dissemination of European GI/GIS activities, and
- The increased interest and presence of projects financed by EC with a GI and GIS component.



Land Cover Changes, Alentejo Litoral 1975/85.

Contact: Karen Fullerton



1991 Population Distribution (Denmark).

European Geographic Information Infrastructure

EGII concerns all aspects related to reference systems, metadata, data structures, data policy and pricing, and seeks to streamline and homogenise these elements in order to enhance the exchange of GI in the EU. The matter is highly complicated, both from political and technical viewpoints. Typical questions that are addressed are: "may citizens use the basic GI datasets the governments have compiled with their tax money?", or "who has the copyright of value-added data?". In the 1999 debate about a GI data policy, different positions emerged. In order to discuss and agree for a common vision a workshop was organised on 15 November 1999 by the GI and GIS project in Amersfoort with the European Umbrella Organisation for Geographic Information (EUROGI: http://www.eurogi.org/) concerning the GI data policy. The workshop addressed, among others, the EUROGI current position related to data policy; the current practice in the various countries, including Member States; the recommendations to be included in the on going discussion for Public Sector Information in Europe focussing on GI aspects (GI2000: towards a Policy Framework for Geographic Information); and the ways to link EGII with the Global Spatial Data Infrastructure (GSDI) initiative.

EGII touches also issues related to interoperability. Exact knowledge, understanding, management and subsequent processing of the co-ordinates of any GI dataset is one of the central aspects of cross-border GI interoperability. The GI and GIS project, together with the consortium of the European National Mapping Agencies (MEGRIN: http://www.megrin.org/), organised the "European Spatial Reference System" workshop in Paris, on 29-30 November 1999, with a panel of leading experts. With this workshop the organising committee sought to advise the EC on data specification related to spatial referencing systems; to assess, at the European level, the issues involved; to identify the relevant actors; and eventually to draft an initial action-plan. Some of the topics addressed were: a common Spatial Reference System for Europe; a survey/collection of the Spatial Reference Systems used in Europe; transformations from national co-ordinates to the common system, and vice versa; specification, validation or certification of software embedded transformation modules.

In order to improve the support and exchange of information on EGII, the GI and GIS staff are involved in several EU-funded projects. One example is the PANEL-GI project (Pan European Link for Geographical Information: http://gisig.ima.ge.cnr.it/panel-gi/), which supports networking in the field of GI between European Union and Central and Eastern European (CEEC) partners. This is achieved by the so-called "example through study" visits. Special attention is given to the preparation of a PANEL GI Package on GI and GIS for which the JRC is in charge of the preparation of the part on GIS application domains. The long-term objective of the PANEL GI project is to support the creation of national geographic infrastructures in the participating countries. Another example is the recently approved project ETEMII (accompanying measure to support the set-up of a Territorial Management Infrastructure). Its main activities relate to building a consensus on such issues as reference data, data access policy, interoperability, standardisation, and integration of various space tools (navigation, Earth observation and telecommunications). The Project will support European participation in such initiatives as Open GIS Consortium, ISO and GSDI.

Contact: Alessandro Annoni, Jean François Dallemand

GI and GIS Interoperability

Complementary to EGII, the activities of which have a strong relation to data pricing and policy, the GI/GIS interoperability has a more technical character. The GI and GIS staff are participating in the GIPSIE project (GIS Interoperability Project Stimulating the Industry in Europe: http://gipsie.uni-muenster.de/) funded by the ESPRIT programme to help and support the European GIS industry development of products compliant with OpenGIS specifications. In order to achieve its aims, GIPSIE focuses on three principal activities: i) to establish an OpenGIS interest group, to unite the European industry, and to establish good communication with the OpenGIS Consortium; ii) to identify and resolve European issues and introduce them to the world-wide OpenGIS specification process; iii) to timely and effectively inform the European IT industry, in particular SMEs about the OpenGIS movement.

As a result of the recommendations from the Strategic View report of the JRC and the requested Virtual Interoperability Laboratory (VIL), the JRC (SAI and ISIS), together with DG Industry, decided that the best way to define such a laboratory was to hold a cloistered workshop to discuss various aspects of the proposal. In February 1999, a group of invited experts convened at the

JRC to participate in a one-day workshop discussing all aspects of interoperability relating to GI/GIS. The report detailing the discussions, conclusions and recommendations arising from the Workshop was published and is available on the EC-GIS website.

The application of information technology for services in the Commission is considered more and more a strategic means to improve the quality and cost-effectiveness of the work delivered. Several GI layers are available to civil servants in the Commission but in order to improve access time and usability of the GI the ARIS unit developed corporate data models for use in the Commission. Important for the efficient use of GI is the availability of centrally and easy accessible meta-information (i.e., information about the whereabouts of GI). Many activities carried out within the EC contain an explicit and important spatial component. Through the incorporation of GI in corporate and scalable databases it is possible to work on the gradual improvement of the data quality and to provide the right information to any place connected to the Internet. The backbone of it all is a data server that uses an open industry standard to deliver data to virtually any client (GIS interoperability). The data model contains the blueprint of what is available and how it is organised, and enables the safe data sharing. In 1999, this has been put into practice in the data model for the EUROSTAT (DG European Statistical Office) GISCO (GIS for the Commission) Office, which has the mandate to disseminate Geographic Information inside the Commission, and in the data model proposed for a new detailed ecological map of Italy.

Interoperability also includes issues related to the understanding of data. For an efficient exploration of integrated remote sensing and GIS datasets of high dimensionality, virtual reality technology is likely to offer much promise in the future and is likely to become indispensable alongside developments in 3-D visualisation techniques. In this context development is underway of prototype tools to visualise remotely sensed data and derived products of high dimensionality – for instance, classified images – GIS datasets and statistics about land use classes by using and integrating a number of innovative emerging technologies.

Contact: Alfred de Jager, Ioannis Kanellopoulos, Rui Meneses

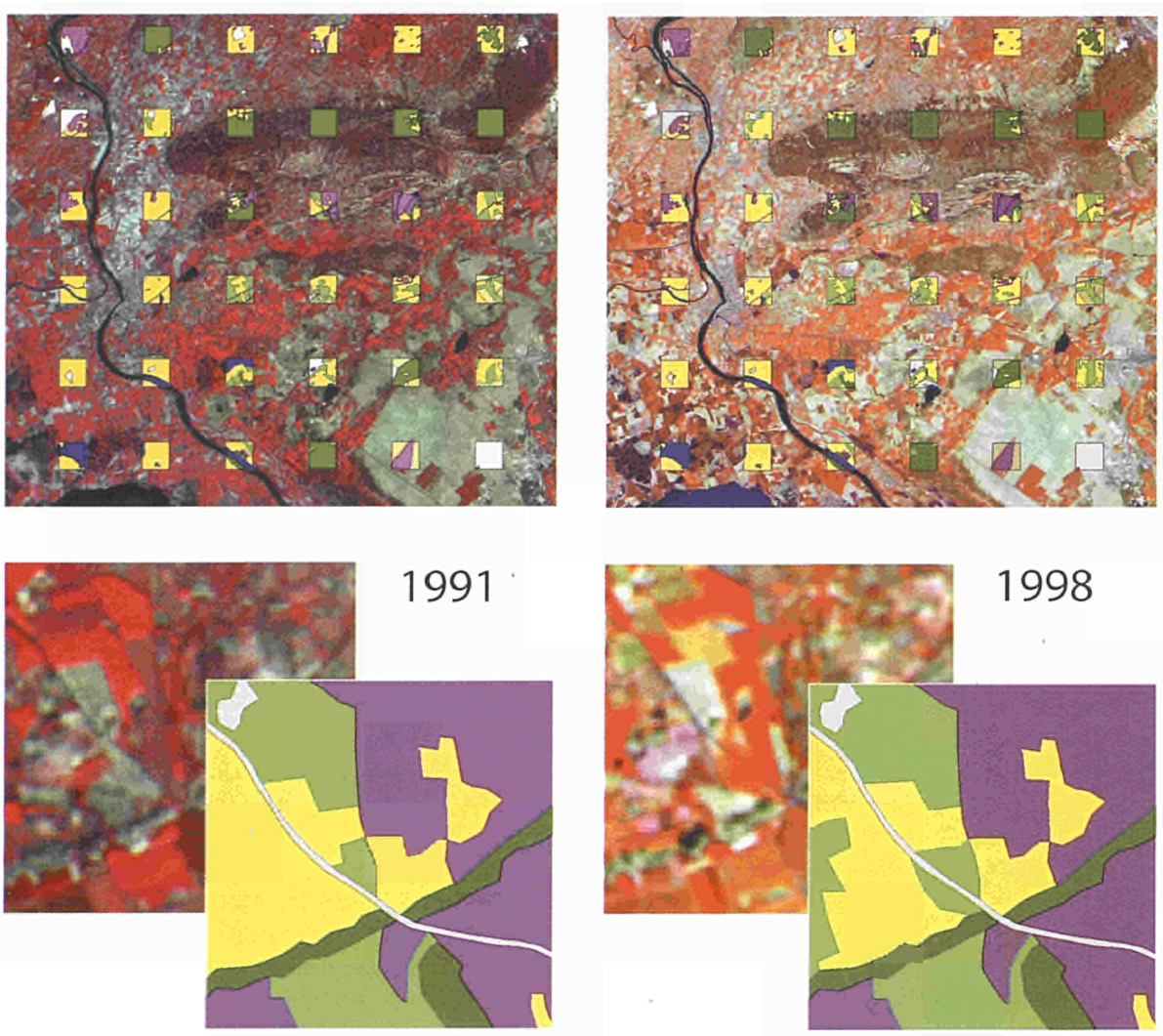
Spatial Analysis

The integration of spatial data is important. There are increasing demands for spatial and territorial analyses to support policy development such as the Common Agricultural Policy (CAP) reform, the Strategic Environmental Assessment of Trans-European Networks, the initiative to prepare a European Spatial Development Perspective, the development of the NATURA2000 network, water management at catchment area level and the enlargement process. Integrated policies cannot exist without a territorial reference. In 1999, the GI and GIS project used advanced spatial analysis for two applications: the characterisation of landscapes, and the disaggregation of population density by using a pan-European land cover/land use database.

The 1992 reform of the CAP saw the introduction of agri-environmental subsidies. After several years of implementation, the Commission, particularly DG Agriculture, needs a tool for evaluating the impact of CAP. A set of agri-environmental indicators to quantify the negative and positive impact of agriculture on the environment is under development by the Commission and the OECD (Organisation for Economic Co-operation and Development) countries. Whilst it is relatively easy to measure and compile indicators for aspects such as pesticides, nitrates and the pollution of ground water, it is much harder to quantify the contribution of agriculture to biodiversity and landscape value. The target of this activity, developed jointly by DG Agriculture, SAI, EUROSTAT and the European Environment Agency (EEA), is measuring the regional diversity of land cover spatial patterns (landscape characterisation) using CORINE (Co-ordination of information on the environment) Land Cover. Landscape characterisation is a complex issue with numerous implications, including cultural and aesthetic considerations. A quantitative analysis requires a restricted concept of landscape and a harmonised database in the area under study. CORINE Land Cover is relatively coarse to characterise a landscape, but it is the only dataset that allows to compare land cover indicators across Europe in a coherent way. Even with a restricted concept of landscape as the geographic layout of different land cover types mapped at a certain scale, it is not possible to describe the complexity with a simple indicator. We have studied the behaviour of several types of indicators computed on CORINE Land Cover and on ground data coming from point surveys on a set of 40 km x 40 km sites across the European Union (MARS sites).

Population density data are available to the European Commission at municipality level (NUTS5). This level of spatial resolution may be insufficient in many cases for planning purposes, especially for countries with large communes. CORINE Land Cover provides information that is geographically more detailed on main types of land cover. A certain municipality may contain for example one part of dense urban nucleus, agricultural land with some sparse population and natural vegetation areas with virtually no population. A first disaggregation of population data has been performed imputing different densities to different land cover categories. Accuracy assessment and geographic improvements of this imputation will be the way forward.

Contact: Javier Gallego, Susan Christensen



Assessing Land Cover Changes on MARS Site "Arles", France. Visual photo-interpretation on segments of 2x2 km.

Land Use and Land Cover

Land use and land cover change varies in space and time. Both are major causes for climate change and loss of biodiversity, and they strongly affect socio-economic conditions and the sustainability of human-environmental interactions. It is important to identify and to understand processes of land use change, how land cover has been affected by human activity and the processes that result in landscape transformation. This is particularly true for critical areas like the coastal fringe with several competing land uses.

The LACOAST project has made a vital contribution in this context since it has provided information on land cover changes between 1975 and the 1990's in European coastal zones. The results were further used in the ALENCOAST project together with socio-economic data to understand the land use changes through the analysis of the impact of human and biophysical dynamics. ALENCOAST developed a methodological approach to understanding the interactions between natural and human systems in coastal areas, for example: the effect of urbanisation and the provision of sport and leisure facilities in EU coastal zones; and the results of changes in the road and rail networks on the overall infrastructure of the coastal zone.

The results of both LACOAST and ALENCOAST have been used in the EEA environmental assessment report. Other indicators, to be used by EUROSTAT, have been developed, for example the loss of land for development along the shore through the drainage of wetland. The most important land use changes that have occurred in each 10 km x 10 km grid square in the European coastal zone have been analysed and demonstrated by the EU demonstration programme on Integrated Coastal Zones Management (ICZM).

The updating of the European-wide CORINE Land Cover database started in 1999 as a joint JRC/EEA project. It is split-up in two phases, namely IMAGE2000 (the collection and processing of satellite imagery) and CLC2000 (the actual updating). The satellite images that are the basic input source for updating the land cover database will provide a common reference between national and European demands. Therefore IMAGE2000 is an EU-wide mosaic of ortho-rectified satellite imagery in both European and national projections, dated 2000 with the maximum allowed deviation of one year (1999-2001). Although IMAGE2000 is primarily designed for the CLC 2000 production, it can be seen as a multipurpose product that can be used for

different topics demanding for spatial information within the Commission. The ARIS unit is responsible for IMAGE2000, in co-operation with EEA. CLC2000 is under the responsibility of EEA and it is jointly co-ordinated by the JRC and EEA.

The challenge for updating the CLC data will be to bridge between the national and European user requirements, which stress the need for a compatible more detailed inventory at local level. The multi-scale approach for the implementation of CLC2000 is the one that better fits the diversity of user requirements. A number of issues regarding the operational use of the CLC2000, namely access to the database, compatibility with other data, harmonisation of metadata and distribution policy are carefully examined.

For a comprehensive analysis of the impact of EU policies in the landscape, it is not enough to know that the area of arable land or pastures has decreased in a certain period. However it is important to know the area changed from arable to pastures or to urban, and the area changed from natural vegetation or from pastures to arable. We analysed the way of using images for the statistical estimation of change. The link between mapping and estimation is not obvious. For example, if in a given area there is a mixture of parcels, out of which 30% are arable, 40% woods and 30% permanent crops, and after a few years the proportions become 50% arable, 25% woods and 25% permanent crops, it may be correct to consider that there has been no change from a mapping point of view (it remains a heterogeneous agricultural landscape), but there is an important change from a statistical point of view. We investigated the ways to combine satellite images, aerial photographs, ground surveys and other data to estimate the area of land use changes.

Historical land cover and land use and the assessment of land cover and land use change from the past to present are important to understand the current processes, to identify trends and to forecast changes that may occur under certain natural, economic, social and institutional conditions. For the flood risk assessment and for agri-environment concerns, land cover and land use are important factors. The comparison of land cover at different dates for the Odra river catchment was performed, after having implemented a land cover database for 1975, compatible with the CORINE Land Cover database.

In parallel to the updating of the CORINE Land Cover database, advanced research is carried out to investigate the economic benefit from automatic and semi-automatic image analysis in general and from data fusion and change detection techniques in particular. From the data point of view, there are three major issues involved in change analysis and change detection, all of which are addressed in the ARIS application oriented research and prototype development: i) image-to-image change analysis; ii) image-to-land-cover database change detection; iii) analysis of changes between two land cover/land use layers collected at different moments.

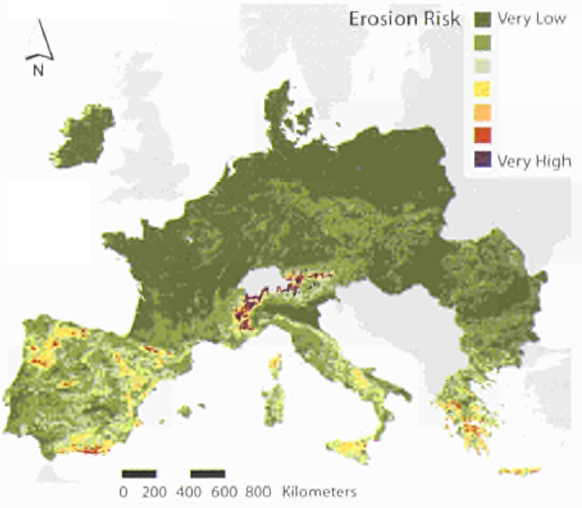
Contact: Vanda Perdigão, Paul Smits

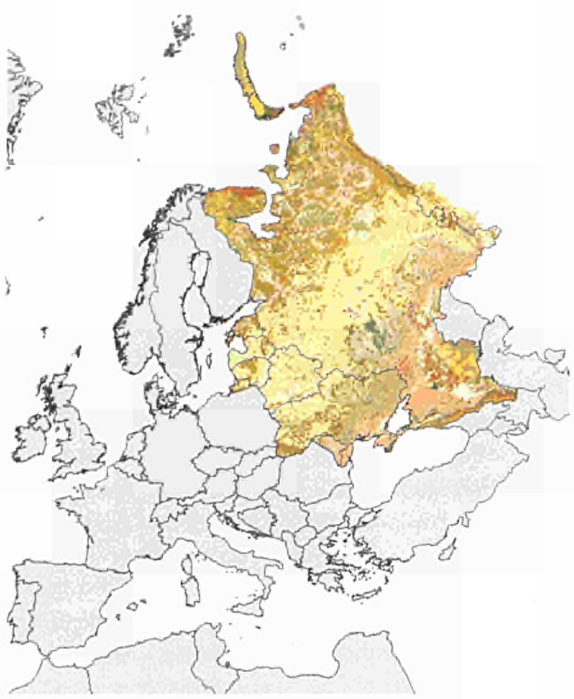
European Soil Information System

Soil is one of the essential elements of the biosphere, which necessitates a global policy for management, evaluation and conservation. To implement such a policy, it is necessary to have harmonised information both in space and time. The Commission is the originator of several programmes aiming to acquire soil data. Associated with other sources of information, such as water, air, and land management, these data constitute a valuable tool for decision support processes, in particular for the control of agricultural production, land management and environmental protection. The MARS programme initiated the development of a geographical database for the soil cover at scale of 1:1,000,000. The European Soil Information System (EUSIS) consists of a geographic dataset, a semantic dataset, a soil profile analytical database, a soil hydraulic parameter database and a knowledge database in a fully integrated GIS. Its aim is the establishment of a common framework on a continental scale for the sustainable use of soil resources in Europe and to provide harmonised soil information relevant to EU policies, its relevant DGs, to the European Environment Agency (EEA) and to related institutions of the EU Member States.

The geographic extension of EUSIS to TACIS and MEDA countries is ongoing. For the former Soviet Union two meetings were organised for the establishment of the necessary co-ordination and contacts. The first one, Northern Circumpolar Soil Map Meeting, took place in Copenhagen, Denmark, on 16-18 March 1999. The second one was entitled "Extension of the European Soil

Actual soil erosion risk in Europe (preliminary results).





Extension of the georeferenced soil data acquired in 1999.

Information System", and was held in the FAO premises in Rome, on 2-3 September 1999. The first set of soil data have been acquired and are in the process of being harmonised to the standards of the Soil Geographical Database of Europe. For the Mediterranean Basin a meeting entitled "Meeting for the Establishment of a Euro-Mediterranean Network of Soil Information for the Mediterranean Basin" was organised on 4-7 December 1999, in Bari, Italy.

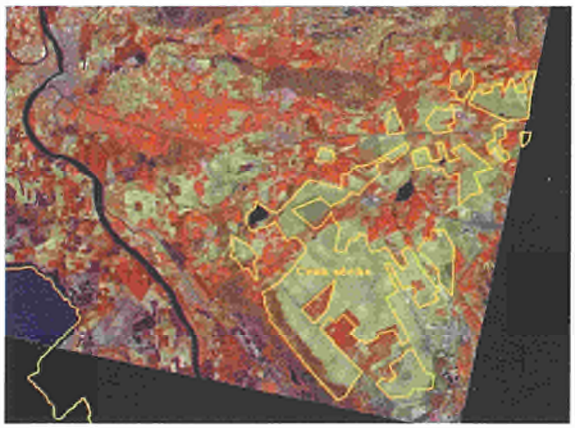
The development of pan-European soil erosion risk assessment started in 1999. Soil erosion is a major socio-economic and environmental problem through Europe. It reduces the productivity of land and degrades the performance and effectiveness of ecosystems. More than half of the land in Europe has suffered various degrees of soil erosion by water and about a fifth has been eroded by wind. The phenomenon is more acute in southern countries, where it often reaches catastrophic dimensions. Eastern countries have also suffered severe soil erosion. In central European countries, the potential threat is significant on arable land.

Existing assessments of present and potential erosion risk in Europe are qualitative and localised. They are adequate for identifying the gravity of the problem but are insufficient for quantitative evaluation of the impact of erosion or for combating it at national and European level. A more accurate pan-European assessment based on simple regional modelling is necessary for developing and applying the necessary strategies to combat soil erosion. The new approach has been tested in France and the medium-term aim is to extend this to the whole of Europe, assessments being based on the European Soil Database and other relevant data sets. Preliminary results have already been elaborated. The annual meeting of the scientific committee of the European Soil Bureau (ESB) was organised in Vienna on 10-12 February 1999. The ESB was created in 1996 as a network of national soil science institutions. The on-going activities of a total of six working groups of the ESB were reviewed.

Contact: Luca Montanarella

GIS for NATURA 2000–Managing Europe's Nature Conservation Sites

NATURA 2000 is a European network of areas, proposed under the Birds Directive and the Habitats Directive, where human activity must be compatible with the conservation of sites of natural importance. The NATURA 2000 network comprises two types of areas: i) areas designated directly by the Member States under the Birds Directive; ii) areas proposed by the Member States under the Habitats Directive and then subjected to a Community selection procedure. NATURA 2000 covers large areas of agricultural land. Contrary to a widely held belief in rural areas, the idea behind the NATURA 2000 network is not to set up full nature reserves or freeze all human activity on the proposed sites. This would be both impossible and undesirable since the NATURA 2000 network could eventually cover 12% of the EU territory. Apart from a few exceptions (intact natural forests and underwater caves), NATURA 2000 sites are managed through productive activity. NATURA 2000 could therefore become a clear sign of the multi-functionality of agriculture in the third millennium. DG Environment co-ordinates the activities related to the establishment of this network, in collaboration with the European Topic Centre on Nature Conservation of the EEA.



One of proposed NATURA2000 Sites (Crau Sèche, SE France, designated as SPA).

The development of the Geographic Information System for NATURA 2000 is part of the activities carried out by the JRC under the agreement between DG JRC and the DG Environment. The components of this system will play two key roles – firstly in providing a mechanism for harmonising and validating incoming data from the Member States, each of which has different approaches, and secondly to provide analytical tools to model, monitor, visualise and publish data relating to the NATURA 2000 sites.

A thorough analysis of the characteristics of the data provided by Member States was undertaken by the ARIS unit in mid-1999, resulting in the specifications and subsequent development of tools to ensure the establishment of a consistent, pan-European spatial database for NATURA 2000. In parallel, work has begun in identifying and analysing requirements for the analytical aspects of the system. Such an information system will be vital to the successful management of the NATURA 2000 network, which is a huge organisational task requiring the efficient and reliable flow of information related to the sites between all the actors at local, national and European level.

Contact: Alessandro Annoni, Stephen Peedell

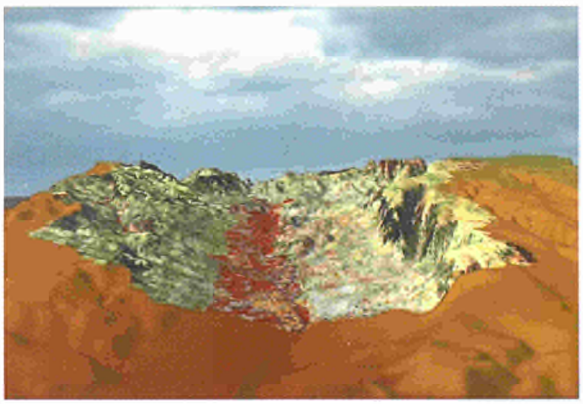


Image classification of catchment in MARS site Guadalajara, Spain for 1992.

Landscape generated by an Image classification of catchment in MARS site Guadalajara, Spain for 1992.

Catchment Information System for Agri-Environment

The development of a Catchment-based Information System (CIS) was initiated in 1998 to assess the impact of EU policies on agriculture and environment and to support environmental conservation. The final aim of the CIS is to provide a quantitative response to agri-environmental queries in the framework of an operational activity. The methodological groundwork was laid during a feasibility study, which started in 1998. The catchment, to be used as a management unit of the system, was further specified. It was defined as a logical unit covering the land area, which drains water to a specific surface water body. The area is represented by a single point (outlet), which is generally located at a stream or river crossing. Within the study the data needs of CIS applications were compared to data available within the ARIS Unit. Available data were evaluated according to the level of detail and spatial coverage, but also with respect to the quality of the informational content. Following the evaluation stage the approach to be taken in designing the system was defined. The CIS is thus based on two principal design characteristics: a multi-level hierarchical system of catchments, and a set of sample catchments to investigate agri-environmental issues.

The 1999 implementation phase concentrated on database aspects of the system. In the course of the work performed a data model was specified under consideration of the structure of the GISCO database. For the recovery of historic data from the MARS project, format conversion procedures were generated and tested on a subset of the data. An extensive search for essential information not available within the ARIS unit was performed. The search focussed on the identification of detailed Digital Elevation Models (DEM) and a European river network. The data were used to define river basins to specify the location of catchment sample sites. The work is being accomplished by Member States and first results were obtained for Italy and France. In parallel to the development of the database, work on agri-environmental applications for the CIS was carried out. A study was undertaken to investigate the changes in agricultural land cover following the introduction of area-based subsidies in 1992. The use of a spatial change matrix demonstrated the effectiveness of using a catchment over non-spatial methods. Changes in land cover and land use could be related to their position within the landscape, thus improving the assessment of actual and potential impact on the environment. In addition, initiating four additional studies related to soil erosion, flooding, modelling nitrogen flow and segmentation of land advanced the task of investigating potential CIS applications.

Contact: Roland Hiederer

Selected Further Reading

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VIL – A Virtual Interoperability Laboratory for Europe. Report EUR 118744.

Zdruli, P., Jones, R.A., and Montanarella, L. Integration of Soil and Climatic Data for the Estimation of Drought Risk in Europe. Agronomie, Elsevier. Accepted for publication on 19 August 1999.

GI and GIS: Harmonisation and Interoperability Project	http://gi-gis.aris.sai.jrc.it/
EC-GIS web site	http://www.ec-gis.org/
European Umbrella for Geographic Information (EUROGI)	http://www.eurogi.org/
GI2000	http://www2.echo.lu/gi/en/intro/gi2000_home.html
Consortium of the European National Mapping Agencies (MEGRIN)	http://www.megrin.org/
PANEL-GI: Pan European Link for Geographical Information	http://gisig.ima.ge.cnr.it/panel-gi/
GIPSIE: GIS Interoperability Project Stimulating the Industry in Europe	http://gipsie.uni-muenster.de/

Highlights

- Development of the architecture for the GIS for NATURA2000 (included in the MoU DG ENV-JRC).
- Proceedings and report on Virtual Interoperability Laboratory workshop held in March 1999.
- Organisation of the 5th EC-GIS Workshop "GIS of Tomorrow" held in Stresa, 28-30 June 1999, with an increased participation (161 participants).
- Workshop on "European Spatial Reference System" held in Paris, 28-29 November 1999. It could be considered a pillar for the creation of the EGII.
- Workshop on "Geographic Information Policies in Europe: National and Regional Perspectives" held in Amersfoort, 15 November 1999, to start putting together a picture of what is happening in European countries with respect to data policies in general, and GI policy in particular.
- Set-up of IMAGE2000 and CLC2000 projects co-led by EEA and JRC.
- The validation of the LACOAST data has been concluded. A CD-ROM and a publication to disseminate the results are now in preparation.
- High number of publications in peer-reviewed journals related to spatial analysis and integrated assessment (IEEE Transactions on Geoscience, RS&PR Letters, Journal of Ecosystem Health).
- Some thematic extensions of soils are undergoing: Soil organic matter map (produced and delivered to DG ENV) and Soil erosion risk map (in preparation).

Courtesy of Space Imaging Europe.

Environment and Security

The increasing importance of the Common Foreign and Security Policy, in conjunction with the demands of environmental legislation and treaties such as the Kyoto Protocol, call for increased involvement by the European Union in topics related to environment and security. The issue becomes more and more global, in particular when considering that increased security threats may occur due to an ever-increasing population pressure from outside the EU, an enlarged EU territory with diverse economic and ecologic standards, and an increasing globalisation of Europe's industrial and political environment. Hence, timely and reliable access to global information of environmental and security issues is needed to ensure the security of Europe's citizens. Access to global information, which will become an important resource of the next century, will determine the economic and strategic strength of a country or region.

The aim is to start from commonly accepted assumptions to illustrate the most likely information needs for policy formulation related to science and technology in the fields of environment and security. The links between environment and security have been recognised for several years by different organisations particularly in the United States, where environmental issues have been discussed earlier and are progressively inserted into foreign policy. There is growing evidence that environmental threats have international implications of not only damage to the environment, but also to public health, and the scarcity of resources such as water, food and forest products.

The Space Applications Institute has been mandated by the Director General of the JRC to develop a strategic document on the topic "Environment and Security". In the following, a brief outline of the still evolving document is given.

Environment and Security

Security as an Element of Sustainable Development

Change of the environment, in particular degradation, poses a very direct threat to the security of a nation or region. The EU is one of the most densely populated world regions and enormously dependent on the rest of the world for its imports of energy and raw material. A key component to any security policy will be a convergence between economic and environmental goals. Trends or events in the environment or resource base which, when combined with other factors (such as political situation, cultural/ethnic traits), can cause instability leading to a decrease in the quality of life, migration, upheavals, starvation or other conflicts.

Both, a creeping and a punctual (spontaneous) hazardous environmental degradation threatening economic and social systems have to be taken into consideration. They can be related to either man made or natural causes. To better illustrate this point, a number of examples are listed: trans-boundary water pollution or water regulation; trans-boundary pollution of the atmosphere through emissions; risks caused by global or trans-national factors such as oil spills, burning of oil fields, bombing of dams, forest fires, etc.; reduction of biodiversity; natural catastrophes such as earthquakes, volcanic eruptions or wind storms; increased exposure to hazards caused directly or indirectly by man-kind through mismanagement of resources or degradation of the environment (e.g. landslides, floods, chemical accidents, etc.); and risks created through the use of nuclear, chemical or biological weapons; disarmament measures which release nuclear or toxic substances.

The current pace of consumption of resources is unsustainable and competition will increase. The key issue is that poverty and social crisis form the breeding ground for social and ethnic tensions, which can in the worst-case degenerate to armed conflicts. Therefore, *the real response to any threat to security remains far-reaching prevention through sustainable development*.

The Impact of Global Environment and Security Problems on Europe

Many of the environment and security problems may appear to be primarily related to specific geographic areas outside Europe in which natural resources are already under pressure and in which the political system is very frequently less stable and able to cope with the problems arising. Such weakened economies, mostly of developing countries, can have repercussions on international relations. The consequences can have impacts on the EU citizens. An example to illustrate this point is that deforestation of tropical rainforests will have effects on Europe through rising sea levels, an increase in areas affected by drought and a shift in agricultural production towards the north, which consequently may result in economic destabilisation in specific regions of Europe. Through global trade as well as global transport and mobility patterns borders of conflicts can emerge and their impacts will be perceived in other regions of the world. Under the new pillar of the Common Foreign and Security Policy of the EU a co-operation between EU and the developing countries (e.g. under the Lomé Convention IV) is essential. Yet, an intra-European dimension arises when taking into account the south of Europe on the fringe of the Mediterranean. Scarce water resources make these areas prone to drought and fires. Over the last years frequent drought events have aggravated the situation in several countries. Moreover, a free-trade zone with countries on the southern border of the Mediterranean basin, bringing the African countries closer to Europe in terms of trade and transfer of technology, can reinforce the concern for environmental degradation.

Policy Context

The EU has signed more than 40 international environmental treaties, which incorporates a more global dimension into the topic on environmental security. A recent example is the Kyoto Protocol, which the EU has signed in April 1998 committing the signatories to reduce the emission levels of six greenhouse gases by more than 5% of 1990 levels within the observation period 2008-2012 at the global scale. The EU has opted for an 8% reduction of these gases. In response to the Kyoto Protocol, several policies and legislative measures have been put in place by the Union, such as the Communication to Council and Parliament on "Preparing for implementation of the Kyoto Protocol", which demands that "with respect to the international context, the EU could consider enhancing the capabilities to monitor the global environment. In particular, monitoring systems attuned to changes in carbon sources and sinks globally need to be further developed. Information technologies including networks of measurement sites and satellite observation systems represent indispensable sources of data, which can be exploited for the benefit of monitoring and verification of implementation of the obligations under the Kyoto Protocol. The well-developed European technical and scientific capabilities could provide a strong foundation for such an expanded monitoring role". Other Kyoto-related policies have been defined on the topics of climate change and the EU's strategy related to it. In addition, the UN Convention to Combat Desertification applicable to the European Mediterranean member states (Annex IV), the Montreal Protocol to combat the depletion of the ozone layer and the UN Convention on Biological Diversity have been signed.

The recently published European Parliament Resolution on Environment, Security and Foreign Policy is a significant recognition of the need to integrate environmental and security issues. The Resolution calls on the Commission to present to the Council and Parliament a common strategy, as foreseen by the Amsterdam Treaty, which brings together CFSP aspects of EU policy with its trade, aid, development and international environmental policies between 2000 and 2010 in order to tackle the following individual issues and relationships between them:

- agricultural and food production and environmental degradation
- water shortages and trans-frontier water supply
- deforestation and restoring carbon sinks
- unemployment, underemployment and absolute poverty
- sustainable development and climate change
- deforestation, desertification and population growth
- the link between all of the above and global warming and the humanitarian and environmental impact of increasingly extreme weather events.

The Way Forward

The JRC can provide support to the decision-making process by building up a risk management strategy for the issue of environment and security. This support can take many different forms. For example, the JRC can stimulate the awareness of decision-makers and encourage discussions on topical scientific and technical issues. It could act as an advisory body and provide timely and relevant information via applied research, scenario modelling and impact assessment for specific and relevant case studies. For such work therefore, the JRC creates a unique and rich pool of expertise ranging from laboratory research, field campaigns, applied research, and integrated analyses of environmental processes and socio-economics.

Although the JRC has well-established and well-recognised experience in many fields related to environmental security, it is currently in a process of building up experience and expertise in the security-related domain. Nuclear safety, demining technologies, food security, crisis areas (e.g., Kosovo reconstruction) serve as a nucleus for this process of gaining experience in new areas. In this light, the way forward can be seen as one of first consolidating the JRC's existing expertise, followed by a shift into new domains, thus enriching the JRC's range of expertise and promoting its capabilities to act as a reference and advisory body on the environment and security issues.

A five-step approach could be envisaged, which has, of course, to take into consideration the development of environment and security in the light of the Commission's policy action related to the EP Resolution on Environment, Security and Foreign Policy. First, would be the need to identify so-called 'focus areas', i.e. areas of conflicts and an analysis of the links between the environment and security. Secondly, there would be a need to concentrate on risk assessment and establishing priorities. Thirdly, decision support systems would have to be designed and set up following the information requirements and fourthly, recommendations could be proposed for response strategies which could range from enhancing international co-operation, institutional reforms, mitigation strategies etc. The fifth and final step, which is of a horizontal nature, is the need to encourage and promote continuous dialogue with the stakeholders, both on a technical and political level.

The Global Monitoring of Environment and Security (GMES) concept takes up the idea of the five steps described above. This is only a starting point, but it forms a nucleus of what could be a more complete decision support system by widening its main scope from space-based monitoring to include vulnerability assessment and apply a proactive policy to prevent risks according to the precautionary principle.

The Baveno Forum, whose original members were BNSC, CNES, DLR, EARSC, ESA, EUMETSAT, and the EC and which ASI later joined initiated the GMES concept in May 1998. Although GMES was originally initiated by space organisations, it widened its focus through a careful consultation process with the users, in particular the Environment DG, the External Relations DG, and the Western European Union. Two major policy lines, the Kyoto Protocol (and related policies and treaties), and the Common Foreign and Security Policy (with emphasis on the Resolution on environment, security and foreign affairs) drive the GMES concept. The increasing importance of these two policy lines calls for an increased involvement by the European Union in topics related to environment and security. Quick and reliable access to global information on environmental and security pressures is needed to ensure the security of Europe's citizens.

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Acronyms

AEM	Agri-Environmental Measures
APL	Anti-Personnel Landmine
ARIS	Action for Research and Information Support in Civilian Demining
ARIS	Agriculture and Regional Information Systems
ASTRON	Applications on the Synergy of Satellite Telecommunications, Earth Observation and Navigation
CAMELEO	Changes in Arid Mediterranean Ecosystems on the Long-term through Earth Observation
CAP	Common Agricultural Policy
CAPI	Computer Aided Photo Interpretation
CASI	Compact Airborne Spectorgraphic Imager
CEO	Centre for Earth Observation
CEOS	Committee on Earth Observation Satellites
CFSP	Common Foreign and Security Policy
CGMS	Crop Growth Monitoring System
CIP	Catalogue Interoperability Protocol
CIS	Catchment-based Information System
CLC	CORINE Land Cover
CORINE	Co-ordination of Information on the Environment
COAST	Coastal Monitoring and Management
CZCS	Coastal Zone Colour Scanner
DESIMA	Decision Support for Integrated Coastal Zone Management
DG	Directorate General
DTM	Digital Terrain Model
EC	European Commission
ECHO	European Commission Humanitarian Office
EEA	European Environmental Agency
EFICS	European Forest Information and Communication System
EGEO	Environment and Geo-Information unit
EGII	European Geographic Information Infrastructure
EGO	European Goniometer
EMSL	European Microwave Signature Laboratory
ENAMORS	European Network for the Development of Advanced Models for the Interpretation of Remote Sensing Data
ENVIFISH	Environmental Conditions and Fluctations in Recruitment and Distribution of Small Pelagic Fish Stocks
ENVIP	Environmental Indicators for Environmental Protection
EO	Earth Observation
EOS	Earth Observing System
ERS	European Remote Sensing Satellite
ESA	European Space Agency
ESB	European Soil Bureau
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EUROGI	European Umbrella Organisation for Geographic Information
EUROSTAT	Statistical Office of the European Communities
FAO	Food and Agricultural Organisation
FP5	Fifth Framework Programme
FUEGO	Early Forest Fire Detection Programme
GEIS	Global Environmental Information Systems
GI	Geographic Information
GIS	Geographic Information System
GISCO	GIS of the Commission
GFIS	Global Forest Information Service
GNSS	Global Navigation Satellite System
GOMOR	Global Monitoring of Marine Resources
GPS	Geographical Positioning System

GVM	Global Vegetation Monitoring
IACS	Integrated Administration and Control System
IDL	Interactive Development Language
IGBP	International Geosphere-Biosphere Programme
INFEO	Information on Earth Observation
LACOAST	Land Cover Changes on European Coastal Zones
LISA	Linear Synthetic Aperture Radar
LPIS	Land Parcel Identification Systems
MARS	Monitoring & Managing Agriculture with Remote Sensing
ME	Marine Environment
MEDALUS	Mediterranean Desertification and Land Use
MIMEVA	Mine Imitiations for In-field Evaluation
MINESIGN	Measurement of Mine Signatures for Civilian Demining and R&D Support
MINETEST	Mine Detection Systems Test and Evaluation
MOLAND	Monitoring Land Dynamics
MoU	Memorandum of Understanding
MSU	Management Support Unit
NGO	Non-governmental Organisation
OECD	Organisation for Economic Co-operation and Development
OLIAREA	Estimate of the Area of Olive Trees per Member State
OLISTAT	Estimate of the Number of Olive Trees per Member State
OLIYIELD	Olive Tree Yield Statistics
PAAGE	Project on Agriculture and AGri-Environment
PANEL-GI	Pan-European Link for Geographic Information
PM	Particulate Matter
RDE	Monitoring Rural Development and the Environment
RTD	Research and Technological Development
SAI	Space Applications Institute
SARI	Satellite Assessment of Rice
SATCOMS	Satellite Communications
SATNAV	Satellite Navigation
SCA	Share Cost Action
SIGEX	Signature Exploitation
SSSA	Strategy and Systems for Space Applications
STRIM	Space Techniques for Major Risk Management
TDP	Technology for the Detection and Positioning of Mines
TFIS	Tropical Forest Information System
TREES	Tropical Ecosystem Environment Observation by Satellite
UN-CCD	United Nations – Convention to Combat Desertification
UN-ECE	United Nations – Economic Commission for Europe
UN-FCCC	United Nations – Framework Convention on Climate Change
WFW	World Fire Web

Index of Applications

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