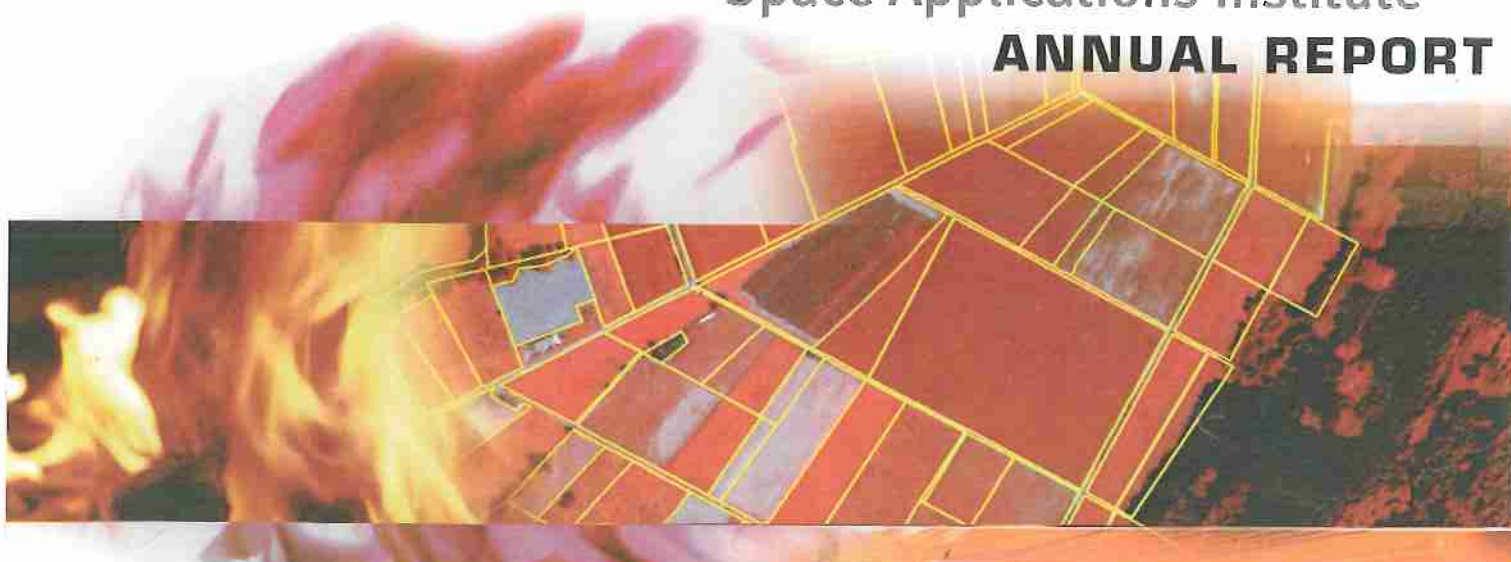




Space Applications Institute **ANNUAL REPORT**



EUROPEAN COMMISSION
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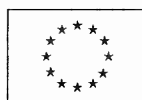
Space Applications Institute

Spatial information Services

Sai

**Space
Applications
Institute**

Annual Report 2000



EUROPEAN COMMISSION
JOINT RESEARCH CENTRE



EUROPEAN COMMISSION

Joint Research Centre (DG JRC)
Space Applications Institute

EDITORS

Lia Karamali
Josef Aschbacher

GRAPHIC DESIGN AND LAYOUT

Information and Public Relations Unit • JRC Ispra

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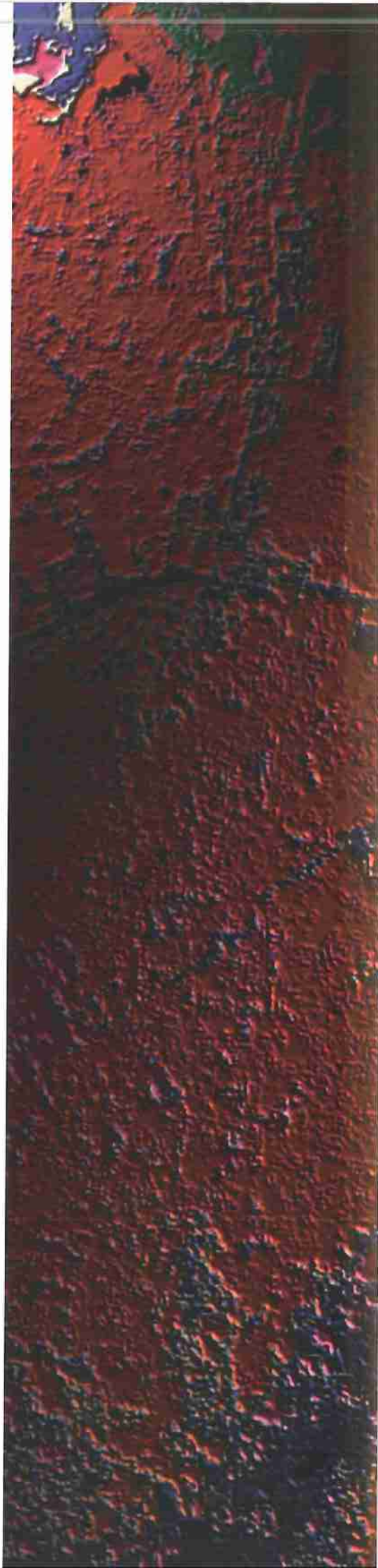
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Foreword

The year 2000 was indeed a very turbulent and exciting year for the Space Applications Institute (SAI). There were some good, and some bad news. First, the good news: During the year 2000 SAI further contributed significantly to the success of the Global Monitoring for Environment and Security (GMES) initiative. 2000 marked the year when GMES went from a technically-driven activity to a political concept. The Communication on Space was adopted by the Commission in September, followed by the adoption of a Resolution by the EU Council of Research Ministers in November. Both documents give a strong emphasis to GMES, suggesting GMES, next to Galileo, to be one of the main activities in space for Europe in the forthcoming years. The Council of Ministers asked the Commission to develop a concept for GMES by June 2001. The Resolution was prepared within the frame of the French EU Presidency, which also organised a GMES conference in Lille, France, attended by the Research Ministers from France, United Kingdom and Belgium, as well as Commissioner Busquin, (Commissioner for Research of the European Commission). SAI has, and continues to play an instrumental role in developing GMES. SAI initiated the initiative in May 1998 at its 3rd Annual Users' Seminar in Baveno, Lago Maggiore, and has moved it forward over the past years. Although SAI focuses on the technical aspects of GMES, its strong and pro-active involvement has undoubtedly triggered many of the political achievements.



2000 has also been a difficult year for SAI. Within the framework of several restructuring exercises as the JRC, SAI suffered some losses of staff and resources. SAI saw a reduction of approx. 20% of its staff resources over the year 2000, mostly due to a refocusing of JRC's scientific work towards new themes, such as health and consumer protection. SAI is now slimmer but fitter. The institute has gone through many brainstorming sessions, and has redefined its focus accordingly. In short, SAI's refocused lines of activities are GMES, spatial information services, and infomobility and rapid access to information. This refocusing resulted in the realignment of SAI's project portfolio. The most significant change was the closure of the "Centre for Earth Observation" Project. In addition, the "SIGMO" project was cancelled, and the "Support to Air Quality Monitoring using Space Techniques" project was integrated into another project in order to reduce project management overheads and hence increase the overall efficiency. On the other hand, three new projects have been created in order to either enhance the visibility of already on-going activities, or react to emerging policy priorities within the JRC. These new projects are, "European Soil Bureau", "Population Dynamics and Security", and "Galileo Technical Support". There have been many individual successes achieved based on the excellent work of the Institute's staff. I cannot name all of them, but just to give a flavour of the achievements, let me mention a few examples: The Mediterranean Fire Risk Forecasting System went operational in 2000, providing fire risk maps on a daily basis of the whole Mediterranean area. The World Fire Web was further developed, providing quasi-global coverage of forest fires on a daily basis. Negotiations have been concluded with the European Space Agency (ESA) to hand over the operation of the INFEO Internet-based Earth Observation data and information exchange system. Or, the Monitoring of Agriculture with Remote Sensing (MARS) project took a number of initiatives to explore new activities, particularly related to agri-environmental issues, food security, and the EU enlargement. The COAST project realigned its activities, taking into account new policy areas, such as the Water Framework Directive. The "Ocean from Space" conference was organised by SAI in Venice, Italy, a major event which takes place every 10 years. There are numerous other examples, which will be described in detail in this Annual Report. Altogether, I am convinced 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 am confident that you share this opinion with me.

Finally, I would like to take this opportunity to thank the 164 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

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Mission

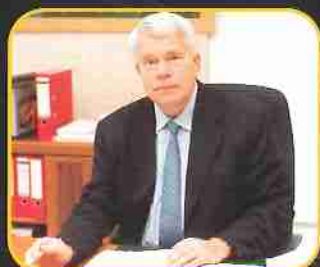
The primary mission of SAI is to develop and promote the use of space-derived data and geo-spatial data from other sources in the service of EU policies, especially those relating to agriculture, fisheries, transport and anti-fraud. SAI also seeks to make the best use of information from space systems, 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/>



Organisation

Directorate



DIRECTOR: Rudolf Winter



DEPUTY DIRECTOR: Jean Meyer-Roux



SCIENTIFIC ASSISTANT: Josef Aschbacher



ASSISTANT FOR PROJECT AND QUALITY MANAGEMENT: Raymond Crandon

Units



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.

EGEO Environment and Geo-Information

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

The EGEO Unit maps and monitors the main ecosystems of Europe, such as forests and large grasslands. The unit also develops methods for environmental protection and monitoring of natural hazards, such as forest fires and floods, and ecologically sensitive regions, such as the Mediterranean basin. To undertake its work, research is performed in the development of advanced methods in image and data processing such as automatic classification, map generalisation, advanced visualisation, and the harmonisation of and interoperability between GIS and remote sensing data catalogues and systems.



HEAD OF UNIT: Jean Meyer-Roux

ARIS Agriculture and Regional Information Systems

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

The ARIS Unit provides demand-driven scientific and technical support for the conception, implementation and monitoring of the policies of the European Union specifically related to agriculture, and agri-environment. In particular, the Unit supports the Common Agricultural Policy (CAP) by integrating the operational use of remote sensing (spaceborne and airborne data), GIS, GPS, area-frame techniques, and geomatics in general for the fight against fraud. Moreover, it functions as a reference centre in the fields of remote sensing, modelling, spatial analysis and statistics applied to agriculture for the production of pan-European statistics and Web-based information systems.



HEAD OF UNIT: Alois Sieber



HEAD OF UNIT: Alan S. Belward



HEAD OF UNIT: Peter Schlittenhardt



HEAD OF UNIT: Peter N. Churchill

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.

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.

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.

SSSA Strategy and Systems for Space Applications

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

The overall objective of the SSSA Unit is to develop strategies and systems based on the application of space systems to support EU policies related to environmental stress, population pressure and sustainable development. This includes technically supporting the application of infomobility and navigation technologies including the development and implementation of Galileo.

GMES Global Monitoring for Environment and Security

<http://gmes.sai.jrc.it/>

Europe's policy makers increasingly recognise the need to have access to continuous independent information services on key issues in the field of environment and security. GMES is a European initiative to help implement those information services that require data from space observing systems. Full consultation with those responsible for particular policy areas will lead to concrete actions to achieve this goal. GMES forms a key element in an overarching European strategy for space.

GMES embraces European and national policies on the environment, resource management, regional development, civil protection, and research, bearing in mind the political emphasis on sustainable development, and Europe's role on the international stage. It also includes issues such as crisis management and humanitarian aid that touch on the additional dimension of security.

Currently, space data that is used for information on environment and security is derived largely from experimental systems. GMES will exploit to the maximum extent Europe's existing and planned capabilities and infrastructures, but will also establish sustainable and consistent operational information-gathering and distribution chains.

Effort in GMES has so far been provided by certain research departments, agencies and industry within the "supply side" of the space sector and related services. It has focussed on an initial identification and understanding of user requirements for geo-spatial information, concentrating on three domains: environmental conventions; environmental stress; and risks and hazards. Implementation scenarios for services in support of GMES are already being developed by relevant agencies, and are being included in their planned programmes.

The next step is to increase the focus on the "demand side", and to establish a structured dialogue with users and other stakeholders. This will build upon and expand the results of the earlier work. There will also be attention on the economic aspects (such as cost-benefit analyses and funding scenarios) and political questions (such as the need for European independence). This will require a high level debate between decision makers across the relevant policy areas.

GMES is primarily motivated by the need to identify and meet public sector policy needs. However, as markets in this area continue to develop, the private sector is expected to have a key role in the provision of information services, and supporting space infrastructure. Initial operational systems are likely to be dependent on the negotiation of public-private partnership arrangements.

The EU Research Council has requested that specific implementing proposals for GMES be drawn up by June 2001, in line with the European Strategy for Space, and with the timetable for expected EU decisions on the European Research Area and the 6th Framework Programme, and decisions of the ESA Council. Building on the meetings held in Baveno, and on the impetus provided by the Lille colloquium held in October 2000 under the auspices of the French presidency, the Commission will use the forum of the GMES Partnership and structured consultations with Stakeholders to meet this timetable.

CONTACT: Josef Aschbacher



SAI and GMES

A significant success of SAI has been its contribution to the rapid advancement of GMES. SAI, being *chef de file* of GMES, has contributed at all levels to the further evolution of GMES, closely involving European space and user organisations. Although SAI's contribution focused on the evolution of the technical aspects, the institute also supported the political and organisational evolution of GMES. Regular consultations with GMES partners in the EU Member States have resulted in consolidated "GMES Products", which form the technical basis for the progress achieved on the political level.

SAI is leading the three technical working groups for GMES: risks and hazards, environmental conventions, and environmental stress. These working groups aim at providing the link to users; at understanding their needs; and at preparing a federated requirements assessment based on the identified GMES themes and involving European and national organisations responsible for the environment and security policy.

Several studies have been performed to identify and quantify the user's requirements in the field of natural disasters. These have been carried out by international organisations such as the European Space Agency (ESA), its American counterpart, NASA, and the Joint Research Centre. In addition, international initiatives such as the International Global Strategy (IGOS) of the Committee for Earth Observation Satellites (CEOS) established a Disaster Management Support Group (DMSG) with the aim of networking national and international agencies interested on the use of space techniques for disaster management. These agencies came together and elaborated a report on "The use of Earth Observing Satellites for Hazard Support", which included several types of disasters, e.g. wildfires, floods, landslides, earthquakes, volcano, among others. The working group on risks and hazards (NADIS) took the evaluation of user requirements as the starting point for reports already produced by the DMSG in order to understand the relevance of these requirements in the European context. Two topics in which remote sensing and space communications may have a decisive role were selected: forest fires and floods. First results are already available and presented in the Natural Hazards chapter of this report.

Article 130r (1) of the Treaty on European Union promotes measures at international level to deal with regional or worldwide environmental problems. These include climate change, biodiversity loss and deforestation. Information requirements arise from the implementation of policies of the Community and of partner countries as well as Community commitments to internationally negotiated environmental treaties such as the Convention to Combat Desertification, the Convention on Biological Diversity and the UN Framework Convention on Climate Change. The working group on environmental conventions is examining the observation requirements arising from and needed for the implementation of and compliance with these key global multilateral environmental agreements. The group also considers the cross-sectoral consequences of these, notably concerning information requirements arising from the environmental dimension in the development process. The EU is the world's largest donor of international aid. It is present in over 150 countries on five continents and is responsible for 10 per cent of all Official Development Assistance worldwide. This year alone the EU spent 9,6 billion Euro on external aid. This sum constitutes 62 per cent of the Commission's total annual direct expenditure. The figures above mean that an enormous number of projects around the world are developed with EU funds. Many of the data sets relevant to the global environmental conventions provide important information on the global conditions for development in the region as well as the priorities set up by the Commission in this field.

The working group on environmental stress focuses on the issues of population pressure, human health, and crisis preparedness. The inter-connection between economic, environmental and social stresses is examined to explore population distribution through time and place. Formal (e.g. urban areas and their surroundings) and informal (e.g. squatter camps) settlements are mapped, monitored and modelled to establish baseline statistics related to population and supporting infrastructure. In particular, the work examines the impact and sustainability of large modern conurbations (within and outside the EU), their industrial base, and their ecological dependency. Work related to human health consists in contributing to the monitoring and assessment of atmospheric parameters related to air quality and natural radiation. The work includes developments aimed at the direct detection of air pollution (gases and particles), at the modelling of surface radiation and at the provision of other information to serve as input to atmospheric pollution models. Last but not least, work aims to develop geo-spatial information systems to be used in preparedness and crises management. The work consists of compiling landscape, topographic and transport network data into geo-information systems for improving efficiency to humanitarian missions. Also, the geo-spatial information system will contain population and economic data that will be used to compute crisis indicators commonly used by decision makers to monitor crises.

Selected Highlights of 2000

JANUARY

- JRC@EP event with strong participation by three institutional projects of SAI: Monitoring Agriculture with Remote Sensing (MARS), European Soil Bureau (ESB), Global Environmental Information Systems (GEIS)

FEBRUARY

- Very positive five-year scientific assessment of SAI by external auditors

MARCH

- Customer workshop organised by the Population Dynamics and Security project

APRIL

- VEGETATION Day co-organised by the Global Vegetation Monitoring Unit of SAI

MAY

- Fifth SAI Users Seminar, Stresa Italy
- Signature of the MoU between SAI and DLR on GMES

JUNE

- Annual EC-GIS workshop, Lyon, France
- SAI exhibition at the EaRSEL conference in Dresden, Germany
- Presentation of the GMES initiative by SAI to the Austrian Army

JULY

- Presentation of the GMES initiative by SAI to DLR, Oberpfaffenhofen, Germany

AUGUST

- Semi-operational use and evaluation of IKONOS data within the framework of the Control with Remote Sensing programme of MARS

SEPTEMBER

- Conclusion of the JRC/Ispra site navigator demonstrator
- Adoption of the "Strategy on Space" COM (2000) 957 final
- Resolution of the European Parliament on Forest Fires, asking for a continuation and reinforcement of the forest fires activities of the SAI Natural Hazards project.

OCTOBER

- Lille conference on GMES (16, 17 October): Audiovisual presentation of flood and forest fire activity
- "Oceans from Space", Symposium, 3rd edition 9-13 October 2000, Venice, Italy
- SAI exhibition in the ESA/ERS conference in Gothenborg, Sweden and in SITEF, Toulouse, France

NOVEMBER

- Demonstration of "Advanced car driver assistant" (GALA Pilot Project by Fiat) at the "Intelligent Transport Systems" (ITS) Conference, Turin (Italy)
- Adoption of a Resolution by the EU Research Council mentioning GMES as one of the main activities
- Proposed decision of the Council on improved community cooperation in the field of civil protection including the flood and forest fire activities of the SAI Natural Hazards

DECEMBER

- 10 years of the TREES-II project
- Achievement of the global coverage by the World Fire Web network
- Transport Council meeting on Galileo
- EC-GIS web site portal operational: <http://www.ec.gis.org/>

Projects

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

Horizontal distribution of projects by Unit

Population Dynamics and Security (PDS)
 Technologies for Detection and Positioning of Anti-personnel Mines
 Natural Hazards
 EUROLANDSCAPE: Geo-Information for Development and Environmental Monitoring
 Coastal Monitoring & Management (COAST)
 Global Environmental Information Systems (GEIS)
 European Soil Bureau (ESB)
 Monitoring Agriculture with Remote Sensing (MARS)
 Galileo Technical Support (GTS)
 Synergy of Earth Observation with Satellite Telecommunications and Navigation (ASTRON)
 GI and GIS: Harmonisation and Interoperability

● Leading Unit
 ● Participating Unit

PDS Population Dynamics and Security

A major focus for the EU's Fifth RTD Framework Programme is the citizen. The aim of the Population Dynamics and Security project, which started in 2000, is to provide spatial information (including that supplied by satellite-based Earth observation) on populations, at town, city and regional levels, in order to assist in assessing the impact or implications for populations of current or planned EU policies. Knowledge of the changes or dynamics of populations, both within and outside Europe, is an important underlying factor for many EU policies. The Population Dynamics and Security project takes account of the various factors that affect the dynamics of populations. These include long-term trends such as urban growth, development of infrastructures, and environmental stress (including air pollution), and also short-term influences such as conflict situations or resource crises. The security (in its non-military sense) of populations is also important, and requires the focusing of resources on development that is economically, socially and environmentally sustainable. As well as assembling data over large areas and from different time periods, the Population Dynamics and Security project uses a variety of modelling techniques to simulate the impact of specific policy scenarios.

The Population Dynamics and Security project also contributes to the overall framework of the EU's initiative on Global Monitoring for Environment and Security (GMES). During 2000, the Population Dynamics and Security project focused on three inter-related themes: human settlement dynamics and sustainable regional development; atmospheric pollution and radiation; crisis preparedness and humanitarian aid. As part of the work on human settlement dynamics and sustainable regional development, the SSSA unit's existing project for monitoring and modelling land use dynamics in urban areas (i.e. MOLAND), has been further developed and extended to include the regional analysis of the interactions between land use and socio-economic factors.

The work on sustainable regional development also aims at developing techniques for mapping, monitoring and modelling environmental indicators related to impact assessment of anthropogenic activities (urbanisation, transport, tourism, industrial development) at regional level. The research on atmospheric pollution and radiation focuses on satellite-based monitoring and assessment of atmospheric parameters related to air pollution and natural radiation. The activities on crisis preparedness and humanitarian aid are concerned with providing geo-spatial information and services to support the work of the EU with respect to its international aid policies, and to assist its work with respect to crisis or emergency (e.g. conflict or natural disasters).



PROJECT LEADER
Carlo Lavalle

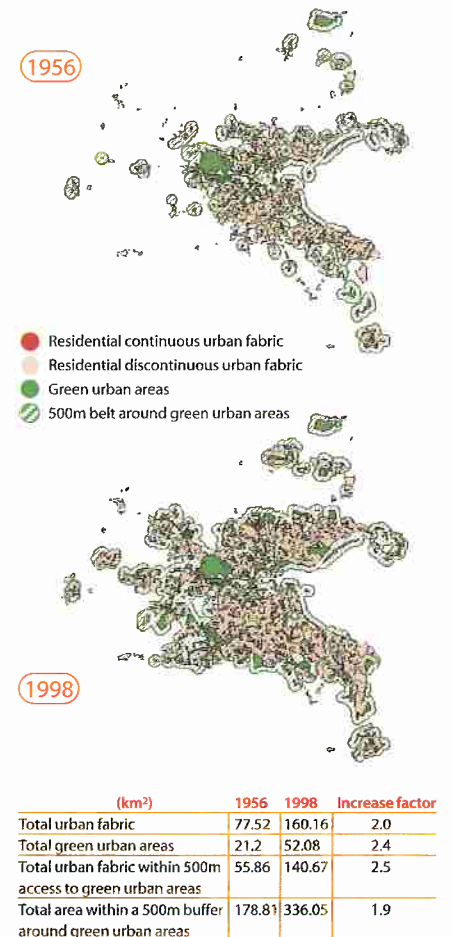
Human Settlement Dynamics and Sustainable Regional Development

The application of the MOLAND (Monitoring Land Cover / Use Dynamics) project to twenty-five European urban study areas, as well to seven non-European "mega-cities", was completed in 2000. The seven mega-cities were: Bangkok; Buenos Aires; Chongqing; Johannesburg-Pretoria; Mexico City; New Delhi; Seoul. The aims of MOLAND were: (a) to produce quantitative information on the evolution of land use and transport networks in selected sites subject to infrastructural changes (urbanisation, transport), from 1950 onwards; (b) to develop a methodology for performing a harmonised analysis of historical trends, including socio-economic aspects, impact of legislation, landscape fragmentation, etc.; (c) to develop models for the harmonised simulation of future European-wide scenarios, at local and regional scales. Implementation of MOLAND is divided into three phases – called CHANGE, UNDERSTAND, and FORECAST – corresponding to the three specific aims. In the CHANGE phase of MOLAND, for each study area detailed GIS databases of land use types and transport networks were created, covering four time-periods over the past fifty years (i.e. early 1950s, late 1960s, 1980s, late 1990s). The mapping scale of these databases was 1:25,000. In the UNDERSTAND phase of MOLAND, advanced spatial analysis techniques were applied to the databases of urban land use types and transport networks, in order to compute various types of environmental statistics, indicators, and maps. These were used to compare the different urban areas in terms of the environmental and socio-economic impacts of urban development. In the FORECAST phase of MOLAND, the urban land use and transport databases were input into a spatial dynamics model of urban growth, and used to explore alternative urban policy scenarios.

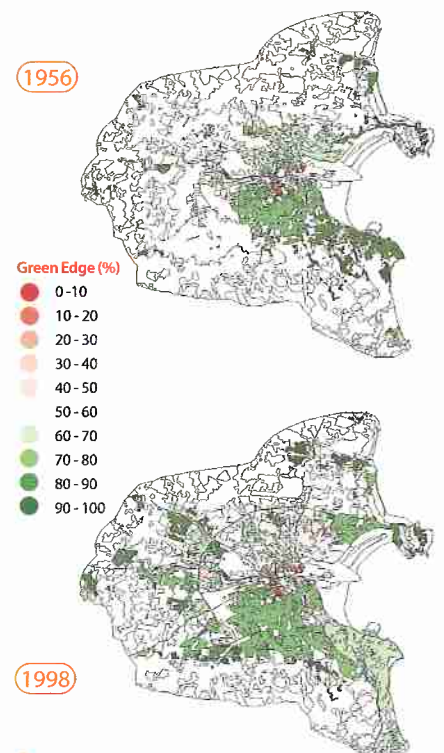
Many different types of urban environmental maps were also produced for the MOLAND urban study areas, during the UNDERSTAND phase of the project. These maps assisted in understanding the various environmental and socio-economic impacts of urban development. One type of map, for example, showed the amount and accessibility of green urban areas relative to urban residential areas. This is an important environmental aspect of urban areas, that directly affects the quality of life of urban citizens. Another type of map showed the distribution of a useful urban environmental indicator called the "Green Edge" Index. The Green Edge Index, which was computed as part of the fragmentation analysis of the MOLAND land use databases, shows how much of a city's urban fabric is directly adjacent to (i.e. has an edge with) vegetated areas. Urban areas with a high values for this index would have greater access to recreational facilities (e.g. parks, wooded areas, sports fields), and would be less affected by noise and air pollution from traffic. Note that the Green Edge Index can often be related to the socio-economic status of citizens. This is because, for many cities, urban fabric in economically affluent areas frequently occur beside green areas, while urban fabric in economically deprived areas commonly occur beside non-vegetated areas (e.g. urban fabric, industrial areas, transport corridors).

During 2000, development of an operational *cellular automata* spatial dynamics model for simulating urban growth – a critical component of the FORECAST phase of MOLAND – was completed. The urban growth model, which can be applied to any city in the MOLAND study areas, takes as input the MOLAND urban land use and transport databases as well as GIS layers representing, for example, the land use suitability, zoning plans, and importance of access to transport networks for the various land use types. Based on these inputs, the MOLAND urban growth model then interactively simulates the likely future urban development during each year in the following twenty-year period. By modifying the inputs into the urban growth model (e.g. by using different land zoning plans), the model can be used as a powerful tool to present alternative realistic future scenarios of urban development. Also during 2000, a prototype version of a so-called *macro-model* for simulating urban development, that takes into account both socio-economic factors and interactions with the surrounding regions, was completed. Further development and testing of this model will continue in 2001.

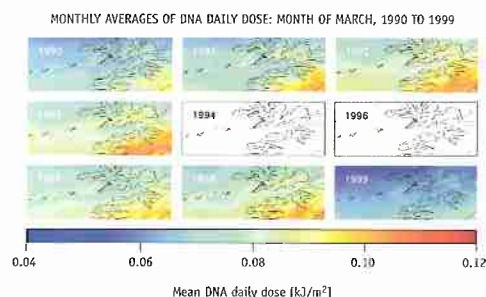
The activity on human settlement dynamics is complemented by the analysis of anthropogenic stress factors such as the expansion of artificial surfaces for settlements, tourism



Access to green urban areas for Dublin. From 1956 to 1998, while the amount of urban fabric doubled, there was an even larger increase in the amount and accessibility of green urban areas.



Green Edge Index for Dublin. In the less affluent North Dublin, the amount of urban fabric adjacent to green areas has decreased (shown in red). In the more affluent South Dublin, almost all urban fabric occurs adjacent to green areas (shown in green).



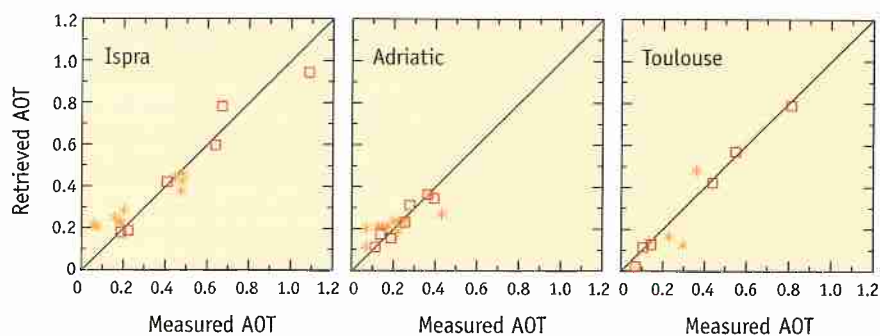
Reconstructed monthly mean of the ultraviolet DNA damage radiation in March, over the Lofoten Islands area, from 1990 to 1999.

amount of available ground measurements to calibrate the model. These ones could for instance be provided by specific campaigns.

A second component of the activity on atmospheric pollution and radiation focuses on surface ultra-violet (UV) radiation and actinic flux. The previously developed processor to generate UV dose rate and dose maps from METEOSAT and ozone sensors (TOMS, GOME) has been improved. The new version is based on a simulation of the METEOSAT signal over the full MVIRI visible band spectral range and with a more realistic description of the clouds. The snow/cloud discrimination has also been improved by dividing the full image in geographical zones of similar geophysical characteristics. This allows a more sophisticated use of the thermal infrared signal, on the base of histograms of the brightness temperature per zone. The UV mapping method is now applied to reconstruct the UV conditions over Europe during the last 10 to 15 years. In particular, these data will be provided to marine biologists to study the influence of UV radiation on cod recruitment in the Northern Atlantic. This action takes place in the new DG Research project UVAC, ultimately aiming at contributing to a better management of halieutic resources.

The UV modelling method has also been adapted to generate the vertically resolved actinic flux, in addition to surface irradiance. A demonstration product is available and the development will be pursued to effectively use it as an input to air pollution models. Future work on UV radiation mapping will also be continued in the framework of two AO projects (ENVISAT and MSG) and of a EUROTRAC-2 sub project (TROPOSAT).

A third component of the activity on atmospheric pollution and radiation focuses on atmospheric trace gases. In the framework of a collaboration agreement between SAI and DLR, an activity has been initiated to compare the GOME retrieved concentrations of NO_2 and SO_2 with ground data. In this period, the DLR has improved the trace gas retrieval algorithms and applied it to more test cases such as volcanoes (where ground data are available at JRC) and more areas of importance for global atmospheric pollution (e.g. industrial areas in China).



Aerosol optical thickness at 550 nm derived from VEGETATION data, versus the one calculated from AERONET sun photometer measurements. The squares indicate that the corresponding AERONET data have been used to optimise the VEGETATION signal model.



Provision of accurate and updated spatial information. This figure illustrates a case study over Montenegro where map data and satellite imagery at different resolutions are used to expeditiously derive geo-spatial information. The Southern Balkans remain an important focus of research and an area of cooperation and data sharing with international organisations and UN agencies.

Crisis Preparedness and Humanitarian Aid

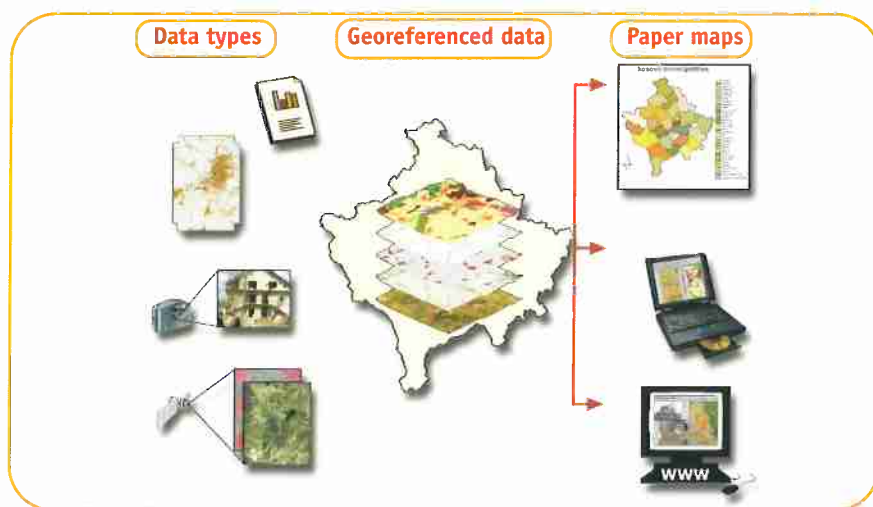
SAI has started activities related to Crises Preparedness and Humanitarian Aid, as part of the Population Dynamics and Security project. The aim of these activities is to improve the preparedness for crises and the efficiency of humanitarian aid missions, by conducting research in the provision of: geo-spatial data; information systems using state-of-the-art information technology; ad-hoc analysis of geo-spatial data.

Natural and man-made crises occur at increased rate especially in developing countries. Recently compiled statistics indicate that the number of reported crises have increased exponentially from just a dozen in the first decade of the 1900 to almost 500 in the 1990-96 time frame alone. These statistics may be influenced by the improved information flow we now have - as opposed to 100 years ago - of events occurring in remote areas and the immediate broadcast of such events across the globe. However, the losses of life and assets as a result of disasters are heightened by our increasingly developed landscapes often in hazard-prone regions such as coastal areas.

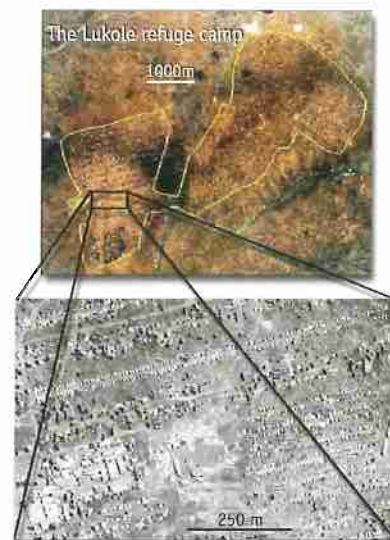
The world community is responding to crises with humanitarian relief missions in the aftermath of a crisis. Development programs are also aimed at preparing for potential crises, mitigating where possible the affects on likely crisis areas. In 1994 the European Commission instituted the European Commission Humanitarian Office (ECHO) aiming to bring immediate relief to crisis-affected population. Currently the EU, including ECHO and the aid programs of the EU member state, is the main international aid donor.

Effective prevention and preparedness is based on having advanced information; a part of this is geo-spatial information. Often, this information is in short supply especially in developing countries. The provision of accurate and updated geo-spatial information can significantly contribute to improve the efficiency of humanitarian disaster relief missions. Also, geo-spatial information is increasingly used in combination with socio-economic data to provide indicators of environmental resource crisis and sustainable development to decision makers.

The current work at JRC / SAI is centred on a request by ECHO to compile a Digital Map Archive (DMA) at different scales accessible over Internet for a large part of developing countries. The DMA will be the backbone dataset for studies supporting Development policies. Complementary work includes the development of a spatial information system for management of disparate data sources related to crises, the development of improved data analysis techniques for spatial data and the analysis of population and environment interactions including those of refugee settlements.



Example of geo-spatial information system developed in JRC/SAI to be used in Crisis Preparedness and Humanitarian Aid work. Disparate source of information can be organized according to space and delivered to customers as: (left) digital databases available on portable equipment; (middle) through Internet; (right) on traditional paper maps.



Lukole (Tanzania) Refugee camp imaged on 24/09/2000 by Ikonos. The camp was established in 1994 originally to provide assistance to Rwandan refugees. The camp subsequently hosted different waves of refugees also coming from Burundi, and with 137,000 refugees is currently the largest in the region. In March 2000, the camp was visited by Mr. Nielsen, EU Commissioner for Development.

Staff contributing to the Population Dynamics and Security project

Name	Area(s) of Activity
Regis Borde	Atmospheric aerosols
Luca Demicheli	Territorial indicators and environmental strategies for urban and regional sustainability
Bernd Eckhardt	Crisis preparedness and humanitarian aid
Daniele Ehrlich	Crisis preparedness and humanitarian aid
Christine Estreguil	Indicators for nature conservation and sustainable regional development
Marjo Kasanko	Socio-economic impact assessment of urban and regional development
Carlo Lavalle	Overall project management; human settlement dynamics and sustainable regional development
Philippe Loudjani	Crisis preparedness and humanitarian aid
Niall McCormick	Fragmentation analysis of urban landscapes; use of urban growth models
Jean Verdebout	Atmospheric pollution and radiation
Peter Vogt	UV radiation and actinic flux

Technologies for Detection and Positioning of Anti-personnel Mines

<http://demining.jrc.it/>

Following its foundation during 1999, the JRC has given strong encouragement to the activity of the Demining Technologies Information Forum. Discussions recognised that complementary to the development of various technologies for close-in mine detection and mine destruction, programmes exist to support research in various aspects of demining technologies. Examples include development of new sensors, fusion of multi-sensor data sets and development of algorithms to improve the effective landmine detection. A joint workshop with the subject *"Research on Demining Technologies"* was organised. Relevant research programmes are supported in Canada, Israel, South Africa, Japan, in the USA, and the EU Member States. The workshop provided an opportunity to exchange views on the state-of-the-art in the area, and to foster future collaboration. This workshop, organised jointly between the European Commission's Joint Research Centre and the US Army Electronics Technology and Devices Laboratory, was co-sponsored by the European Research Office.

The format of a new Journal has been defined and the first invited contributions from recognised experts have been received. Publication of the first issue is foreseen early in 2001.

The year was a significant one for the International Test and Evaluation Programme (ITEP) as it marked its start and the end of over 18 months of negotiations. On 17 July, Belgium, Canada, the Netherlands, Sweden, the UK, USA and the European Commission represented by the Joint Research Centre signed a Memorandum of Understanding for the ITEP on Humanitarian Demining.

The JRC sponsored a Humanitarian Demining Information Meeting to elaborate on the outcome of a JRC sponsored study on "Operational Needs and Equipment Requirements for Mine Action in South Eastern Europe", which was undertaken by the Geneva International Centre for Humanitarian Demining (GICHD). The study aimed to establish the effectiveness of current demining methods and the foreseen impact that different technology might have on the demining process.

The Action for Research and Information Support in civilian demining (ARIS) network of excellence continued to provide support to industry, researchers and to the users of equipment in the mine-affected areas. The network built on previous activities and provides regularly updated information on its website at: <http://demining.jrc.it/aris>.

Last but not least, other on-going projects, such as MINETEST, SIGEX, and MINESIGN were successfully carried on during the reporting year.



PROJECT LEADER
Alois J. Sieber (Acting)

ARIS Network:

Action for Research and Information Support in Civilian Demining

During the year a number seminars and workshops were held in Ispra and at members' premises. In support to the recovery in SE Europe, which is a key concern of European Union, a workshop "Towards Harmonized Information Systems for Mine Action in South Eastern Europe" was held in Ispra. In this two-day meeting delegates explored what can be done to improve the availability of harmonised information to support Strategic Decision Making regarding Mine Action Programmes for South Eastern Europe.

A seminar entitled "Minefield indicators and workshop on the needs of airborne and spaceborne data for minefield survey was held in Ispra chaired by Professor Marc Achery of the RMA Brussels.

The Nordic Demining Research Forum, which is an affiliated node of the network, in conjunction with ARIS and with co-operation from the GLCHD, hosted a seminar with the subject *Risk Management and Quality Assurance (RMQA) in Humanitarian Demining* which was held in Copenhagen, Denmark.

International Test and Evaluation Programme (ITEP)

The International Test and Evaluation Programme, initiated on 17 July of the reporting year with the signature of the Memorandum of Understanding (MoU) between Belgium, Canada, the Netherlands, Sweden, the UK, USA and the European Commission, is expected to establish a responsive and sustained global network of Test and Evaluation (T&E) capabilities for measuring performance and evaluating the effectiveness and suitability of all forms of equipment, systems, and methods for use in humanitarian demining. In pursuit of this objective, ITEP will:

- Conduct T&E of existing equipment, systems under development, and of promising technologies, processes, and algorithms;
- Establish and employ standards, protocols, and methodologies for cooperative T&E;
- Collect, generate, assess, evaluate, and distribute robust, scientifically objective data and information on the performance and effectiveness of such equipment, processes, and methods under a variety of environmental, physical, technical, and operational conditions;

ITEP will place its reports and standards in the public domain although ITEP Participants retain the right not to disclose certain information and technology should such information affect national security or IPR concerns.

ITEP will establish and maintain a working relationship with the United Nations, regional organisations, mine-affected states and entities, donor institutions and investors, non-governmental organisations (NGOs), research organisations, demining equipment manufacturers, and the equipment user community. ITEP will develop and implement outreach programmes and mechanisms with these organisations.

International Pilot Project for Technology Co-operation (IPPTC)

IPPTC is an initiative to explore the sharing of resources with a view to increasing the understanding of a technology relevant to Civilian Demining and issues of international co-operation. The JRC, together with staff from the United States Army, Royal Netherlands Army, UK and Canadian National Defence research establishments, conducted extensive trials of 29 metal detectors. The JRC facilitated the Croatian in-country trials, conducted near Obrovač in Dalmatia, assisted by the Croatian Mine Action Centre.



▲ The FGAN team taking measurements with a high sensitivity Infra-Red camera (sensitivity 10 mK) on the reference test plot supported by TDP personnel.



▲ Signature of the ITEP MoU on July 17, 2000 in Brussels, Belgium.



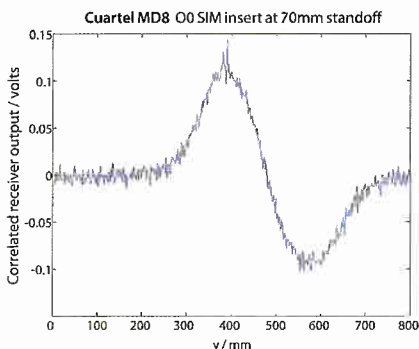
▲ Preparation of test scenarios for the INFIELD. The four objects in foreground are sources of false alarms, since they have features similar those of real mines (limited metal content embedded in a dielectric matrix) for the types of sensors assessed. In the adjacent scenario, pairs of reference objects are buried to assess the spatial discrimination capability of the system under assessment.



▲ The soil moisture is measured using Time Domain Reflectometer Probes, buried at two depths: 3.5 and 8 cm respectively.



▲ The prototype of the multi-sensor head is scanned manually on each test scenario. Sensor data and position of the head are acquired and displayed in real time by the control unit (on the right).



▲ Section through the peak of image from SIM insert 00 at 70 mm height.

Objective scores of detector performance, using representative targets, were combined with subjective opinions of deminers. For instance one such assessment was carried out on a lane constructed in a realistic soil environment. The hills in the area hid real minefields, which still need to be cleared.

The JRC published the summary report of the complete IPPTC test showing the strengths and weaknesses of the detectors in several demining environments. Individual project partners can provide the detailed results from their section of the tests.

MINETEST

This project, sponsored by DG Information Society within the IST programme, provides European consortia developing sensors and systems for mine detection, access to the JRC test facilities. The activity has continued in 2000 with the trial of INFIELD, a handheld multi-sensor system developed by a consortium led by Thomson-CSF Detexis.

The trials included three groups of test scenarios. First, mine-like objects and false alarm objects were buried in ten different configurations to assess the detection performance. Second, deterministic reference objects were used to assess the detection threshold and the spatial separation capability of the sensor, and finally, clutter objects were used to assess the system capability to reject false alarms.

The test protocol was jointly defined between the JRC and consortia teams. Test scenarios were implemented in the JRC Outdoor Test Facility in three soil types: clean agricultural soil, clean sandy soil and cluttered grassy soil. The trials were performed in April 2000. During the test the JRC monitored periodic meteorological conditions and soil parameters.

Other improvements have been made to the test lane in preparation for trials to be performed in early 2001 on Ground Penetrating Radar with an array antenna (MINEREC Project). Since this system is designed for a vehicle, one of the gantries of the JRC test lane has been motorised to simulate the actual operation up to a speed of 1 m/s.

International Database of Mine Signatures

The provision of a database of mine characteristics has been extended by the completion of the work in support to MINESIGN for DG Information Society and by the commencement of a complementary project; the so-called: Multi-Sensor Mine-Signature measurement project. Both activities are published through the SIGEX and follow-on activities.

A series of systematic in-air metal-detector measurements with three detectors and ten targets were made at the JRC Ispra between May and August 2000 as part of the project MINESIGN under the sponsorship of DG Information Society. The results are presented here in the form of images of the metal detector coil response in a plane above the target. All the experiments were conducted at the Karl Friedrich Gauss laboratory, a purpose-built low-metal structure intended for metal detector, magnetometer and radar measurements.

The main group of targets measured were the model fuzzes from the PM-MCD/ITOP "SIM" surrogate mines provided by the US Army. These objects were made within the framework of an international project to develop safe and convenient but representative targets for testing demining equipment. They are currently under consideration as a NATO standard. A bronze sphere, which is particularly suitable for comparisons with analytical models, was also scanned. Finally, some images of the signal from a striker pin and spring from a real mine were collected.

The three commercial off-the-shelf metal-detectors used, all of which are currently in use in humanitarian demining operations, were the following:

- Vallon ML 1620C
- Guartel MD 8
- Schiebel AN-19/2

The JRC landmine signatures database (<http://www.tdp.sai.jrc.it/APL-Database>) started the brokerage service in January 2000. Since then about 170 users from all over the world registered on to the server as users of the signature data (see the table summarising the access statistics).

The loading of the following four signature data packages was completed:

- Royal Military Academy, Belgium
- The Belgium HUDEM project
- The École Polytechnique Fédéral de Lausanne
- The MACADAM project (lead by Thomson-Detexis CSF)

These data packages include signature data gathered with metal detectors, Ground Penetrating Radar (GPR) and infrared cameras. In addition, an extensive data package including the signature data collected at the experimental facilities of the JRC was also made available. These measurements were carried out within the framework of the MINESIGN project.

The signature data currently being collected as part of the Multi-Sensor Mine-Signature project will be made available early in 2001.

International Multi-sensor Mine-signature Project (MsMs)

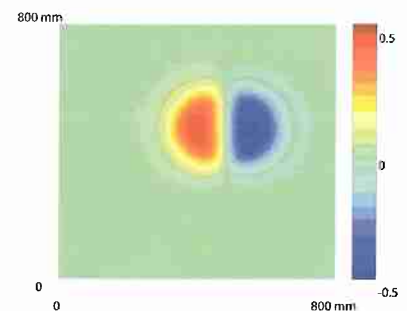
The difficulty to detect landmines reliably with a single sensor, has led investigators to consider possible benefits from combining information from different types of sensors. This approach compares to the way humans and animals use information from their senses to build up a picture of the world. A number of groups have started to develop theoretical approaches to this problem for landmine detection; however, there is at present very little experimental data on which they may base their work.

In 2000, the Technologies for Detection and Positioning (TDP) unit, in collaboration with the Royal Military Academy of Belgium (RMA) and the German Aerospace Agency (DLR), recognising that a coherent and well documented dataset on multi-sensor signature of mine-like objects and non-hazardous objects is not presently available to researchers, took the initiative to launch an International Multi-sensor Mine-signatures (MsMs) project. The project will run a number of campaigns to collect sensor data to be published to the international research community via the World Wide Web.

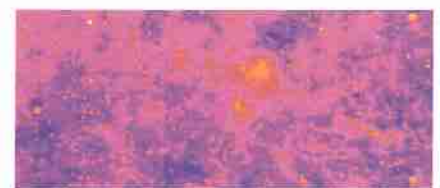
The project participants are the JRC, RMA, DLR, FGAN (*Forschungsgesellschaft für Angewandte Naturwissenschaften*) and DERA (Defence Evaluation and Research Agency). Additionally, TNO and ONERA have expressed their interest to participate in future measurement campaigns.

The objective MsMs project is to organise and execute an experimental campaign for collecting data with multiple sensors in controlled but realistic conditions. The data collection is performed over different types of target objects including various mine simulants,

Percentage	Number of Hits	Domain	Country Organisation
15.76	1808	IT	Italy
11.52	1321	DE	Germany
10.07	1155	NL	Netherlands
8.69	997	FR	France
8.24	945	UK	United Kingdom
7.63	875	BE	Belgium
6.76	776	COM	Commercial
5.90	677	NET	Network
3.63	417	EDU	Educational
3.21	369	HR	Croatia
2.97	341	AU	Australia
2.22	255	CH	Switzerland
2.11	242	CA	Canada
1.82	209	SE	Sweden
1.73	199	ES	Spain
1.36	156	JP	Japan
1.03	119	GOV	US Government
0.94	108	RU	Russian Federation
0.64	74	ZA	South Africa
0.63	73	HU	Hungary
0.57	66	RO	Romania
0.35	41	AT	Austria
0.31	36	EE	Estonia
0.27	31	DK	Denmark



▲ Image of Guartel MD8 response to PMN striker pin at 50 mm height.



▲ Thermal image of a 6x2m plot containing buried objects in the test field.



▲ A thermal imager mounted at 6m above ground level in the test field during the MsMs trials.

Natural Hazards

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

Realising an increase in natural and man-made catastrophic events during the last years; realising the demand on Community involvement in disaster-related topics and taking into account the available competencies at SAI level, the Natural Hazards project was launched to provide scientific and technical support for the conception, implementation and monitoring of EU policies linked to the protection of individual citizens against floods and forests fires and to develop tools for the improvement of existing management practices before and after a disaster by combining Earth observation derived information with auxiliary information.

In 2000, the different activities of the project linked to forest fire risk assessment, forest fire damage assessment as well as flood modelling, flood simulation and flood damage assessment are progressing according to the project plan. Strong links to the customer at EU level (DG Environment, DG Agriculture), related national thematic networks (Forest Fire Services and Hydrological Services), and direct collaborations with targeted national research institutes guarantee a high quality of the project deliverables. Most of the tools agreed on, have reached a validation level before entering a pre-operational phase to be performed with relevant national institutions.

Beside the technical work already under development, links have been created with other SAI projects, namely GI & GIS and ASTRON, in order to work out synergies between the ongoing applications, and telecommunication and navigation studies. A common approach is envisaged to test and develop tools in view of a new Rapid Response Capability (RRC) within SAI.

At political level there have been calls for urgent improvement of Civil Protection action at Community level within the year 2000. The main common elements in these forceful expressions are demands for a strengthened structure for interventions and for the establishing of a Community mechanism for the co-ordination of civil protection intervention in the event of emergencies, occurring both within and outside the Union. The Natural Hazards project activities on floods and forest fires are mentioned as one of several Community initiatives which contribute to the aims of civil protection and which could be activated as appropriate (COM (2000) 593).

In the context of the Global Monitoring for Environment and Security initiative (GMES), an important element in Europe's strategy for space, the major hazards problematic has been identified as an area which is of increasing importance for the citizens of Europe.



PROJECT LEADER
Guido Schmuck

Forest Fire Activities

The forest fire activities evolved according to the project plan fixed within the Natural Hazards project. Tools for fire prevention and forest fire risk assessment were improved both from a short-term and long-term point of view. Regional (pan-European) approaches to evaluate structural as dynamic forest fire risk indices are currently in place. The computation of these indices, as opposed to those computed at the national or local level, enables the regional evaluation of forest fire risk. In addition, the use of harmonised regional forest fire indices allows the inter-comparison of risks for different areas of Europe, which was not possible in the past. Forest fire risk is influenced by many variables. These variables have a wide range of spatial and temporal variability. It is for this reason that, according to this variability forest fire risk can be classified into long-term prediction and short-term prediction. The methods as well as the applications of the derived fire risk maps vary with this time frame. Long-term prediction is provided by indices that are referred to as static or structural. Short time prediction is provided by the so-called dynamic indices. Long-term fire risk prediction is intended for long term planning, which may serve to characterised regions as subject to high or low risk of fires. On the other hand, short-term prediction is more related to fire fighting and extinction and it can be seen as a decision support mechanism for the allocation of forest fighting resources by operational fire fighting centres. The activity on burnt area mapping and forest fire damage assessment moved from the testing phase to the production phase in which complete maps of burnt areas for the EU Mediterranean region will be derived.

Structural forest fire risks, which are based on fairly static variables, were validated and distributed to the users. These users were the civil protection services of the EU Mediterranean countries, i.e. Portugal, Spain, France, Italy, and Greece. Countries such as Germany, Austria, Luxembourg, and Finland requested through DG ENV the inclusion into the scheme for receiving forest fire risk maps during the peak of the fire season, from June to September.

Dynamic forest fire risk indices were also improved during this period. The vegetation stress risk, which was already available in our web site, was improved. The fire risk maps produced with the new algorithm were validated for Spain, France and Italy. Validation in the rest of the countries is ongoing. The square correlation coefficient of the index when fitting the model to fire events was 0.98, which shows that this type of index can be used for predicting forest fires in the study area. This can be considered in itself an outstanding result, since the index only measures the degree of vegetation stress, which is just one of the factors related to fire outbreaks.

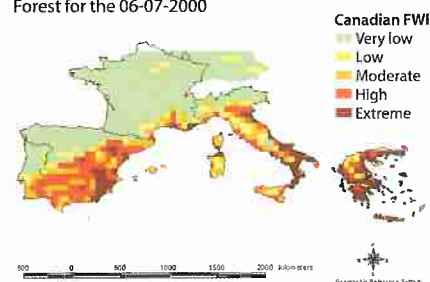
The second type of dynamic indices, that is those computed from meteorological parameters, was also improved. The computation of the indices moved from daily fire risk assessment to the forest fire risk forecast. An application that computes six meteorological indices using forecast weather parameters was put in place. This is referred to as the European Forest Fire Risk Forecast System (EFFRFS). Risk forecast maps for 1, 2, 3, and 5 days were produced using historical data. When validated, the results were presented to the final users; that is civil protection and forest fire services of the Member States. For the first time all the EU Mediterranean Member States used a common method for the evaluation of forest fire risk in the region. Forest Fire Risk Forecast Maps of the indices selected by each country, in addition to the European forest fire risk forecast maps, were daily delivered to the Member States as well as to DG ENV during the fire season (15 June to 30 September 2000). Transmission of the maps was performed through the Internet. A meeting with all users was held after the fire season. Their feedback was very positive and they urged the Natural Hazards project to continue with this service in the coming years. As mentioned above other countries (Germany, Austria, Luxembourg, and Finland), which also participated in this meeting, requested the foreseen improved service starting the year 2001.

Progress was also accomplished in the advance forest fire risk index referred to as Fire Potential Index. The proposed model uses jointly static and dynamic variables from three

CONTACT

J. San Miguel-Ayanz (Activity Leader), P. Barbosa, G. Libertà, A. Napoli, A. Sebastian, M. Gimenez

Fire Danger Map (Forest: day + 3)
Forest for the 06-07-2000



Fire Danger Map (Forecast: day +3) Forecast
for 06-Jul-2000.



EU Mediterranean mosaic of medium spatial
resolution images used for burnt area mapping.

data sources: fuel type maps, NOAA AVHRR images, and meteorological data. These data are integrated in a geographic information system environment to derive what is referred to as fire potential. Fire potential can thus be understood as the likelihood that a fire would take place in a given area due to the intrinsic characteristics of current vegetation, its moisture content, and the existing (and precedent) meteorological conditions. The model, which is based on the Fire Potential Index developed for the U.S.A. (Burgan et al, 1998), was modified and adapted to European conditions.

The main assumption behind the Fire Potential Index (FPI) is that fire potential can be assessed if the moisture content of live and dead vegetation is reasonably represented. In order to do this, three factors are considered in the model: the live ratio of vegetation, and the moisture contents of dead and live vegetation. The fuel model serves to compute the live ratio by making use of the live and dead fuel loads that are described for each fuel type. The moisture content of small dead fuels is estimated by means of meteorological data and through the computation of the equilibrium moisture content. In other words, the moisture content that a fuel particle will attain if exposed for an indefinite period in an environment of specified constant temperature and humidity (FAO Wild land fire management terminology). Finally, the moisture content of the live vegetation is estimated through the relative greenness. The index is computed for all Europe, with special emphasis on the calibration over the Mediterranean region, where most of the European forest fires occur. The FPI was computed for a historical 5-year period in order to calibrate the model and to adjust the levels of risks according to the number of fire events. The work on this topic is ongoing and it is expected that the FPI will be distributed through the existing EFRFS in the year 2001.

Algorithms developed for burnt area mapping were tested on several sites of Europe using high and medium spatial resolution satellite images. The ground resolution of this type of imagery ranges from 20 meters to 180 meters. EU Mediterranean mosaics were produced for the years 1998, 1999, and 2000. The mapping of burnt areas for the Mediterranean regions is initially being performed for the year 2000.

The results of the burnt area mapping activity will be integrated in a complete system of forest fire information, which will constitute an interactive European Forest Fire Information System. This system will allow authorised users to retrieve all the existing information on forest fires, from forest fire risk maps of a given area to the tabulation of forest fire damage for fires that took place in a region during a specified period of time. The system will be set up as a dynamic web application that will be updated, as new information on forest fires becomes available. The transmission of information via satellite was tested within a competitive activity named RIMS. In this test, civil protection services of Portugal, Spain, France and Greece were interconnected with an on-going video-conference system that enabled them sharing the information provided by the Natural Hazards project and permitted live explanation of each of the fire products.

The evaluation of forest fire damage is performed by intersecting the maps derived from the classification of satellite imagery with the European CORINE Landcover database. Here from top to bottom: fire event, mapping of burnt areas, damage analysis.

CORINE Code	CORINE Class	Non-burnt Area (ha)	Burnt Area (ha)	% Burnt
112	Discontinuous urban fabric	109878	42	0.0%
211	Non-irrigated arable land	1194065	6990	0.6%
212	Permanently irrigated land	682939	403	0.1%
221	Vineyards	134274	2843	2.1%
222	Fruit trees and berry plantations	123157	1398	1.1%
223	Olive groves	518360	2421	0.5%
241	Annual crops associated with permanent crops	16563	10	0.1%
242	Complex cultivation patterns	1007677	5040	0.5%
243	Land principally occupied by agriculture, with significant areas of natural vegetation	773877	11269	1.4%
244	Agro-forestry areas	164627	2314	1.4%
311	Broad-leaved forest	840208	1006	0.1%
312	Coniferous forest	526430	3812	0.7%
313	Mixed forest	573425	3930	0.7%
321	Natural grassland	1247403	6448	0.5%
322	Moors and heathland	260835	1628	0.6%
323	Sclerophyllous vegetation	2070419	25739	1.2%
324	Transitional woodland-shrub	1044180	5266	0.5%
331	Beaches, dunes, and sand plains	31072	68	0.2%
332	Bare rock	22903	59	0.3%
333	Sparsely vegetated areas	249691	437	0.2%
334	Burnt areas	19081	2102	9.9%
	Unclassified forest surfaces	1371987	17445	1.3%
	Total	12983050	100724	0.8%



Flood Activities

During 2000 the development of the three LISFLOOD flood simulation models continued. LISFLOOD is a physically based simulation model simulating the hydrology in a river basin. The *Meuse* and *Oder* catchments were studied as pilot projects. LISFLOOD-WB simulates on a daily basis the water balance in a catchment. LISFLOOD-FS simulates floods with an hourly time-step, and uses the results of the water-balance model as boundary conditions. Typically, LISFLOOD simulates large European catchments using 1-km² grids. For sub-catchments, 100-300 m grids are used. LISFLOOD-FP simulates flood inundation on selected parts of river floodplains using high-resolution (5-50 m pixels, 10-15 cm vertical accuracy) digital elevation models.

The LISFLOOD model is now also capable to simulate the effects of water reservoirs, retention areas, changing cross section and floodplain geometry, besides its capability of simulating the effects of land use changes on floods. Scenarios with combinations of above mentioned measures can be designed and the effects on floods calculated with LISFLOOD.

LISFLOOD Applications

Land use changes	Deforestation, Set-aside, Afforestation, Urban growth
Climate changes	Precipitation and Temperature changes
Water reservoirs	Size and location
Water retention areas	Size and location
River geometry	Width, depth, slope gradient, roughness
Floodplain geometry	Width, storage capacity, roughness

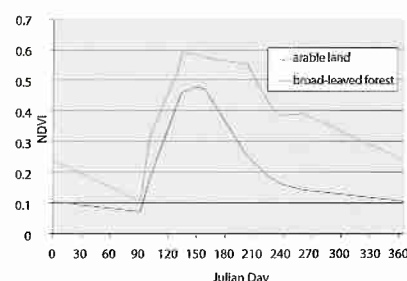
Within the EC contribution to the International Commission on the protection of the *Oder* river (IKSO), relevant water authorities from the Czech Republic, Poland, and Germany have already defined some realistic scenarios linked to flood prevention, which will be calculated by LISFLOOD in the near future.

IRS-WIFS satellite images of 180-m resolution were used to obtain vegetation cover dynamics during the year. The data were then used in LISFLOOD to simulate evapotranspiration. Combining the IRS-WIFS images with the CORINE Land Cover maps, NDVI-profiles were derived for each CORINE class.

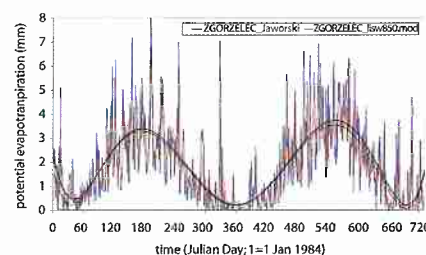
Much effort was put on the validation of the LISFLOOD models. For the *Oder* catchment, three major historic flood events (1977, 1985 and 1997) were used to validate the model. Through cooperation with the national water authorities, measured discharge data from 64 gauging stations from the Czech Republic, Poland and Germany were made available to validate the model coupled with local data on evapotranspiration. In the *Meuse* basin, validation work is continued at catchment level, and in sub-catchments such as the *Ourthe*, *Geer*, *Lhomme* and *Geul*, together with the Free University of Amsterdam and within the framework of the DAUFIN competitive project.



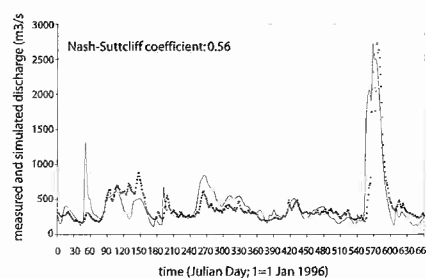
▲ IRS-WIFS image of a part of the Oder catchment along the Polish-German border.



▲ Normalized Vegetation Indices for arable land and broad-leaved forests in the Oder catchment, derived from IRS-WIFS satellite images.



▲ Comparison of potential evapotranspiration calculated using LISFLOOD and the Polish Jaworski method for the Zgorzelec station.



▲ Measured (*) and simulated (-) discharge in the Oder river near Slubice (Polish-German border) for the years 1996 and 1997.

Highlights

2000

- Launch of a feasibility test for a European Flood Forecasting System.
- Launch of the European Forest Fire Risk Forecasting System.
- Resolution of the European Parliament on Forest Fires, asking for a continuation and reinforcement of the forest fires activities of the SAI Natural Hazards project.
- Proposed decision of the Council on an improved community cooperation in the field of Civil protection including the flood and forest fire activities of the SAI Natural Hazards project as one of the Community initiatives which contribute to the aims of Civil protection and which could be activated as appropriate.
- Lille conference on GMES (16, 17 October): Audiovisual presentation of flood and forest fire activity.
- Meeting in Hyeres on Forest Fires. Discussion with Commissioner Busquin on Fire Risk and Burnt-area Mapping activities.
- First trial of RIMS on forest fires (testing the synergy of Earth observation and telecommunication means within a network with National Civil Protection Services).
- Completion of LISFLOOD modelling system. IKSO agreement: LISFLOOD as reference tool for scenario development of the Oder catchment.

2001

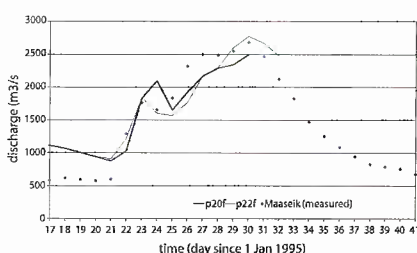
- Launch of the pre-operational Advanced Forest Fire Risk Forecasting System (Fire Potential Index FPI).
- IKSO meeting at SAI: Discussion on scenario development for the Oder Action programme.

One application of the LISFLOOD modelling system is studying the effects of historic land use changes on floods in the *Meuse* and *Oder* catchment. For both the *Meuse* and *Oder* catchment the CORINE Land Cover maps (dated around 1995) are used as a baseline condition. Using Landsat MSS images of the year 1975, for both the *Meuse* and the *Oder*, a CORINE land use classification was derived, such that the effects of land use changes over the last 20 years could be evaluated. It appeared that no major land use changes occurred in the *Oder* basin between 1975 and 1995. In the *Meuse* basin there were some land use changes between 1975 and 1995. To simulate the effect of these changes on floods, the 1995 *Meuse* flood event was simulated both with the 1975 and 1995 land use. Differences occurred especially in the initial conditions prior to the flood. These were obtained with the daily water-balance model. On average, soil moisture storage capacity just before the flood period resulted reduced from 210 mm using the 1975 land use, to 198 mm using the 1992 land use: a decrease of 5.85%. When these initial conditions were used to run the flood simulation model, the peak discharge as a result of the 1992 land use was 0.20 % higher than the peak discharge simulated using the 1975 land use. The total volume of water simulated during the flood was 4.06% larger. The peak water level at *Borgharen* was slightly higher when the 1992 land use was simulated as compared to the 1975 land use. Work is ongoing to develop digital historic land use information for the *Meuse* (cooperation with the Free University of Amsterdam) and the *Oder* basins. In both areas, historic maps, going back as far as 200 years, are available. The effects of land use changes on floods over the past 200 years will be examined in 2001.

Furthermore, work was initiated to test the feasibility of LISFLOOD for flood forecasting. As a test, the LISFLOOD flood simulation model was used to simulate the *Meuse* flood in January 1995 using the 10-day precipitation forecasts given by the DMO-ECMWF forecasts. In this test the daily timestep model was used, evapotranspiration was neglected, and simulated discharges were not updated with measured discharges, a common practice in flood forecasting. 15 runs were simulated using 15 days of ECMWF-DMO precipitation forecasts from 17-31 January 1995. All simulations started at 12 January 1995. Initial conditions on 12 January 1995 were simulated using the LISFLOOD water balance model using observed meteorological data from 1 March 1994 until 11 January 1995. Each run consisted of a number of days observed precipitation data since 12 January 1995, and 10 days of forecast precipitation. The first results of the flood-forecasting model (LISFLOOD daily version) were very promising. The results show that flood forecasting could benefit a lot from using precipitation forecasts of 3-10 days ahead, which at the moment is not operational at many flood-forecasting authorities in Europe. The results should however be interpreted as valid for the test only; the same success cannot be guaranteed for other rivers.

A competitive project (EFFS) was initiated together with several universities, consulting companies and weather forecast services to test and develop a European Flood Forecasting System. The aim is to develop an early flood warning system, 4-10 days in advance, using precipitation forecasts and other weather variables. The system could be used to alert the national water authorities and serve as a background-backup system for countries without these forecasting systems.

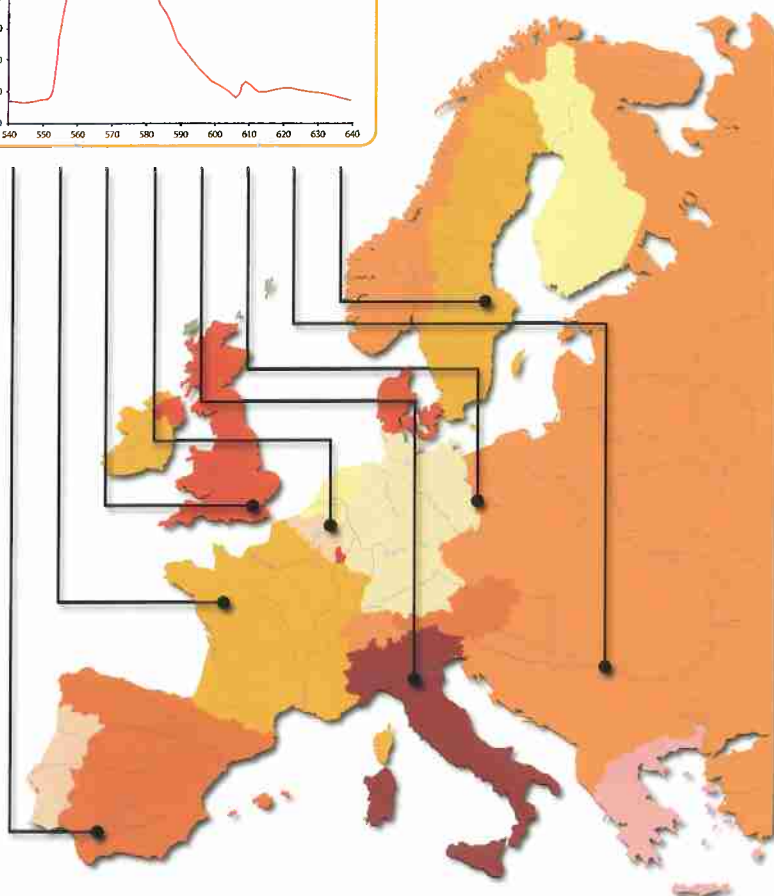
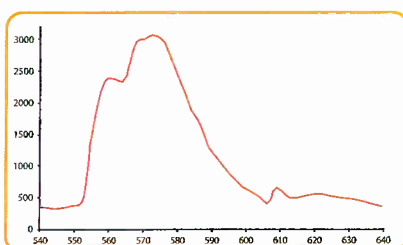
Within the flood damage assessment activity, the PSNAKE algorithm, which is used to calculate flood extent from SAR images, was further tested on Radarsat images - in addition to the tests done with the ERS-images. High resolution IKONOS satellite data will be used to assess land use types in the inundated areas of the two pilot areas in the *Meuse* and *Oder* catchments. Using these data, flood damage reports could be prepared shortly after a flood crisis.



Flood forecasting simulation results using ECMWF 10-day precipitation forecasts of the *Meuse* flood in January 1995. The forecast of 20 January (p20f) for 30 January is already close to the observed peak discharge (indicated by the dots) on 30 January.

LISFLOOD output

	Landuse 1975	Landuse 1995	Change (%)
Peak discharge (m3/s)	3099	3105	0.2
Total discharge (M m3)	7621	7930	4.1
Cumulative evapotranspiration before the flood (mm)	486	429	-11.7
Initial soil moisture storage capacity (mm)	210	198	-5.9



A European Flood Forecasting System is presently tested and developed to provide an early flood warning 4-10 days in advance to national water authorities.

Selected Further Reading

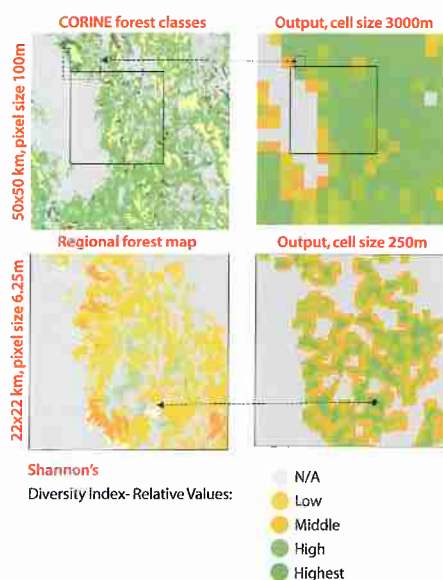
- Barbosa, P., San-Miguel Ayanz, J., and Schmuck, G., 2000, Using GIS for forest fires damage assessment in Greece, *17th International CODATA Conference-Session: Symposium IV Geographical Information Systems*, held at Stresa, Italy, 18-19 October.
- Salvador Civil, R., and San Miguel-Ayanz, J., 2000, An extension of a non-parametric clustering algorithm to derive radiometrically homogeneous objects pointed by seeds, *International Journal of Remote Sensing*, in press.
- San Miguel-Ayanz, J., Verstraete, P., Pinty, B., Meyer-Roux, J., and Schmuck, G., 2000, The use of existing and future remote sensing systems in natural hazard management: Specifications and requirements. In Verstraete M. Menenti, M and Peltoniemi, J. (Eds.) *Observing Land From Space: Science, Customers and Technology*, pp. 53-60, Kluwer Academic Publishers, Dordrecht.
- Sebastian-Lopez, A., San Miguel-Ayanz, J., Libertà, G., An integrated forest fire risk index for Europe, *20th EARSeL SYMPOSIUM, Remote Sensing in the 21st Century: A decade of Trans-European Remote Sensing Cooperation*, 14-16 June 2000, Dresden, Germany.
- De Roo, A.P.J., Wesseling, C.G., Van Deursen, W.P.A. (2000) Physically-based river basin modelling within a GIS: The LISFLOOD model. *Hydrological Processes*, Vol.14, 1981-1992.
- Bates, P, De Roo, A.P.J. (2000), A Simple Raster-Based Model For Flood Inundation Simulation. *Journal of Hydrology*, Vol.236, 54-77.
- De Roo, A., Bates, P., Van Der Knijff, J., Schmuck, G. (2000), A simple floodplain inundation model to assist in floodplain management. In: Maione, Majone Lehto & Monti (eds.), *New trends in Water and Environmental Engineering for Safety and Life*. Balkema Publishers, Rotterdam, pp.164.

CONTACT

A. De Roo (Activity Leader), J. Thielen, M. Odijk, G. Somma, B. Gouweleeuw

Information Dissemination

- **Publications:** 9 articles in refereed journals and books; 8 articles in conference proceedings.
- **Website:** <http://natural-hazards.aris.sai.jrc.it/>
- **Leaflets:** LISFLOOD FP – Flood inundation model; LISFLOOD simulation for catchments; Flood extend maps and damage estimates; Forest Fire Risk assessment; Forest Fire Burnt Area Mapping; Forest Fires Damage Assessment
- **Video:** Flood activities of the SAI Natural Hazards project; Forest Fire activities of the SAI Natural Hazards project
- **Press:** Flood activities: Haagse Post, Arnhemse Courant; Forest Fire activities: De Morgen, La Libre.



Shannon's Diversity Index calculated as an indicator of ecosystem diversity for forested landscapes in the Umbria Region, Italy.

The investigation of environmental stress factors on forest condition in Europe has been undertaken using the ground observation data from a 16 km x 16 km grid covering the European Union. This is referred to as the Level-I network of the EU and ICP (International Co-operative Programme) Forests, which has produced a 13-year archive of observations indicative of forest damage. These data have been analysed in conjunction with European-wide soil, ozone and climatic data sets to investigate the relationships between causal factors of damage such as, elevated concentrations of atmospheric gases and extreme climatic events.

Catchment Characterisation and Modelling (CCM)

During 2000 work in the CCM activity was carried out in accordance with the four main working directions specified in the strategy document resulting from an expert meeting in 1999, namely the mapping catchments at the pan-European scale, the characterisation of the resulting catchments, the development of a catchment typology, and the progress modelling of catchments.

In mapping the catchments at the pan-European scale, the goal was the development of a GIS of drainage networks and catchment boundaries at a nominal scale of 1:250,000, covering Europe from Scandinavia to the Mediterranean and from the Atlantic to the Ural Mountains. The development of an appropriate coding system formed an integral part of this activity. The characterisation of the resulting catchments was carried out by physical and socio-economic variables. Such data form an important step towards a sound and reliable analysis of cause-effect relationships between policies and landscape processes in the different regions of Europe. The development of a Catchment Typology (classification) has been defined as a necessary step for the extrapolation of results of sophisticated models of landscape and hydrological processes, usually applied at the watershed or sub-watershed scale. Last but not least process modelling of a set of selected catchments can be used to assess the impact of policies, societal changes, and climate change on the dominant landscape processes acting at the catchment scale.

In 2000 considerable progress was achieved in the fields of catchment mapping and catchment characterisation. In close collaboration with the European Environment Agency (EEA) and EUROSTAT-GISCO, CCM consolidated its strategy for the implementation of a pan-European GIS and database on drainage networks and catchment boundaries, including a set of physical and socio-economic descriptors.

A sound methodology for an automatic delineation of river networks and catchment boundaries from digital elevation models (DEM) and ancillary data - climate, relief, soils, geology and vegetation cover - was developed and tested. A prototype version of a digital drainage network and catchment database was delivered to DG Environment, EUROSTAT-GISCO and the EEA for comments and testing. This database covers the territory of Italy and corresponds to a nominal scale of 1:250,000. It is based on a DEM with 250 m grid cell size and the ancillary data mentioned above. The landscape stratification performed as part of the mapping process, provides a first set of physical characteristics for the catchment characterisation.

According to the work plan, activities on catchment classification and process modelling will start in 2001.

Modelling for Environmental Impact Assessment

During the reporting year, a series of studies were undertaken. In particular the study on "Analyse des politiques communautaires par rapport à l'environnement rural- conditions requises pour une évaluation territoriale intégrée" was completed.

Another study aimed to design an integrated methodology in order to understand land use changes in coastal areas and to propose a comprehensive analysis which examines the influence of socio-economic and biophysical driving forces on land use changes;

CONTACT
Jürgen Vogt

identifies the various actors playing in the territory and explains how their behaviour and strategies determine land use changes; and contributes to the development of the application of methodological tools, such as GIS for an integrated analysis in an effort to achieve compatibility of various kinds of data.

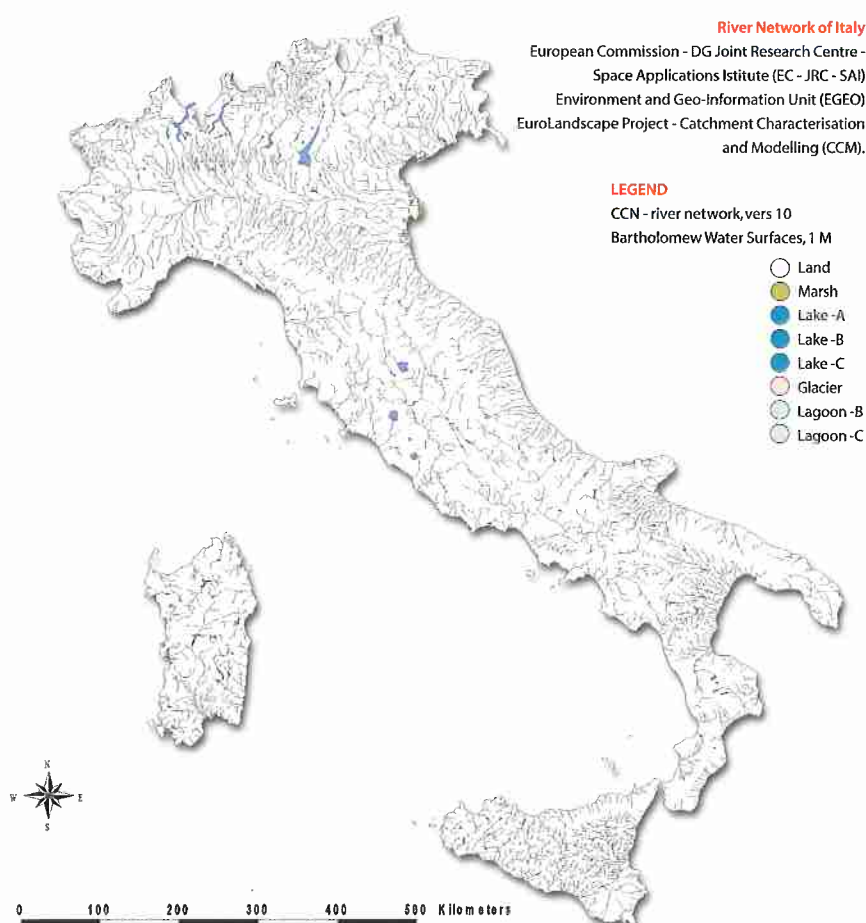
Last but not least, a study on *"Spatial Impact of Rural Environment EU Policies: A Regional Comparative Analysis of Land Use Changes (SIMLUC)"* was undertaken, and aimed to analyse the impact of EU policies on land use changes in different regional contexts, focusing on agricultural, rural, regional and environmental policies. Three countries recently joining the EU were chosen, characterised by different agricultural production systems and farm structures. The research is based on a cross-disciplinary approach to understand the land use changes in different areas, integrating both the socio-economic and biophysical dimensions. It examines the societal driving forces - political, economic, institutional and social that influence land use and land cover changes. The methodology should be applicable for national, regional and local analyses.

CONTACT

Vanda Perdigão

Highlights

- Workshop on *"Spatial Impact of European Union policies on land use"*. The Workshop coincided with the final meeting of the research project (SIMLUC). The meeting dealt with the methodological approach implemented by the project and the results obtained by the team of each country involved in the project.
- Participation in the joint workshop of the EEA-EIONET and DG Environment Water Framework Directive Expert group on *"Streamlined Reporting at the European Level"*. Presentation and discussion of CCM.
- Report on Catchment Mapping and Characterisation and delivery of a first version of a 1:250,000 database for Italy.
- Expert Meeting *"Contribution of EO data and GIS techniques for assessing the structural diversity of the forests in Europe: A landscape approach"* held at SAI/EGEO on 9,10 March 2000.
- Expert Panel on Remote Sensing. A meeting was organized by SAI on 21, 22 February 2000. For the first time a chapter was dedicated to remote sensing techniques in the Annual Report of the Intensive Forest Monitoring (Level-II survey) and the Executive Report on Forest Condition in Europe, contains a section on Integrated Analysis, with contributions from SAI.
- Completion of a calibrated 1km x 1km forest database for Europe, which is being utilized as input data for BGC models for estimating the carbon stocks in Europe's forests. Map published by EUROSTAT in *"Statistics in Focus"*.

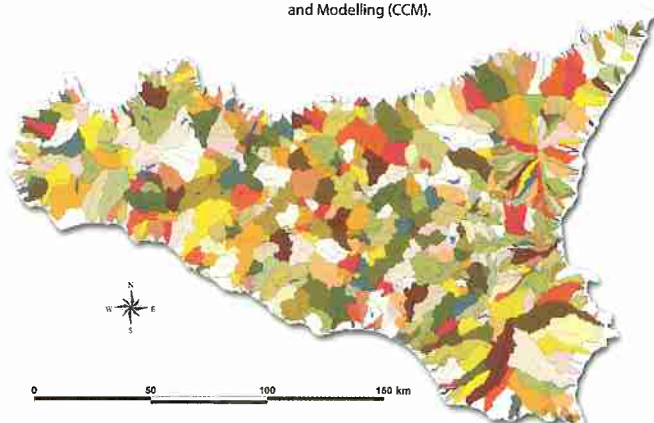


Drainage Network of Italy.

Second Order Catchments of Sicily.

2nd Order Catchments of Sicily

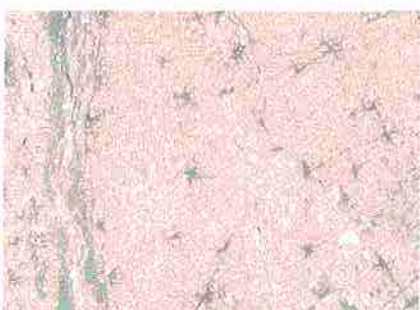
European Commission - DG Joint Research Centre -
Space Applications Institute (EC - JRC - SAI)
Environment and Geo-Information Unit (EGEO)
EuroLandscape Project - Catchment Characterisation
and Modelling (CCM).



Studying Complex Landscape Structures (SCALE)



Comparison between the representation of the built-up structures made by the CLC dataset (in red) and a satellite-derived automatic processing. The built-up structures derived by automatic textural classification of SPOT P data (10 meters of spatial resolution) are shown in black. The area shown is of about 11x8 kilometres, in the north of Padova, Italy.



An example of detection of agricultural parcelling structure using Landsat TM data as input and a morphology-based image segmentation process. In grey the radiometric information, in red the borders of the detected structures. The area shown is of about 16.5x12 km placed in the North-East of Italy (Friuli).



An example of non-linear fusion between CLC and Landsat TM datasets. Different families of colour are linked to CLC information. The TM image is of about 16.5x12 km placed in the North-West of Athens, Greece.

The sub-project SCALE deals primarily with the development of advanced methods to study complex landscape patterns including those areas experiencing fast changes. Complex landscapes maybe defined, at a given resolution, as geographical areas connoted by complex structural and/or thematic behaviour, such as presence of patterns of relevant small and/or intricate structures, high fragmentation and local mixture of different land use/ land cover. Emphasis is given on the extraction of useful spatial information from Earth observation imagery, for large-area analysis.

The methods developed are based on research on textural and structural image analysis and, in particular, on mathematical morphology. Recent advances in mathematical morphology applied to Earth observation data enabled us to provide tools for automatically detecting land-cover parcelling structure, which could ultimately be operationally integrated in the Corine Land Cover (CLC) exercise during the reporting year. Indeed, concepts of image simplification by levellings or flattenings, multi-scale pixel signatures, and directional morphology already led us to provide a wide range of effective tools for automatically extracting structural information from satellite images.

Typically, three steps compose the detection procedure: pre-processing and image standardisation, image texture analysis and built-up structure recognition, image morphological segmentation and agricultural field structure recognition, quality control and refinement of the detection. The detected structures are subsequently transformed into vector format to allow for easy integration of the new dataset within a standard GIS environment. The above methodologies were tested and further developed for the automatic updating of the (CLC) 2000.

Crest line extraction on multi-spectral gradient images and digital elevation models benefited from research carried out within the project on order-independent homotopic skeletons generalised for gray-scale images. Spatial analysis and modelling techniques to identify relationships between spatial structures and other features were also studied and applied in spatial planning activities and environmental impact assessment studies.

Image fusion techniques were further developed. These could be used to create new digital cartographic products, a hybrid between the two archetypal satellite-derived mapping strategies (namely, colour composite of the raw data and thematic maps). This final product can then be used as a base for Web mapping applications or for a paper-printed cartographic product. The objective is to merge the semantically discrete information about land cover with more semantically continuous or photographic information, which improves the readability and the overall communicative quality of the cartographic document. In this approach, colours in the fused image are fully conventional and not derived from a linear data merging procedure as in common data fusion approaches. Different families of colours are linked to the CLC information, while structures are extracted from Image2000 panchromatic datasets. This fact allows the mapmaker to fully and easily control the graphical layout of the final map, and so have complete control of the amount of semantically continuous and discrete information that constitute the final cartographic product. From a general point of view, the work for each scene is composed of a phase of pre-processing and processing. In the first phase, there is a step related to image standardisation followed by a filtering conditioned to different landcover classes. In the second phase, the image fusion process takes place using a given colour code set of rules.

Finally, the development of techniques for extracting relevant environmental structural information from the new generation very-high resolution remotely sensed imagery (IRS-1C/D, IKONOS-2) was initiated and some methods were implemented.

CONTACT

Ioannis Kanellopoulos, Pierre Soille

Environmental Indicators for Monitoring and Protecting Sensitive Areas (ENVIP)

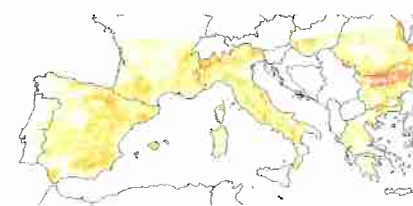
ENVIP aims to contribute to the provision of harmonised, spatial information so as to support the implementation and monitoring of environmental protection policies at pan-European level. For the implementation of EU environment policies, the European Commission services and other involved parties (e.g. Member State services, non-governmental organisations) require regularly up-dated, regional indicators. These indicators are needed to assess the environmental status of European landscapes and the extent and development of environmental risk factors in an integrated, regional planning and monitoring framework. Against this background, the core objective of ENVIP is the development and application of methods and indicators for the status assessment, long-term monitoring and protection of environmentally sensitive areas. The main focus of ENVIP is on Earth observation and GIS-based methodologies in order to link multi-spectral remote sensing with ground physical and ecological parameters, as well as with available thematic spatial data layers, in order to obtain spatial information on land ecological conditions and their behaviour over time.

The following specific tasks were identified:

- Investigate spatial, physical and ecological indicators of bio-diversity, soil quality and land degradation and their integration into spatial analysis and environmental monitoring systems.
- Investigate the potential of new Earth observation systems to improve existing methods and add new possibilities of environmental assessment and monitoring in Europe.
- Demonstrate the applicability of indicators in feasibility studies of environmental monitoring with specific emphasis on issues of land degradation and bio-diversity, in a nested approach from local to continental scales.
- Identify indicators linked to changes in vegetation functioning and soil quality parameters and particularly those that may be derived from combinations of remote sensing and modelling.

Research on the derivation of spectral indicators of environmental conditions resulted in new methods of iterative spectral mixture modelling applicable to large heterogeneous remote sensing imagery and of using artificial neural networks (ANN) to quantitatively derive soil mineralogy and heavy metal contamination from spectral measurements. As a basis of this research, the MEDSPEC spectral database was completed providing several hundred, highly resolved spectra (1 to 10 nm) of natural surface materials and contaminated soil samples measured in the range from 400 to 2500 nm. The spectra are stored together with the sampling point co-ordinates, documentation of the environmental conditions of the sampling site and, where available analytical data of the sample. The data base application provides a large number of data exchange features with standard image processing software as well as spectral re-sampling according to the specifications of a wide range of remote sensing systems. Besides its use in spectral analysis, MEDSPEC can be further applied on radiometric correction and spectral mixture analysis (SMA) of optical remote sensing data.

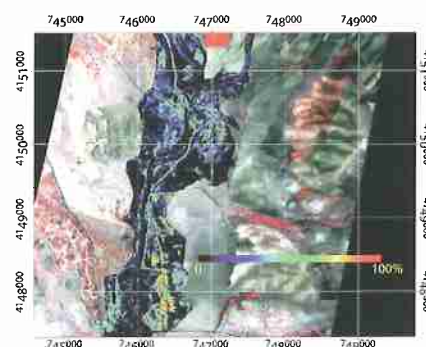
Work on the application of new remote sensing systems had a clear focus on the application of hyperspectral image data to quantitatively derive soil properties, such as soil organic matter, soil mineralogy and soil geochemistry that are important indicators of soil quality and soil contamination after mining accidents.



July 1993



Percent surface contamination with heavy metal sludge in the Guadianar river flood plane after mechanical removal of contaminated topsoil, derived from HYMAP imaging spectrometry data, status July 1999.



Comparison of modelled regional potential erosion for current climate (reference July 1993 top) and future climate (reference July 2080) based on 1993 MARS climate data and Hadley Centre climate change scenario for 2080 (MODEM Project: SAI-EGEO/University of Leeds, UK).

Selected Further Reading

- Benediktsson, J. A. and I. Kanellopoulos. (2000). Information extraction based on multi-sensor data fusion and neural networks, in C. H. Chen editor, *Information Processing for Remote Sensing*, World Scientific, Singapore, New Jersey, 1999.
- Folving, S. and Kennedy, P. 2000. European Forest Mapping and monitoring within the frame of the FIRS Project: A Review on progress and results (1995-1999). *XXIIUFRO World Congress Forests and Society: The Role of Research*, Kuala Lumpur, Malaysia, August 7-12, 2000.
- Häme, T., Stenberg, P., Andersson, K., Rauste, Y., Kennedy, P., Folving, S., Sarkeala, J. AVHRR-based forest proportion map of the Pan-European area. *Remote Sensing of Environment* (In press).
- Kemper T., García-Haro J., Preissler H., Mehl W. and Sommer S., 2000: Application of a multiple endmember unmixing approach to Hymap data for mapping heavy metal contamination after the Doñana mining accident (Sevilla, Spain). *2nd EARSel. workshop on Imaging Spectrometry*, ITC Enschede, July 11-13, 2000, proceedings in print.
- Kennedy, P., Folving, S., Häme, T., Andersson, K., Stenberg, P., Sarkeala, J. and Väättäinen S. 2000 Sub-pixel area estimation of European forests using NOAA-AVHRR data. In: *Proc. IUFRO Conference on Remote Sensing and Forest Monitoring*, June 1-3, 1999. Rogow, Poland.
- Leone A.P. & Sommer S., 2000: Multivariate analysis of laboratory spectra for the assessment of soil development and soil degradation in the southern Apennines (Italy). *Remote Sensing of Environment*. 72, pp. 346-359.
- Pesaresi, M. and J. Benediktsson. (2000). Image segmentation based on the derivative of the morphological profile. In J. Goutsias, L. Vincent, and D. Bloomberg, editors, *Mathematical Morphology and its Applications to Image and Signal Processing*, Boston. Kluwer Academic Publishers.
- Soille, P. (2000). Morphological operators with discrete line segments. *Lecture Notes in Computer Science*, vol. 1953, pages 80-99.
- Sommer S. & Kemper Th., 2000: Use of Hyperspectral Data for the Detection and Assessment of Soil Degradation Phenomena. In: *Tagungsband 16. Nutzerseminar des Deutschen Fernerkundungsdatenzentrums des DLR*, ISRN DLR-Mitt—1999-03, pp. 63-72.
- Sommer S., 2000: Assessment of Data Requirements and Availability For Remote Sensing Based Land Degradation and Desertification Monitoring in the Mediterranean Basin. EU Workshop on "Desertification Convention: Data and Information Requirements for Interdisciplinary Research" Proceedings in print.
- Vogt, J.V. and F. Somma (Eds) (2000): Drought and Drought Mitigation in Europe. *Advances in Natural and Technological Hazards Research*, vol. 14 (Kluwer Academic Publishers) Dordrecht, 336 p.

A programme to assess and monitor heavy metal contamination and related acidification through imaging spectrometry after the accidental toxic pyrite sludge spill of the Aznacollar mine in Seville, Spain, had already been initiated in 1999. Two airborne imaging spectrometry and campaigns flown with the DAIS and HYMAP sensors in 1999 and 2000 allowed to produce quantitative estimates of residual heavy metal contamination in the flood plain of the Rio Guadiamar. This is important information to assess and monitor the success of the various decontamination and reclamation measures initiated by the Spanish authorities immediately after the Aznacollar accident in 1998. The work is performed in close collaboration with the JRC Environment Institute and with the support of DG ENVIRONMENT, the EEA and local authorities.

Major efforts were focused on the refinement of the set-up of the ENVIP DEMONET (Land Degradation Monitoring Network). This feasibility study in the Mediterranean region is based upon methodologies and expertise developed in the framework of EC-funded research projects such as MEDALUS and DEMON. The goal is to demonstrate the current possibilities to provide indicators of land degradation in a regional context deploying 15 to 20-year remote sensing datasets and available ancillary data (soils, lithology, climate, relief).

In this context changes of vegetation functioning and soil erosion, being the ultimate consequence of the loss of vegetation cover, are considered valid biophysical indicators for estimating the status of land degradation and the sensitivity of a landscape to desertification under changing environmental conditions. Vegetation functioning trends (in terms of rain use efficiency and erosion risk) in the Mediterranean Basin were derived at 1-km resolution through physical modelling based on relief parameters, accumulated run-off, potential and actual vegetation, climate and rainfall scenarios.

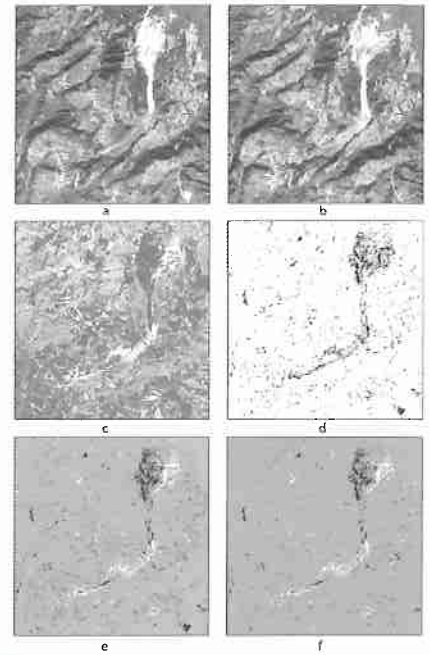
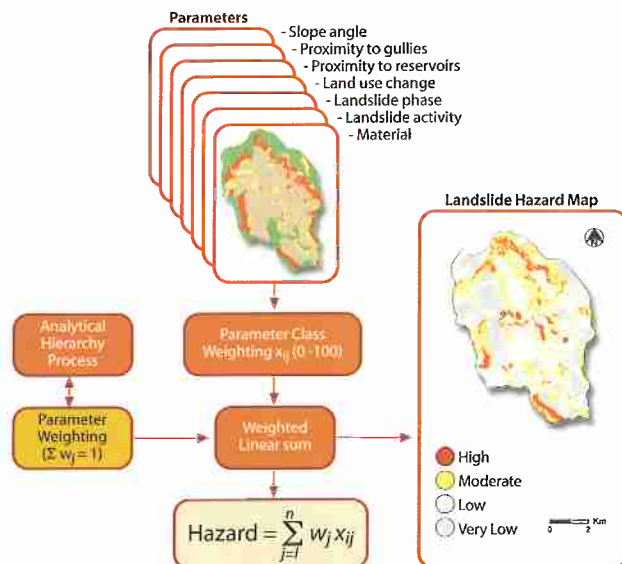
The actual vegetation percentage per 1 km pixels, derived from 10-day to monthly intervals from NOAA AVHRR and SPOT VEGETATION satellite data, was used to condition the models. Fractional vegetation cover derived through spectral unmixing techniques also proved to be a consistent parameter to establish improved links between the various scales involved from coarse resolution (1 km) satellite imagery to high resolution remote sensing (e.g. Landsat TM) and ground observation. These links are needed to calibrate and validate the models on the 7 reference test sites distributed across the entire Mediterranean Basin and to perform more detailed studies on cause-effect relationships between vegetation change and soil degradation particularly in conjunction with socio-economic information.

Landslide Recognition, Monitoring and Hazard Assessment

Increase in rainfall during the last years coupled with urbanisation and deforestation have intensified landslide hazards and their devastating effects both to human lives and property. This has raised higher awareness from land management and civil protection authorities at EU, national, regional and municipal levels about these natural events. From recently proved evidence of tsunamis caused by coastal landslides, concern of catastrophic effects on coastal urban areas possibly caused by tsunamis following large landslides triggered by volcanic eruptions in Atlantic islands have increased, thus extending the indirect risk from remote landslides to coastal areas across national borders.

Collecting information on landslide occurrence and activity over wide areas is a crucial task for landslide hazard assessment. Field techniques (e.g. geodetic, geotechnical and GPS), despite being very precise, are usually not sufficient to achieve this goal, since they mostly provide point-based measurements. To this end, an image processing method to map and monitor landslide activity over extensive areas using multitemporal high-resolution optical remotely sensed imagery has been developed. The method entails automatic change detection of suitably pre-processed (orthorectified and radiometrically normalised) sequential images, followed by thresholding, thus classifying image pixels according to landslide activity conditions. Subsequent filtering based on the degree of rectangularity of regions has also been considered to eliminate pixel clusters corresponding to man-made land use changes. This method is particularly useful for monitoring surface changes caused by moderate-velocity landslides, even if involving high internal deformation, in humid and heavily vegetated areas, where the application of more accurate radar interferometry techniques is often not possible. In addition, the method can be applied to aerial photographs, thus allowing the monitoring of past landslide activity in unstable areas during the last decades. Progress has also been made in landslide hazard assessment at medium scales (1:25,000 to 1:50,000) through integration of satellite-derived information and spatial datasets using GIS heuristic approaches.

In 2000, the EU 4th Framework Programme competitive project RUNOUT was completed. In this project, an integrated approach to monitor and assess hazards from large-volume landslides was developed using optical remote sensing data and geodetic and GPS measurements. The 5th Framework Programme competitive project MUSCL on monitoring landslides and urban subsidence by remote sensing was initiated. At the same time, networking has increased through new partnership with Cardiff University, UK, University of Innsbruck, Austria, Technical University of Milan (POLIMI), Italy, and Central University of Venezuela (UCV) at Caracas, in addition to ongoing collaboration with IRPI-CNR of Padua and University of Ferrara, Italy, Universities of Las Palmas and Alcalá, Spain, UCL, UK, and ITC, Netherlands.



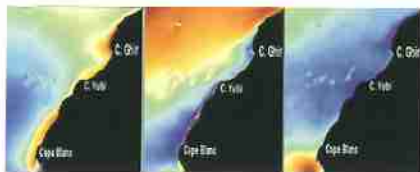
Landslide monitoring from optical remotely sensed imagery by thresholding and filtering the before (a) and after (b) landslide reactivation difference image (c). Tessina landslide, NE Italy.

CONTACT
Javier Hervás

Selected Further Reading

- Barredo, J.I., Benavides, A., Hervás, J., and Van Westen, C.J., (2000). Comparing heuristic landslide hazard assessment techniques using GIS in the Tirajana basin, Gran Canaria Island, Spain. *Int. Journal of Applied Earth Observation and Geoinformation*, 2, 9-23.
- Hervás, J., Barredo, J.I., Rosin, P.L., Pasuto, A., Mantovani, F., and Silvano, S. Monitoring landslides from optical remotely sensed imagery: the case history of Tessina Landslide, Italy. *Geomorphology*. In press.
- Rosin, P.L., Hervás, J., and Barredo, J.I., (2000) Remote sensing image thresholding for landslide motion detection. *Proc. 1st Int. Workshop on Pattern Recognition Techniques in Remote Sensing*, Andorra, 1 September, pp. 10-17.

Generation of landslide hazard maps using a GIS heuristic approach and multicriteria evaluation techniques in Gran Canaria Island.



▲ Spatial amplitude patterns for the first three SST spatial EOF modes corresponding to the Canary area.

Coastal Fisheries

Abundance, variability and diversity of marine populations are affected by a wide array of factors. The determination of the temporal and spatial scales of oceanographic variability is vital to our understanding of marine populations. In this light, great effort was undertaken by the Marine Environment Unit to improve and make accessible high quality relevant information, and to analyse it taking into account fisheries requirements. Thus, high-quality oceanographic data acquired over the last two years were purchased and processed. The processing was undertaken in-house and included the refinement, improvement and implementation of algorithms to process both sea surface temperature (SST) from satellite (AVHRR-NOAA) and meteorological data. Then, quality-controlled derived oceanographic indices of relevance to fisheries were improved and augmented from last year's achievements. Upwelling indices, covering the whole of the West African coast and including both thermal and meteorological information are now available. Empirical orthogonal function (EOF) analysis of the spatial variance for more than 700 weekly composite images all along the coast was performed.

The average SST pattern, the extent of the seasonal cycle, as well as the percentage cloud-cover for the area, as depicted by the satellite imagery was also identified. The first EOF mode, accounting for the highest variance in the data, resembling the mean of all images, showed the mean extent of the main upwelling centres along the coastline. All subsequent modes progressively accounted for a smaller portion of the variance and thus only the first five modes were retained. The temporal amplitude of these EOF modes revealed how the SST features changed temporally. The seasonal cycle, once described, is then removed from the analysis and the EOF analysis is then performed again to obtain a clearer interannual signal variance from each of the EOF modes. The first mode still retains the "average" SST pattern but the other modes now show interesting oceanographic features.

The work supported the implementation of relevant policies of the Development DG, such as the ACP-EU Fisheries Research Initiative for African, Caribbean and Pacific States, and strengthened the cooperation with the Food and Agriculture Organisation (FAO) of the United Nations.

Highlights

- Successful second year of collaboration with the EEA and the EEA-ETC/MCE on coastal environment monitoring
- SeaWiFS European Archive established
- AVHRR (GAC data) European Archive consolidated
- Launch of CoastBase Project (January 2000) and completed CoastBase Study on Information Definition and User Requirements
- MEDCOAST International Workshop on "Applications of Remote Sensing of River Catchment Areas and their Coastal Margins in the Mediterranean and Black Sea", 10-12 April 2000, Ispra, Italy
- HELCOM Meeting, Monitoring and Assessment Group (MONAS), 9-12 May 2000, Tallinn, Estonia
- "Oceans from Space", Symposium, 3rd edition (Venice 2000), 9-13 October 2000, Venice, Italy
- COLORS Final Project Meeting, 4-6 December 2000, Ispra, Italy

The European environmental legislation, such as the nitrates directive, urban wastewater directive, and the Water Framework Directive, set the frame for the activities of the project in the monitoring and assessment of water quality in coastal/marine waters. In particular, eutrophication as a result of high nutrient input from rivers or direct discharges is of major concern in a number of coastal areas in Europe.

In this context, the fruitful collaboration with the European Environment Agency (EEA) was strengthened also through participation in and contribution to the activities of the European Topic Centre on Marine and Coastal Environment (ETC/MCE). Contacts with DG Environment were further developed mainly in the field of Integrated Coastal Zone Management and in support to the implementation of the European environmental legislation. Collaboration with HELCOM (Helsinki Commission for the Protection of the Baltic Sea Area) is planned to be put on a broader basis by setting up a Memorandum of Understanding for the provision of continuous information derived by satellite for their monitoring programme.

Within COAST methods are developed to support the monitoring of coastal water quality. Ongoing activities concentrate on the evaluation and further development of a trophic index (TRIX) for the characterisation of the trophic state of coastal waters. This index includes the levels of chlorophyll, oxygen, nitrogen and phosphate in the water column. Hence, the estimation of the trophic level focuses on the most important bio-geochemical variables in this context.

The index was verified and tested for Mediterranean water by Italian institutions (see Vollenweider et al, 1998). Within COAST the applicability of TRIX for North Sea, Skagerrak, Kattegat and Baltic Sea waters was investigated together with ETC/MCE. The results obtained using in-situ data for the TRIX calculation demonstrate the applicability of this approach also for monitoring eutrophication levels in northern marine and coastal waters.

A spatial indicator was developed using *chlorophyll a* data from the SeaWiFS satellite. This spatial view improves the identification of hot spots and problematic areas and is expected to assist the assessment of the impact of nutrient input from rivers on the coastal ecosystem. In the long term, this should support the monitoring of the implementation of relevant European environmental legislation.

CONTACT

Wolfram Schimpf, Sara Casarelli

Selected Further Reading

- Barale, V., P. Cipollini, A. Davidov, and F. Melin (2000) Water constituents in the NW black sea from optical remote sensing and in situ data, *Estuarine Coastal and Shelf Science*, EROS 21 Black Sea Supplementary Issue (in press).
- Barale, V., S. Zampierin and D.J.T. Carter (2000) The surface colour, temperature and wind fields of the Mediterranean sea, *Proceedings of the 6th Thematic Conference "Remote Sensing for Marine and Coastal Environments"*, Charleston, South Carolina, 1-3 May 2000, Vol II, p. 501-508.
- Barale, V., and I. Zin (2000) Impact of continental margins in the Mediterranean Sea: hints from the surface colour and temperature historical record, *Journal of Coastal Conservation*, vol. 6, p. 5-14.
- Berthon, J.F., G. Zibordi, J.P. Doyle, S. Grossi, D. van der Linde, C. Targa (2000). Coastal atmosphere and sea time series (coasts): data set analysis for ocean colour modelling in the north Adriatic Sea coastal water. *Journal of Geophysical Research* (submitted).
- Bulgarelli, B., V. Kisselev and L. Roberti (1999). Radiative transfer in the atmosphere-ocean system: the finite element method. *Applied Optics* 38: 1530-1542.
- Eleveld, M.A., A.G. Siebert and W.B.H. Schimpf (2000) CoastBase. Information definition and user requirements. EC EUR EN Report (in press).
- Eleveld, M., W. Schimpf, A. Siebert, S. Gandini, and V. Barale (2000) Towards DESIMA-cc: a case study on suspended sediment transport and coastal change, *Journal of Coastal Conservation* (submitted).
- Gandini, S., V. Barale, M. Eleveld, and W. Schimpf (2000) remote sensing applications for the integrated management of a hydrographic basin and its coastal margins; the impact of the outflow of the Po on the Adriatic sea. *Journal of Coastal Conservation* (submitted).
- Barale, V., C. Schiller, C. Villacastin and R. Tacchi (2000) The Adriatic sea SST & CHL historical record from the AVHRR (1981-1999), CZCS (1978-1986) and SeaWiFS (1997-1999) time series, *Proceedings of the Oceans from Space "Venice 2000" Symposium*, Venice, Italy, 9-13 October 2000.
- Siebert, A and W. Schimpf (2000). DESIMA evaluation, verification and improvement. EC Report EUR 19555 EN.
- Siebert, A. and W. Schimpf (2000). DESIMA future developments. EC Report EUR 19632 EN.
- Vollenweider, R.A., F. Giovanardi, G. Montanari and A. Rinaldi (1998). Characterisation of the trophic conditions of marine coastal waters with special reference to the NW Adriatic Sea: a proposal for a trophic scale, turbidity and generalized water quality index. *Environmetrics*, 9, pp. 329-357.
- Zibordi, G., J.F. Berthon, J.P. Doyle, S. Grossi, D. van der Linde, C. Targa, L. Alberotanza and P. Cova. (2000) coastal atmosphere and sea time series (coasts): a long-term measurement project supporting bio-optical modelling and ocean colour cal/val in the north Adriatic sea. *Journal of Geophysics Research* (submitted).

Information Systems Supporting Study and Coast Management

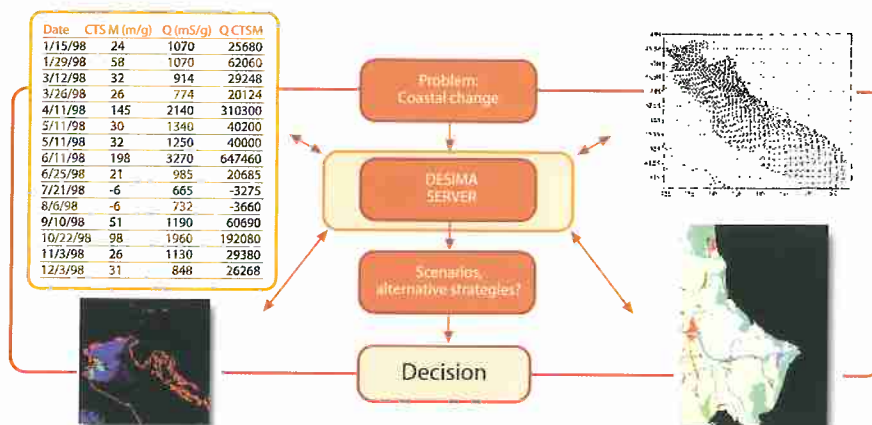
There is a need for easy access to disparate data and information for the study and management of coastal areas. These requirements are addressed in three activities that are related to the COAST project: DESIMA-Demonstrator, DESIMA-CC, and the CoastBase RTD project. These activities have as a common objective to support integrated coastal zone management through the development of methods, tools, and systems for distributed coastal data and information. They apply geo-information science for coastal research and management.

DESIMA stands for DEcision support Systems for Integrated coastal zone MANagement. The DESIMA projects aim to support coastal zone management by integrating various data and information sources. The DESIMA-Demonstrator (<http://desima.jrc.it>), developed with partial support from the Centre for Earth Observation programme, was especially designed to demonstrate the feasibility of a distributed information system. The demonstrator is based on CORBA and uses Java for the user interface. It contains a coastal defence and an oil-spill scenario.

DESIMA-CC (DESIMA-Coastal Change), aims at developing a method that integrates (disparate and distributed) data on the Adriatic coastal zone. In DESIMA-CC, river plumes and patterns in suspended sediment transport are related to coastal change along the Adriatic Sea. First results reveal good correlations of the Po river discharge data with river plume extension and direction in the Adriatic Sea, as derived from SeaWiFS imagery. Future thematic research will focus on suspended sediment transport by incorporating model results, and on its relationship with locations of overall erosion or accumulation that will be extracted from European databases. In addition, GIS and GIS-related Internet technology (Web-based mapping, OpenGIS) are being tested for the development of DESIMA-CC.

Through its Information Society Technologies (IST) programme, the European Commission supports the development of a European Virtual Coastal and Marine Data Warehouse – CoastBase (<http://www.coastbase.org>). The aim of CoastBase is to improve European coastal and marine information search and exchange by the development of a distributed data warehouse. The Marine Environment Unit was closely involved at the start of the project with a study of user requirements and information definition. The results of this study were implemented in the system architecture, and were used to define two scenarios: the eutrophication in the North Sea, and planning in the Mediterranean and North Sea.

The DESIMA tools can support evaluation of distributed and disparate data and information, and the integration of data. The CoastBase tools can help find data and information on similar topics, and will stimulate comparison and discussion. In this context the COAST/DESIMA activities follow the recommendations given in the Communication from the Commission to the Council and the European Parliament on Integrated Coastal Zone Management: A Strategy for Europe.



Data integration in DESIMA-CC.

The full SeaWiFS-LAC (1.2 km resolution) data set, on the European Seas and adjacent ocean basins, was acquired for use by and inclusion in the project archive. The archive includes virtually every image (1 per day, in general) with acceptable cloud cover collected by the SeaWiFS over the areas of interest, since the sensor started operations in September 1997. After processing, the archive contains images at level 1A (original top-of-the-atmosphere radiances), at level 2 (surface radiances and derived geophysical parameters, such as the concentration of chlorophyll-like pigments or total suspended matter) and at level 3 (remapped, composite statistical products).

A dedicated set of processing algorithms was developed in house, and implemented for processing SeaWiFS data from the NASA-provided level 1A to levels 2 and 3. The data collected by the main European HRPT ground stations are received from the NASA/GSFC DAAC and processed to level 2 with a combined land-sea algorithm. Standard products such as water-leaving radiance, aerosol radiance and optical thickness at 865 nm, chlorophyll-a and total suspended matter concentrations, and diffuse attenuation coefficient, are retrieved over all marine surfaces.

A separate Northern Adriatic Sea time series has also been processed and published on Internet routinely (in near real-time for the summer 2000, as a service to the scientific community involved in monitoring the exceptional development of *mucillagine* in the northern basin), as a reference product for calibration and validation purposes (*in situ* optical and bio-optical data are being collected continuously on a offshore platform in the Northern Adriatic Sea, in the framework of a parallel activity). Products for terrestrial applications result from the additional application of an Optimised Vegetation Index algorithm developed by another group of SAI.

Each individual SeaWiFS scene is re-mapped onto a standard 2 km pixel geographical grid for a number of marine basins (NE Atlantic, NW Africa, North Sea & Baltic Sea, Mediterranean Sea, Black Sea, Caspian Sea and Aral Sea, Red Sea and N. Indian Ocean) for each available day. The daily images are then averaged on a pixel-by-pixel basis, to generate monthly and annual composites. The processing of SeaWiFS high-resolution LAC data (and of low-resolution GAC data, in the near future) will continue for the whole duration of the project.

The complete AVHRR-GAC (4 km spatial resolution) data set, for the years 1994 to 1999, was processed to derive Sea Surface Temperature (SST) and Cloud Cover information, continuing the time series originally developed by the Cloud and Ocean Remote Sensing around Africa (CORSAR) project. Level 2 processing was carried out by means of improved algorithms developed in house. The individual satellite passes data, were then further processed into weekly and monthly sea surface temperature maps. Thus, the AVHRR-derived archive now covers the whole 1981-1999 period.

Two upwelling indices for the entire West African coast and for the period from 1981 to 1999 have been developed, using such archive and additional ancillary data. The first was derived from SST differences as observed in the satellite imagery and hence provided information about the thermal signature of upwelling. The other consisted of wind-derived Ekman transport information (see below about meteorological data acquisition) and signalled the potential for upwelling. The AVHRR data for the years 2000 and 2001 is on order and will start being processed soon.

The project augmented its environmental archive by acquiring meteorological data from the European Centre for Medium Range Weather Forecast (ECMWF) covering all of the 1990's.

CONTACT

Vittorio Barale, Wolfram Schrimpf

Information Dissemination

- SeaWiFS data browsing facilities (for all European Seas and adjacent ocean basins, from September 1997 to present) published in the unit's web site under *online datasets* (<http://www.me.sai.jrc.it/>)
- Adriatic Sea bio-optical indicators time series published in near real time, from June to September under *news & events* (<http://www.me.sai.jrc.it/>), and used to plan and conduct ship borne surveys of the Adriatic Sea areas impacted by the *mucillagine* (as well as to study the phenomenon development, in the preceding seasons).
- Updated AVHRR GAC data browsing facilities, all European Seas and adjacent ocean basins, 1981-1999, under *online datasets* (<http://www.me.sai.jrc.it/>)
- Adriatic Sea SST time series, full basin, 1981-1999, browsing facilities and numerical data collection, published on dedicated CD-ROM.
- DESIMA Demonstrator accessible via Internet (<http://desima.jrc.it/>)

GEIS

Global Environmental Information Systems

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

The GEIS project addresses various components of the global terrestrial environment and the marine environment. Though global in scale (and thus encompassing the EU15) the project is mainly concerned with environmental issues outside the European Community. The objective is to provide relevant timely and accurate information on changes in the location and condition of global vegetation types and oceanic primary production to support EU development and environment policies. Support for the implementation and verification of multilateral environmental agreements (especially the UN Framework Convention on Climate Change, the Convention to Combat Desertification and the Convention on Biological Diversity) and the integration of environment in Development policy receive particular attention.

The TREES II project in its last year finalised the development of a prototype information system for monitoring tropical forests at a pan-tropical scale. The work, funded by DG Environment, was being progressively adapted to meet the forest related information needs of the Commission services. The project uses coarse resolution (1 km) satellite imagery for the day-to-day monitoring of forest condition. Thousands of scenes were acquired from the ERS-2 ATSR and SPOT-4 VEGETATION sensors. The evaluation of these data demonstrated the potential for the updating of existing vegetation maps at regional scale and for identifying active deforestation areas at a small scale.

However the measurement of forest area change in the Tropics during the 1992-1997 period called for the use of much higher resolution data sets. Using a statistically conditioned sample of 95 sites, around 300 high-resolution images were acquired during the course of the last three years. Twenty-six local partners in South America, Africa and Southeast Asia carried out the detailed interpretation of the high-resolution images. Most of the results of interpretation were collected and archived in the TREES-II database. Figures of forest cover change were calculated per sample site. Figures are at this stage still preliminary but it can be noticed already that for the TREES sample sites belonging to the defined stratum of 'Deforestation Hot Spot' deforestation rates are high. For regional estimates the individual rates are being considered in a statistical calculation which takes into account the selection probabilities and variances per stratum.

As well as paper maps, the TREES project provided access to the information in digital form via the Tropical Forest Information System (TFIS). The TFIS has been widely expanded via the integration of new products such as the new regional forest classifications. Development of TFIS tools continued with the dedicated TFIS for the DG-Development funded ECOFAC project in Central Africa and the development of an Internet-TFIS prototype. As in previous years, the project supported an on-site TFIS within DG Environment in Brussels. The project contributed to the international effort on the Global Forest Information Service (GFIS) under the auspices of an UN Interagency Task Force on Forests through a prototype of an interoperable catalogue search engine. These methods can now be integrated into an operational analysis and monitoring system. The key actions within the project are described in detail in the following pages.



PROJECT LEADER
Alan S. Belward

Real-time Fire Monitoring at Global Level

In 2000 the geographical coverage of the World Fire Web network reached almost global proportions. The only exception is the very northern part of South America (*Figure 1*). From the six regional nodes scheduled for implementation in 2000, five were successfully installed: Canada, Central African Republic, Western Russia, Siberia and Maspalomas. Three of these regional fire-monitoring nodes are of particular importance as they allow fire location maps to be generated for the boreal forests (Canada and Siberia) and for the rain forest of the Congo Basin (Central African Republic). The complete coverage of the African continent is also a notable achievement.

Improvements to the geo-location accuracy of the fire information generated by the world fire web software have been made and a new module created for the quantitative assessment of burnt areas. Two prototype algorithms are already available: one for the Canadian boreal forests and one for the tropical woodland ecosystems. The assistance and technical innovation of our colleagues in the ISIS substantially improved access to the maps of fire occurrence, produced by the World Fire Web network through the use of OpenGIS protocols.

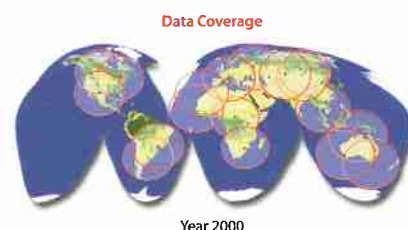
The global assessment of areas burnt for the 11-year period (1982-1994) was completed using archives of 8-km resolution satellite imagery. This period is of particular interest as it includes four "El Niño Southern Oscillation" events. As a contribution to the Global Land Cover – 2000 initiative (see below), a global assessment of the areas affected by burning during the year 2000 began. This is based on the processing and analysis of one year of daily global data from the SPOT-VEGETATION system. A network of eight partner institutions from around the globe was established. The development of regional products has already started, under the co-ordination of the GVM Unit. The final global map is expected at the end of 2001.

Experimental in situ work has proved indispensable to our fire related research over the last few years. In 2000 this work both supported the methodological development and the validation of existing products. As in the previous year work in 2000 was carried out in collaboration with the Australian CSIRO Earth Observation Centre. This work focused on studies related to the assessment of fire intensity and burning efficiency as measured by 1-km resolution satellite imagery (in particular SPOT-VEGETATION imagery). The campaign took place in Northern Australia in September 2000. Assessing the burning efficiency (the quantity of biomass actually burnt during a given fire event) is critical to the calculation of greenhouse gases emissions. The fire intensity, which governs directly the effect of the fire on the tree and shrub cover, is one of the main factors of changes in forest cover conditions, due to fires, and is therefore critical to the land cover and carbon budget issues.

FUEGO is a concept for a constellation of satellites dedicated to operational fire monitoring with a focus on (but not limited to) the countries of the EU. During 2000 the SAI completed a feasibility study for mapping burnt areas at high resolution using the FUEGO system. A prototype algorithm was developed and this will be delivered to the FUEGO Programme after validation.

CONTACT

Jean-Marie Grégoire (co-ordinator, and GBA-2000),
Simon Pinnock (World Fire Web Network),
César Carmona-Moreno (FUEGO)



 The World Fire Web network.



 Global Land Cover 2000.

Selected Further Reading

- Gobron N., B. Pinty, M. M. Verstraete, J. V. Martonchik, Y. Knyazikhin, and D. J. Diner (2000) "The Potential of Multi-angular Spectral Measurements to Characterize Land Surfaces: Conceptual Approach and Exploratory Application", *Journal of Geophysical Research*, 105, 17539-17549.
- Gobron N., F. Melin, B. Pinty, M. M. Verstraete, J.-L. Widlowski, and G. Bucini (2001) "A Global Vegetation Index for SeaWiFS: Design and Applications", in *Satellite Remote Sensing Data and Climate Model Simulations: Synergies and Limitations*, Edited by M. Beniston and M. M. Verstraete, Kluwer Academic Publishers, Dordrecht, in print.
- Pinty B., M. M. Verstraete, N. Gobron, Y. Govaerts, and F. Roveda, 2000 "Do Human-induced Fires Affect the Earth Surface Reflectance at Continental Scales?", *EOS transactions of the AGU*, 81, 381-389.
- G.F. De Grandi, P. Mayaux, J.P. Malingreau, A. Rosenqvist, S. Saatchi, M. Simard, "New Perspectives on Global Ecosystems from Wide-area Radar Mosaics: Flooded Forest Mapping in the Tropics", *International Journal of Remote Sensing*, vol. 21, no. 6-7, pp. 1235-1250.
- Eva, H.D. and Lambin, E.F., 2000, Fires and land-cover change in the tropics: a remote sensing analysis at the landscape scale. *Journal of Biogeography* 27(3).
- Mayaux P., Gond V. and Bartholomé E. 2000 A near-real time forest-cover map of Madagascar derived from SPOT-4 VEGETATION data, *International Journal of Remote Sensing*, vol. 16:3139-3144.
- Richards T.S., J. Gallego, and F. Achard, 2000, Sampling for forest cover change assessment at the pan-tropical scale, *International Journal of Remote Sensing* 21 (6&7):1473-1490.
- Bartalev S., F. Achard, D. Erchov and V. Gond, 2000, The potential contribution of SPOT 4 - VEGETATION data for mapping Siberian forest cover at continental scale. *VEGETATION 2000 conference Proceedings*, <http://vegetation.cnes.fr:8080/>
- Dwyer E., S. Pincock, J.-M. Grégoire, and J.M.C. Pereira, Global spatial and temporal distribution of vegetation fire as determined from satellite observations, *Int. J. of Remote Sensing*, Vol. 21, No. 6/7, April 2000, 1289.
- Ahern F., J.-M. Grégoire, and C. Justice (editors). *Forest fire monitoring and mapping: a component of Global Observation of Forest Cover*. Publications of the European Commission, EUR 19588, Luxembourg, p. 253, June 2000.
- Stroppiana D., S. Pincock, and J.-M. Grégoire, The Global Fire Product: daily fire occurrence, from April 1992 to December 1993, derived from NOAA-AVHRR data. *Int. J. of Remote Sensing*, Vol. 21, No. 6/7, April 2000, 1279-1288.
- C. Perigaud, F. Melin, and C. Cassou (2000), ENSO simulated by intermediate coupled models and evaluated with observations over 1970-98. Part I: role of the Off-Equatorial variability. *J. Climate*, 13: 1605-1634.

Mapping Forest Resources in Siberia

During 2000 Staff from the GEIS project worked in partnership with the International Forest Institute, Moscow, Russia. The main objective of this activity is to develop a remote sensing based system for Siberian forest monitoring. Such a system will improve the understanding of current conditions and the evolution of the Siberian forest.

Preliminary results of forest cover classification using SPOT-4 VEGETATION S-10 products acquired during the year 1999 over Central Siberia have been obtained. In this preliminary exercise, the method for analysis of the satellite imagery was developed from the temporal profiles of land cover reflectances without taking into account the angular information. Relatively poor results (forest cover classification accuracy of between 54% and 77%) indicate a need to test approaches taking into account the bidirectional reflectance properties for use at high latitudes.

Forest Carbon Budget Process Modelling and Information System

Research on Siberian and European forest carbon budget, using a remote sensing based approach began in 2000. At the European Union scale, the Biome-BGC model was implemented in a geographical information system to estimate the carbon budget of member countries using different spatial data sources provided by other projects (meteorological database soil map and CORINE land cover map from the MARS project, and a forest stratification map from the EUROLANDSCAPE project).

In general the estimates for different countries show too high a ratio between Net Primary Production and Net Ecosystem Production. These estimations will be refined by using new ecophysiological parameters specific to the different forest strata of Europe and by using a Leaf Area Index derived from SPOT VEGETATION data. Future research will also examine ways in which new approaches for derivation of biophysical parameters (such as the FAPAR derived from SeaWiFS data) may be used for carbon sink monitoring.

This approach is expected to provide a consistent and homogeneous estimation of the forest carbon budget at the European scale through the use of a detailed ecophysiological model and the most up-to-date ecosystem spatial parameters.

Country	NEP [Tg Carbon]	NPP [Tg Carbon]
Sweden	3.10	26.7
Finland	1.27	10.6
Spain	2.43	29.4
France	4.59	61.7
Germany	3.96	39.1
Italy	1.06	16.5
Austria	0.88	8.5
Portugal	0.29	4.6
Greece	0.51	7.3
UK	0.59	7.1
Belgium	0.17	1.9
Denmark	0.09	1.0
Netherlands	0.10	1.0
Ireland	0.01	1.0
Total	19.1	216.4

Carbon budget estimations per EU member country.

TREES II Project: Development of a Prototype for a Global Forest Monitoring System

Data and Information Collection Module

Coarse-resolution data have been acquired on an ad-hoc basis. In particular coarse resolution image mosaics have been produced for all three continents for the year 1999 (from ESA ATSR or SPOT-4 VEGETATION instruments). Near-real time mosaicking methods have been developed.

The ESA's (European Space Agency) ESRIN site in Frascati, Italy, has implemented a pilot NRT service for ATSR data. This service is open to a restricted group of users - including TREES. Extensive use was made of the ATSR-NRT service. Over 1000 images have been collected from the ESA-Trømso site for the period 1999 - 2000. The images are available at Ispra, 3 hours after acquisition. They can be processed and fitted into the existing continental maps with 2 hours.

The VEGETATION (VGT) sensor forms the basis of the TREES third coarse (1-km) resolution coverage of the tropics. The sensor has better radiometric precision, has precise geometric location data and acquires data in a larger track (2400 km) compared to ATSR (600 km). This is resulting in a daily coverage of the Tropical zones. The TREES team has received all 10-days composites of the tropics during the period: April 1998 (launch of SPOT-4 satellite) until August 2000. TREES has designed an in-house pre-processing tools to turn out processed images ready to be analysed.

The sample of more expensive fine-resolution optical data selected over 95 sites has been completed to reach in 2000 the final number of more than 70 scenes from the SPOT satellites and more than 200 scenes from the Landsat satellites. A collection of ancillary information from different sources: field missions, air video, national digitised maps, press news available from the WWW, digitised Congo basin river network from the 100 m resolution radar mosaic.

Remote Sensing Data Analysis Module

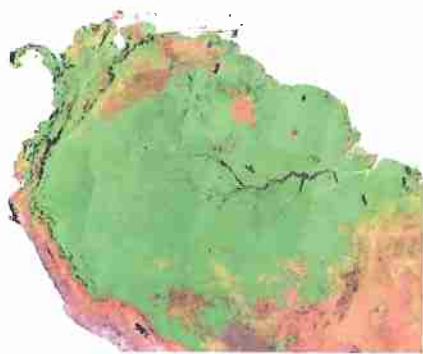
The project continued to release new tropical forest maps and achieved the full coverage of the Tropical belt. New regional forest classifications have been achieved for South America, Central Africa and Madagascar, and Insular Southeast Asia (including Philippines and Sulawesi) using coarse resolution image mosaics of the period 1999/2000.

A mosaic was produced from more than 1000 ATSR-2 images over South America acquired from 1997 and showed where the broad vegetation formations are at a continental level. They were used to update the TREES vegetation map of South America (Eva et al. 1999), which was derived from the analysis of 1992- 1993 NOAA AVHRR data. A pilot study was carried out for continental mapping of all forest types, including seasonal and needle leaf forests. The approach taken was to assemble continental mosaics representing vegetation under water stress and at its greenest. These mosaics were achieved by using different compositing techniques, highest surface temperature for a "dry season" mosaic and highest NDVI for "wet season" mosaic. The two mosaics are then assessed by bio-climatic region - based on Holdridge's life zones. These mosaics have been classified to give a first pass forest / non-forest map. This process has taken 3 months and compares to the 2 years required under the TREES-I phase to achieve the same product.

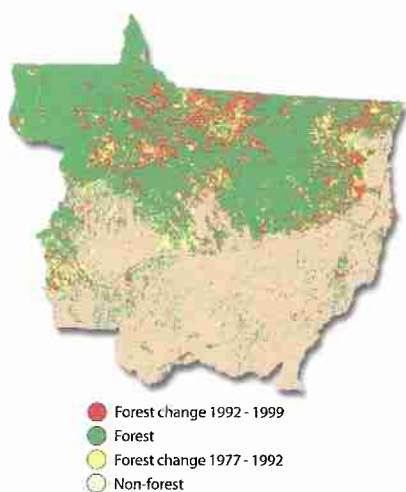
The TREES Vegetation map of Central Africa was suffering from several limitations for an operational use in sustainable forest management and conservation perspectives. The major missing class is the flooded forest in the centre of the Congo Basin. A regional scale vegetation map of Central Africa was derived from the combined CAMP (ERS SAR) and GRFM (JERS SAR) data set over the Central part of the Congo Basin (15°E to 22°E, 5°N to 3°S). In this area the largest formation of swamp forests are present. Exploiting the complementary characteristics of the two sensors (the C-band ERS and the L-band JERS-1)

Selected Further Reading

- Achard F., H. Eva, P. Mayaux, T. Richards and H.-J. Stibig, 2000, Development of a global tropical forest monitoring system using Earth observation satellite data, Proceedings of Remote Sensing and Forest Monitoring Conference, EUR 19530 EN, European Commission, Luxembourg, pp. 200-207.
- Achard F., Eva H. and P. Mayaux, Tropical forest mapping from coarse spatial resolution satellite data : production and accuracy assessment issues, *Int. J. Remote Sensing*, accepted.
- De Grandi G.F., P. Mayaux, J.P. Malingreau, A. Rosenqvist, S. Saatchi and M. Simard, 2000, New perspectives on global ecosystems from wide-area radar mosaics: flooded forest mapping in the tropics, *Int. J. Remote Sensing* 21 (6&7):1235-1249.
- Eva, H.D. and Lambin, E.F., 2000, Fires and land-cover change in the tropics: a remote sensing analysis at the landscape scale. *Journal of Biogeography* 27(3).
- Grégoire J.-M. et al., 2000, Forest Fire Monitoring and Mapping for GFOC: Current Products and Information Networks based on NOAA-AVHRR, ERS-ATSR and SPOT-VGT Systems, in "Forest Fire Monitoring and Mapping: A Component of Global Observation of Forest Cover", EUR 19588 EN, European Commission, Luxembourg, pp. 111-135.
- Mayaux, P., De Grandi, G.F., and Malingreau, J.P., 2000a, Central Africa forest cover revisited: a new approach based on a multi-satellite analysis, *Remote Sensing of Environment*, 71:183-196.
- Mayaux, P., Gond, V. and Bartholome, E., 2000b, A near-real time forest-cover map of Madagascar derived from SPOT 4-VEGETATION data, *Int. J. Remote Sensing*, 21 (16): 3139-3144.
- Mayaux, P., De Grandi, G.F., Rauste, Y., Simard, M., and Saatchi, S. 2000c (in press), Large Scale Vegetation Maps Derived from the Combined L-band GRFM and C-band CAMP Wide Area Radar Mosaics of Central Africa, *Int. J. Remote Sensing*.
- Richards T.S., J. Gallego, and F. Achard, 2000, Sampling for forest cover change assessment at the pan-tropical scale, *Int. J. Remote Sensing*, 21 (6&7):1473-1490.
- Sgrenzaroli M., H. Eva and F. Achard, 2000, Assessment of resolution L-band radar mosaics for regional forest change detection in lowland tropical forests of South America, Proceedings of Remote Sensing and Forest Monitoring Conference, EUR 19530 EN, European Commission, Luxembourg, pp. 208-215.
- Stibig, H.-J., J. P. Malingreau and R. Beuchle, 2000, New possibilities of tropical forest cover in insular Southeast Asia using SPOT-VEGETATION satellite image mosaics, *Int. J. Remote Sensing*, in press.
- Stibig H.-J., F. Achard, H. Eva, P. Mayaux, P. Janvier and T. Richards, 2000, Monitoring of Tropical Forest Cover at global and regional scale using Earth Observation Satellite Data, XXI IUFRO World Congress Kuala Lumpur, Malaysia 7-12 August 2000.



▲ New forest map of South America from ATSR-2 mosaic acquired in 1996 - 1997.



▲ Forest cover changes in Mato Grosso between 1977 and 1992, and since 1992.

and the multi-feature data set used in the classification (amplitude and texture) a vegetation map of the Congo Basin floodplains could be generated with improved characteristics. The map contains better spatial detail than any existing regional scale map, especially with regard to the extent of inundated formations. Moreover, distinction between the permanently and periodically flooded forests could not be achieved in thematic maps derived from optical remote sensing data. However, radar mosaics alone cannot consistently map all the vegetation features of interest in this tropical ecosystem. In particular, the ribbons of secondary forest are not detected by C-band or L-band imagery, while they are very clearly detected in the optical data due to the high contrast with the return from the primary forest. This problem points to the need of integrating radar data and optical data, an approach that can for sure provide at regional scale better thematic products.

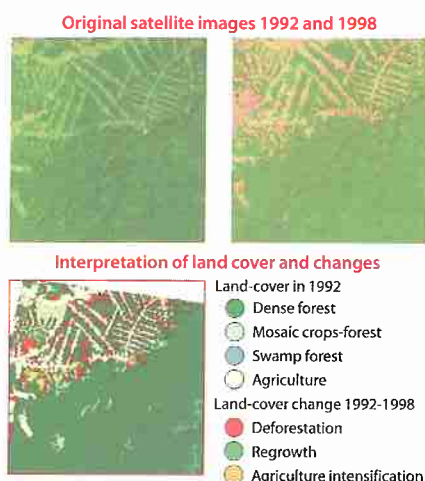
The VEGETATION data used in this study are the standard ten-day images including the ground reflectance of all spectral channels, and composed using the highest daily Normalised Difference Vegetation Index (NDVI) of the period October 1998-September 1999. A forest-cover classification was derived from the 12 monthly composite images (Mayaux et al, 2000c). Five classes were mapped: dense humid forest (lowland and montane), dense dry forest, mangrove, secondary complex and savannah (woody savannah, grasslands and bare soil). The accuracy of the resulting map was assessed by comparison with Landsat classifications interpreted by local experts over three sites. The user's accuracy for the "dense humid forest", which is our main class of interest, is 87.8%.

This exercise has now been applied to the entire Congo Basin, in order to produce the first vegetation map identifying swamp forests with a high spatial detail. Data of two full years (1998 and 1999) of SPOT 4-VGT images (1 km resolution) were analysed. Methodologies for processing these data for regional forest cover mapping were developed, separate for conditions in continental and in insular Southeast Asia. A forest cover map could be produced for insular SE-Asia from a series of SPOT VGT mosaics from the years 1998 and 1999. SPOT VGT appears to be also quite sensitive for detecting burned areas as demonstrated below for Eastern Kalimantan.

Scientific investigations regarding monitoring of deforestation using coarse-resolution sensors have been carried out. Recent (from 1997 up to 2000) 1 km resolution data were pre-processed into regional mosaics and combined with information on active fires from the Near-Real Time ATSR system or the World Fire Web. Initial results show that these data are suitable for updating the maps of the extent of tropical forest cover and for identifying more precisely some forest types. The interface between fire and vegetation cover maps has provided unique views on the coincident distribution of those ecosystems characteristic (examples of fires in Southern Brazil and Indonesia during July-August 1999). Moreover, this method allows the monitoring of active "hot spot" areas in the case of large-scale events (examples of Mato-Grosso and Kalimantan).

The last area of development is to use the new mosaics for hot spot determination, either by comparing the 1992 TREES classification (from AVHRR data) with the new ATSR or SPOT4-VGT data from 1998-2000, or by generating indices from the new mosaic. Such analysis has been carried out for the NGO Ecoforca for the state of Mato Grosso, Brazil. TREES provided Ecoforca with two map overlays. The first shows the changes in forest cover that have occurred since between 1977 and 1992, and since 1992. A second layer was produced to show the areas which are currently undergoing conversion. This second layer was achieved by locating the areas where fires are now occurring within regions previously forested. What is evident is that the forest area of Mato Grosso is being depleted rapidly, and that the remaining forest areas are becoming more fragmented and isolated.

New VGT satellite image mosaics (from 1999) at regional level in Southeast Asia were overlaid with actual fire locations as detected from AVHRR in January/February 1999 from the World Fire Web. A quick analysis indicated an increasing number of fires, eventually again threatening forest. The information was communicated to the local EU projects for information and comments.



▲ Example of a sample site from Brazilian Amazonia, Rio Branco, Acre state (sample 001/67).

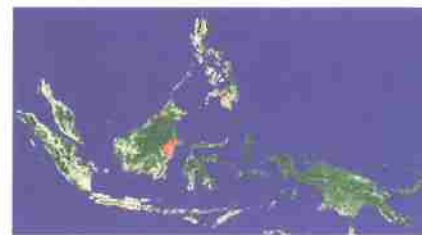
However the measurement of forest area change in the Tropics during the 1992-1997 period called for the use of much higher resolution data sets. Mapping all the worlds' tropical forests with such data would be both hugely expensive and very time consuming. The TREES II project has adopted a sampling approach using high-resolution imagery. A new methodology had to be developed both in terms of the stratification into and the selection of imagery. A novel sampling scheme was developed to minimize problems associated with unequal sampling probability.

The sampling scheme is specifically designed to estimate the rates of deforestation between the years 1992 to 1997 and to provide deforestation estimates at both the pan-tropical and regional levels. Using a statistically conditioned sample of 95 sites, around 300 high-resolution images were acquired during the course of the last three years. The new statistical sampling scheme for the high-resolution exercise has been implemented with a large number of local or regional partners: contracts or collaborations have been established with 10 Latin American, 3 African and 13 Asian partners for the interpretation of high-resolution data. A specific classification scheme (legend) has been developed for this activity. A common strategy for the analysis of high-resolution satellite data was developed aiming at visual on-screen interpretation of forest cover from satellite images and, as far as possible, at local collaborators, who would be able to contribute their knowledge on local forest conditions to the monitoring procedure. The execution and quality of the work carried out by these partners was monitored on a continuous basis: three regional workshops were organised in 2000 in Bogor, Indonesia, Libreville, Gabon and Caracas, Venezuela. The main objectives of the regional workshops were to discuss the deforestation results obtained for the TREES forest cover change sites and to achieve harmonization of methods and results between the TREES partners.

The results of analysis of the 95 sample high resolution sites by the 26 local partners were received and archived, consisting of the historical and recent satellite images, interpretation results and the resulting change matrix and change analysis. All data sets were imported and processed in order to meet the TREES format and standards. A first quality assessment was performed and a more detailed accuracy assessment and correction phase has been launched. An initial interpretation of the results shows that high deforestation annual rates are displayed for Sumatra and Kalimantan sites (mean annual rate of deforestation 3.0% and 1.1%), also due to the fires in 1997 and 1998. Quite high deforestation rates appear also for the Myanmar sites, also partly due to a burning. From the Madagascar sample sites (mean rate: 2.8%), it appears that the dense forest is mainly converted to tree savannah, while the tree savannah is converted to crops and degraded to grasslands. The Mexico-Central site with a relatively small areas of forest (147,967 ha) has been heavily deforested (124,155 ha) but the contribution of this site in the regional estimate will be small compared to more forested sites as Mexico-Yucatan, Guatamala-Belize or Honduras- M de Colon (with more than 500,000 ha each).

In addition, there is indication of degradation for significant areas. This refers to degradation processes visible or at least 'interpretable' from satellite images. The real magnitude may be much higher and it may be dangerous to conclude that deforestation is slowing down not mentioning at the same that degradation remains is high or may even increase. Figures are at this stage still preliminary and indicative until final checking and correction is completed. It seems that at least for the TREES sample sites belonging to the defined stratum of "Deforestation Hot Spot" deforestation will remain high. For regional estimates the individual rates will have to be input in a statistical calculation which takes into account the selection probabilities and variances per stratum.

The full information potential of the TREES high resolution data set is much higher than just monitoring forest area change and would need to be further explored with regard to forest degradation and modelling of deforestation processes. Although degradation is often excluded from the Amazonian deforestation rate, it appears to be an important factor in the monitoring of forest impoverishment phenomena. We have seen how forest degradation phenomena look like on Landsat Thematic Mapper images. Two different degradation phenomena were identified. In the first degradation case, surrounded by



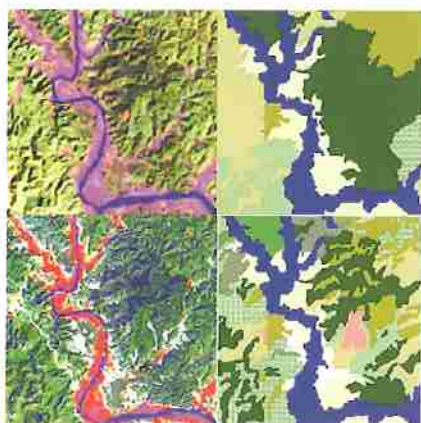
Forest cover map for insular Southeast-Asia based on VGT data from 1998 and 1999.



Improved vegetation map of Central Africa derived from SPOT-4 VGT and radar satellite data.

Information Dissemination

- Media
Interviews of A. Belward, H. Eva and H.-J. Stibig for BBC World Service (Discovery – Week 27 – "Future of Forests").
Movie on the Cyber-Tracker / ECOFAC project including reference to the TREES collaboration.
- Web-based and similar services: As in previous years, the project supported an on-site TFIS within DG Environment in Brussels.
- World forest conference: Preliminary regional results of forest cover change assessment and the contribution to the GFIS initiative were presented at the XXI IUFRO World forest conference in Kuala Lumpur in August 2000.



▲ Test of very high resolution satellite images on the Bangladesh site a) Landsat TM image and original interpretation b) IRS PAN-Landsat TM image and improved interpretation.

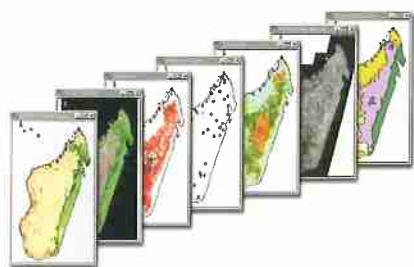
forest canopy, isolated bare soil areas can be visually detected. Such small bare soil regions are due to selective logging. The spatially regular distribution reinforces the hypothesis that some anthropogenic activity has occurred in the forest. The second type of forest disturbance consists of clear cuts that have been abandoned and partially regrown "capoiera". These are areas with a regular shape whose spectral behaviour is quite similar to the forest spectral signature. A new three-stage classification scheme has been used to detect the two degradation problems. The new classification process was validated using aerial photos from a 1999 campaign in Pará state carried out jointly by the TREES staff and INPE. We had compared our thematic results with public domain thematic maps produced by NASA's TFRIC project and by the FAO FRA exercise. In the Mato Grosso test site, TRIFIC and FAO map underestimation of the degradation is estimated about 10-15%.

A study for the assessment of forest cover and degradation processes based on new very high-resolution satellite images from IRS-PAN (5m resolution) was carried out. The selection of sites was guided by the need to represent the main forest-non-forest interfaces in Asia. 10 images were selected and distributed to the partners. The images cover a subset of the 30 statistically selected TREES TM sample sites. Results obtained for a test block in Bangladesh are displayed. The integration of IRS 5m images resulted in a more accurate estimate for the forested area (total area 1607 ha, forest cover from TM: 978ha, from IRS-TM 878ha) and the possibility to map consistently fragmented forest cover, i.e. forest degradation processes.

Tropical Forest Information System and User Interface Modules

Currently, the Tropical Forest Information System (TFIS) contains classifications of satellite data and ancillary data collected to support the analysis. These data are obtained from a number of sources and their thematic range is guided by the needs of the users (analysis Module). The AVHRR data are stored by so-called "image windows" covering ecologically homogeneous regions. The validation data sets (high-resolution satellite data, field reports, other maps) have been progressively introduced in the same framework.

The TFIS has been expanded via the acquisition of new spatial data sets, such as the new products of the Analysis module such as a new map of swamp forests of Africa and the interpretations (forest maps) of the 95 sample sites at two dates. The TFIS was used to extract the content or to set up the layout of different products including a final version of the Vegetation Map of South America at 1:5,000,000 scale; and data-sets (vegetation map, radar mosaic) compiled into a specific database for the six components of the ECO-FAC programme.



▲ Example of information layers from the Tropical Forest Information System (TFIS).

The User Interface represents the "window" of the TREES Project to the outside world. New actions have been taken in order to maintain, improve or otherwise open new contacts with external partners or other EC services through direct contacts or through the Internet. The link between the Tropical Forest Information System (TFIS) and DG Environment for data communication and exchange has been fully operated until Summer 2000 through the presence of a GIS expert from NR-International in DG.A.4. A strategy was developed to provide an interface available to a wider number of partners: an Internet Web TFIS first prototype was developed. After much experimentation it has been found to be feasible to serve very large spatial data on the web. This system can provide Internet access to the main layers of the TFIS database in the form of country maps such as: forest cover, topographic features, protected areas, fires as derived from the WWF, location of EU funded forest projects, and the like. An approach of a "TFIS in a Box" to be packaged in a professional manner has been considered and a test case has been made through the JRC "Kosovo project". TREES Project staff have continued to be active in the IUFRO GFIS (Global Forest Information Service) Task Force. A GFIS prototype of an interoperable catalogue search engine was developed by the TREES project and passed to the IUFRO GFIS partners (METLA in Finland).

Links with key partners in the Tropics have been reinforced. TREES had already identified partners in Brazil (Intersat, IMAZON, Ecoforca, Pixel), Colombia (CIAT), Bolivia (CLAS), Venezuela (CPDI), Costa Rica (CATIE) and Mexico (EPOMEX, CONABIO). New collaborations with Ecoforca and IMAZON of Brazil, and the Global Forest Watch Programme have been established. The regional ECOFAC programme funded by DG DEV through EDF, aims at the biodiversity conservation and at the sustainable management of six national parks. A mid-term objective of ECOFAC is the set-up of a database dedicated to the management of protected areas at a regional scale. In that perspective, collaboration has been launched between TREES and ECOFAC. This collaboration is aiming at the improvement of the management of the field patrols and at the understanding of the animal migrations. The ECOFAC project itself funded the development of a software interface between their field data collection system (Palm system) and the TFIS. This link has been tested by the Congo component in Odzala. The GVM Unit has been further asked to develop and implement the GIS database. This request means that the pilot-project initiated by the TREES project was meeting the ECOFAC needs and expectations.

Contacts with the EU projects in Indonesia, particularly with the Forest Liaison Bureau were continued, including a visit in January 2000. In preparation is a proposal for co-operation between the EU projects in Indonesia and the JRC GVM Unit. The proposal aims at establishing a sub-regional forest information system, which would link the spatial databases between the projects in the region but also to the database of GVM. Links would also be possible to the EU delegation and the databases at the related DGs at Brussels.

The TREES partners in Southeast Asia expressed a demand that TREES project should continue with enlarged mandate to address issues like mapping and monitoring of additional forest types, model afforestation and deforestation processes. It was also felt that TREES should incorporate more stable areas as sample sites to monitor forest change phenomenon in the Southeast Asian region. Finally, the partners recommended that TREES should undertake Forest cover mapping and monitoring exercise in repeat cycles of 1995, 2000 and 2005.

Highlights

- TREES-II Regional meetings during the first half of 2000: Three regional meetings were organised in early 2000 to monitor the execution of the work: in Bogor, Indonesia, Libreville, Gabon and Caracas, Venezuela. These regional workshops have significantly contributed in bringing together the institutions and individuals involved in Forest cover mapping and monitoring in the region particularly for TREES project. The regional workshops have also been successful in pooling up the resources in the regions and provided forum for discussion and sharing of the experiences. This has resulted in overall capacity building in the region. See for example: Mayaux P., Justice C., and Sinse Lumbuenamo R., 2000b, Observation par satellite des forêts d'Afrique Centrale. Création du réseau GOF - OSFAC, report EUR 19585, 48 p.
- Presentation by A. Belward and F. Achard to the ENV.A.4 Unit in June 2000.
- Final report distributed to DG Environment in October 2000.
- Final workshop to be organised in Brussels with DG ENV, DG DEV, SCR and DG RELEX in early 2001.

CONTACT

Frédéric Achard (Project co-ordinator);
 Franco De Grandi (radar activities co-ordinator);
 Jean-Marie Grégoire (fire activity co-ordinator);
 Tim Richards (Tropical Forest Information System Manager);
 Hans-Jürgen Stibig (Southeast Asia Analysis Manager);
 Philippe Mayaux (Tropical Africa Analysis Manager); Hugh
 Eva (Latin America Analysis Manager)



form of Pedotransfer Rules is also supplied for the estimation of variables not available directly from the geographic database: for example, organic matter content, density, available water content. The quality of the information that is stored in the geographic database or that can be inferred from the pedotransfer rules is expressed by in two ways. These give the purity of the SMU, indicating the complexity of the soil associations that constitute it, and the confidence of the STU, giving an estimate of reliability of the data provided by the experts.

From the database, a soil map was extracted as a particular thematic view of the Soil Geographical Data Base of Europe. It indicates the type of soil that dominates the mapping units, according to the nomenclature of FAO (1974). This terminology has been modified to accommodate specific soil conditions in Europe. The database and the associated maps could be improved in a number of ways. For example, the distribution and intensity of the soil patterns for Scandinavian countries require more elaboration. Furthermore, additional effort should be directed at harmonising soil information beyond the political borders of the participating countries. New versions of the database should be produced periodically in future.

The creation of the European Soil Database at 1:1,000,000 scale, is an important step in the provision of environmental data to the user community. The European Soil Bureau built up a network of soil scientists, from all over the continent, who readily invested considerable amounts of time and energy in compiling the database. For the first time, the soils of all Europe are described according to a common methodology and soil classification system. This facilitates the exchange of information and makes agro-technology transfer possible.

Soil Geographical Database Extension

The ESB has initiated an extension of the 1:1,000,000 Soil Geographical Database of Europe to include the countries around the Mediterranean basin and the New Independent States. The objective is to construct a map similar to that published for the European Union and the neighbouring countries of Central and Eastern Europe (PHARE countries). The technical part of this project will be realized through a collaboration between INRA (Orleans, France), CIHEAM (Bari, Italy), IIASA (Vienna, Austria) and ESB.

Discussions have started with the countries involved. The principle remains the same : the information needed is provided by each individual country following the ESB Instructions Guide. Changes in this guide are possible to take into account specific features and problems in the new regions being added. New scientific developments and policies must also be taken into account, for example the use of the new World Reference Base (WRB) for soil resources or a new list of parent materials. Another aim is to harmonize some characteristics of the 1:1,000,000 soil database with the new 1:250,000 database program. A new version of the Instructions Guide is in preparation. It will be submitted to the persons responsible for soil mapping programs in the countries involved. This new version of the guide will also be submitted to the ESB Scientific Committee.

Eventually, all data collected within the framework of this extension will be harmonised with the previous data of the 1:1 M soil database of Europe. But revisions are also needed for some areas in the European Union and the PHARE countries. Complements of information are expected for several countries (Bosnia, Croatia, Iceland, Serbia, Sweden), and the task of border harmonisation between some countries is yet to be completed. It is already time to think about preparing a second version of the CD-ROM.

New Manual for the Georeferenced Soil Database for Europe

In the autumn of 1999, the Working Group on the 1:250,000 soil database for Europe met to update version 1.0 of the Manual for the GSDBE. The experiences from pilot areas in Italy and France were presented and steps were taken to prepare version 1.1 of the Manual. Issues such as the relationship and compatibility between GSDBE and the 1:1,000,000 database were also discussed.

Experiences with the application of the Manual in pilot projects in Italy and France, as well as in the border area between Germany and the Czech republic were presented. Four different regions in Italy are being mapped using the Manual as a reference, and a vast program has been launched to ensure the complete coverage of the country. In France, the area chosen to test the Manual methodology is the Côte d'Or, previously mapped at 1:250,000 under the direction of the national IGCS program. Pilot projects helped identify the necessary modifications for the Manual and its accompanying Soil Pedological Regions Map at 1:5,000,000. Changes were decided on the basis of both the outcome of the Vienna Scientific Committee meeting and the more recent experiences presented at the WG meeting. A revised version (version 1.1, in English) of the Manual was prepared in the year 2000 under the direction of P. Finke, W.G. chair. Version 1.1 of the Manual has already been translated in French, Italian and Spanish. The new edition is available in Italian through the ESB, and publication in the other languages is pending.

Discussions have been held on a protocol for data clearing at the EU level, as well as the creation of a helpdesk function by ESB at the JRC. Proposals for the establishment of new pilot projects in other areas were made, while Italy decided to pursue full implementation of the Manual for the whole country.

The 1:250,000 GSDBE will be maintained by the ESB at the JRC in Ispra. Dr. B. Jones at the ESB is setting up through the Internet a system that will allow for both the semantic and geometric parts of the data to be remotely entered in the database.

The Map of Soil Pedological Regions used in the Manual has also been evoked as a possible basis to realise the Soil Map of Europe for the FAO using SOTER methodology. There has been a proposal to setting up a small working group including ESB, FAO, ISRIC, 1:250,000 and 1:1 M WG members to prepare the transfer of data to the 1:5,000,000 SOTER database.

Future work by the 1:250,000 working group will involve the extension of the Map of Soil Pedological Regions to regions presently not covered, such as those of the New Independent States of those surrounding the Mediterranean. Changes and refinements will be brought to the manual and its methodology as more pilot projects develop and new regions are covered. Another project would involve the preparation of the field guide to accompany the Manual and based on its methodology.

Selected Further Reading

- European Land Information Systems for Agro-environmental Monitoring. D. King, R.J.A. Jones and A.J. Thomasson (eds). EUR 16232 EN, 284 pp. (1995). Office for the Official Publications of the European Communities, Luxembourg.
- Soil Databases to support sustainable development. C. Le Bas and M. Jamagne (eds). EUR 16371 EN 149 pp. (1996). Office for Official Publications of the European Communities, Luxembourg.
- The use of pedotransfer in soil hydrology research in Europe. A. Bruand, O. Duval, H. Wösten and A. Lilly (eds). EUR 17307 EN 211 pp. (1997). Office for Official Publications of the European Communities, Luxembourg.
- Land Information Systems: Developments for planning the sustainable use of land resources. H.J. Heineke, W. Eckelmann, A.J. Thomasson, R.J.A. Jones, L. Montanarella and B. Buckley (eds). EUR 17729 EN 546 pp. (1998). Office for Official Publications of the European Communities, Luxembourg.
- Inventory of Computer Models Using Soil Data - Evaluation of the usefulness of the European Soil Map and the EC Soil Analytical Database for computer models. E. Van Ranst and B. Gellinck. EU report. 111 pp. (1998). ESB WG on Analytical Method. Ghent University, Belgium.
- Using existing soil data to derive hydraulic parameters for simulation models in environmental studies and in land use planning. J.H.M. Wösten, A. Lilly, A. Nemes, C. Le Bas. Report 156. 106 pp. (1998). Wageningen, The Netherlands.
- Georeferenced Soil Database for Europe: Manual of Procedures Version 1.0. European Soil Bureau, Scientific Committee. P. Finke, R. Hartwich, R. Dudal, J. Ibáñez, M. Jamagne, D. King, L. Montanarella, N. Yassoglou. EUR 18092 EN 184pp. (1998). Office for Official Publications of the European Communities, Luxembourg.
- Le Système d'Information sur les Sols d'Europe. Rapport Final. D. King, C. Le Bas, J. Daroussin, V. Souchère, M. Jamagne. JRC-INRA 11084-9507. 254 pp. (1999). INRA Science du Sol - SESCPF, Orléans.
- Soil Resources of Europe. P. Bullock, R.J.A. Jones and L. Montanarella (eds). EUR 18991 EN 202 pp. (1999). Office for Official Publications of the European Communities, Luxembourg.
- Heavy Metals (Trace Elements) and Organic Matter Content of European Soils. A Feasibility Study. Report by the European Soil Bureau - Scientific Committee. 16 pp. (1999). ESB WG on Heavy Metals and Organic Matter in Soils.

Pan-European Soil Erosion Assessment Project (PESERA)



A few members of the soil erosion group met on the 15th of March 1999 in Brussels with of the DG XI, XII, of the European Commission and discussed the possibility and the usefulness of launching the Pan-European Soil Erosion Assessment Project (PESERA) and sources of financing it. The meeting was productive in terms of clarifying the context and the expectations of the users and of the Commissions of such a project. The main conclusions of the meeting was a respective project proposal to be prepared under the coordination of Prof. G. Govers and be submitted to the 5th Framework Programme. The project has seven work packages:

- Development of modelling strategy and model code
- Temporal and spatial resolution linkages
- Calibration and validation at high resolution test sites
- Validation at low resolutions and comparison with other regional approaches
- Database development and application at the European scale
- Scenario analysis
- Development of a user interface and user groups
- The participants of the PESERA project are : Laboratory for Experimental Geomorphology, of the Katholieke Universiteit Leuven (Belgium) ; ULeeds: School of Geography, of the University of Leeds (United Kingdom) ; Unit of Soil Science, of the Institut National de la Recherche Agronomique (France), Space Applications Institute, CEC-DGJRC (Italy), Agricultural University of Athens (Greece), Estacion Experimental de Zonas Aridas, CSIC (Spain) and ISRIC (The Netherlands). User groups from European countries will be linked to the project. The kick-off meeting was held in Leuven (Belgium) 28 and 29 February 2000, starting a three year project.

Soil Background Values in European Soils

Concerning the German experience on drawing up heavy metal background values in top-soils and the imminent revision of the Sewage Sludge Directive 86/278/EEC, the German Federal Environment Agency and DG XI - Environment of the European Union commissioned a feasibility study on trace element and organic matter contents of European soils. On the initiative of the Scientific Committee of the European Soil Bureau (ESB), an expert working group was formed from the EU countries and one representative of Albania, which met for the first time in ISPRA, Italy from July 28 to 29, 1999.

The goal of the meeting was to evolve a procedure how to make an objective assessment of soil quality in Europe with respect to their heavy metal (HM) and organic matter (OM) contents. This assessment is intended to form a basis to state and to monitor these elements and - at least - to help policy makers in their decision making e.g. concerning sewage sludge disposal on agricultural lands.

Because of the fundamental and current interest of DG XI in this topic, the members of this first meeting agreed that this ESB-Working Group should be steered by the JRC Environment Institute and the ESB as well.

Many debates took place concerning the concept of "geochemical background contents" (natural or anthropogenic?), the diversity of analytical methods for measuring the total element contents, the bioavailability of some elements (harder to be defined than their total content), and the mapping and monitoring techniques for HM and OM (use of

soil strata on the 1:1,000,000 soil map, and/or use of geostatistical methods).

At least, a plan involving several phases has been proposed:

- Feasibility Study : It should define the future procedure of this working group, mainly based on a questionnaire to be made in each European country to determine the types and the amount of available information.
- The next phases should include provision of harmonised information (e.g. tables) about trace element and organic matter contents in European soils, the elaboration of thematic maps, based on the 1:1,000,000 Soil Geo-graphical Database of Europe and taking into account the total elemental contents, as well as the development of European guidelines for soil sampling and analysis, and soil quality monitoring.

In a first approach, the Feasibility Study has been prepared, based on a questionnaire eliciting information on trace element and organic matter contents of soils and using the results to make appropriate suggestions for further action.

This survey took into consideration the responses from 12 countries of the EU 15. The database of the individual countries proved to be very complex both qualitatively and quantitatively. For this reason, the assessment across the whole of Europe proved considerably more difficult than anticipated.

Thus, a specific approach within a limited time span has been proposed:

- a "short term action" over about one year, aiming to ascertain what the needs for data and standardisation in Europe are;
- a "long term action" over about three years, to fulfil the obvious need for standardisation and fill the gaps in data.

At the end, it will be necessary to take further samples in regions that clearly need more data. Moreover it will be necessary to propose a European "Soil Monitoring System" to be set up using already existing structures in the EU member states and adjacent countries.

The Feasibility Study has been presented at the European Soil Forum (ESF), which took place in Berlin, Germany from November 24 to 26 1999. This presentation impressively underlined the well organised structures and the effectiveness of the ESB and its members.

Following this ESF, the General Director of DG XI, J. Currie sent out a request to all the EU member states to support this European initiative. Presently, the very next activities of this working group and an urgent request of DG XI are under discussion between the ESB, the JRC Environment Institute and this working group as well.

The Feasibility Study has been spread in a slightly revised version among the members of the working group and will be published as part of the ESF proceedings. Moreover, it is available at the ESB as well as at the Federal Institute for Geosciences and Natural Resources in Hanover, Germany.

The European Soil Bureau project was transferred from SAI to the Environment Institute (EI) at the end of the reporting year.

Information Dissemination

- The European Soil Data Base. Version 1.0. (1999). European Soil Bureau, Joint Research Centre, European Commission.
- Soil Resources of Europe. P. Bullock, R.J.A. Jones and L. Montanarella (eds). (1999). European Soil Bureau, Joint Research Centre, European Commission.

MARS Monitoring Agriculture with Remote Sensing

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

The MARS project provides technical support and expertise to the Directorate General Agriculture for the implementation, management and follow-up of the Common Agricultural Policy (CAP). The expertise developed within MARS incorporates the operational use of remote sensing (satellite / airborne data), GIS, GPS, and more generally geomatics, and area-frame techniques. These methods are deployed for the fight against fraud,

- In support to the management of the Common Agriculture Policy (CAP); and
- For the production of pan-European statistics and information systems, in particular for crop yield monitoring forecast and the production of the MARS bulletin.

During 2000, the MARS project was developed in accordance with DG AGRI priorities, as well as the medium term orientation of the JRC.

On the request of DG JRC, a proposal of a MARS PECO activity was submitted and subsequently approved for a funding of EUR 500,000 by DG JRC. This activity, initiated in 2000, will be further developed in 2001-2002, and focused on the fight against fraud and especially the implementation by the Candidate countries of the IACS, and LPIS systems as well as testing controls with remote sensing. In co-ordination with DG AGRI, this will allow us to develop contacts, establish a network of technical exchanges through visits, conferences and pilot projects. This activity has already been received enthusiastically by the Administrations in charge of the accession within the ministries of agriculture of the PECO countries, due to the strong requirement of support to implement the "*acquis communautaire*" in the field of CAP

The *Fight against Fraud* activity of the MARS project experienced new dynamics in 2000, due to:

- The arrival of the new very-high resolution satellite IKONOS with a 1m spatial resolution; and
- A new Council Regulation 1593/00 (adopted with the direct support of DG JRC), which imposes the use of digital Land Parcel Identification Systems (LPIS) and the development of orthophotos. On a more general context, this will revolutionise, in the medium term, the availability of large-scale coverage in rural areas and their access through the Web, and will reinforce the future development of the project in the field of geomatics and rural cadastre.

In the context of the Global Monitoring for Environment and Security (GMES) initiative, a key element to European policy needs has been *Food Security* linked to crisis situations outside Europe, such as war, or climatic events, such as drought. MARS took a number of limited initiatives to explore and develop its expertise in this field, which is of strong interest for DG RELEX, DEV and ECHO. A pilot project was carried out over Kosovo, and datasets are expected to be completed on four pilot regions in the world leading to prototype development in the forthcoming years. In the meantime, partnerships have been being defined with organisations such as FAO and contacts were established with DG RELEX and DG DEV.



PROJECT LEADER
Olivier Léo

Crop Yield Forecasting

The second and last year of experience of the pilot project on *crop area change estimate derived from a scattered sample of mini-sites* allowed to produce area-change estimates on the target crops on the test areas based on the following elements:

- The sample sites were defined according to a systematic random sampling.
- The site size was 6x6 km² with a distance of 50 km from one to the other. In total 123 mini-sites were used on the test areas (Italy and BENELUX).
- A post-stratification on the mini-sites was applied using the CORINE land cover information on arable land class.
- Remote sensing data were acquired on the mini sites 3 times during the year.
- A ground survey on the mini-sites was included during the campaign and it represented the first layer of information for the estimate.

The pilot experience on the test areas gave the necessary elements to a possible set up at European level. The pilot project showed that:

- Only areas of aggregated classes of crops can be estimated in an early stage of the season with this approach;
- To have sufficiently good performances the sample should be reinforced in a EU application in terms of size of the sites sample;
- To exploit more efficiently the current remote sensing products and in the light of the current image price policy, wide areas scene should be used;
- To obtain good identification of crop on ground, the survey should be conducted in a late stage of crop growth to discriminate among crop varieties;

This experience completed a collection of approaches performed by the MARS project in the field of the use of Earth observation for crop area estimates like the past *Regional Inventories and Rapid Estimates*. The MARS project will continue to assure a technological watch for similar applications in the future.

Crop Yield Forecasting System

The 2000 crop yield forecasting system continued its activities 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 analyses, forecasts and thematic maps on crop yield expectations.

CONTACT
Giampiero Genovese



 The MARS Bulletin.

activities on olive and vineyard registers confirms the propensity to house the activity in the MARS project.

Apart from the observatory role of the project's LPIS activity, a research component is maintained that is aimed at demonstrating innovative information technology solutions in support to the widespread use of the new LPIS, both within the Administrations, but also for future use in electronic filing of, for instance, farmers' aid applications. Development of a software prototype that initiated in 1999 continued. This resulted in a 100% pure Java client-server solution, based on components that are available in the Open Source environment. The system was used to demonstrate the possibility to supply the user with arbitrary resolution digital image data, including 1 m ortho-images, against which agricultural parcels can be delineated and registered on a central server for a typical area-based support measure. Especially the latter part of the system bears obvious importance for the future deployment of the fully implemented systems. At the annual conference on Control with Remote Sensing in Dublin (November 2000), commercial systems with similar, and even more advanced features were demonstrating the feasibility of typical Internet-central approaches for future LPIS deployment.

As in the case of the Control with Remote Sensing, a major new activity in LPIS is related to the preparation of the Candidate Member States. The implementation of the (new) IACS is, obviously, required as part of the *acquis communautaire*. At the Dublin conference, a number of Candidate Member States demonstrated the, sometimes already advanced, status of their efforts. Again, the role of the MARS project will gain a significant boost with the perspective of the future adhesion of those Member States.

CONTACT

Pär Johan Åstrand
<http://mars.aris.sai.jrc.it/agri-environment/>
<http://agrienv.sti.jrc.it/>

Management of Agri-Environmental Programmes, Schemes, and Measures

The experience that has been built up within 10 years of support to DG Agriculture - in the context of the CAP element of the MARS project - has formed the basis to the ongoing work. The goal of the specific activity is to use the knowledge acquired in setting up the Control with Remote Sensing programme, the Integrated Administration and Control System (IACS) and the Land Parcel Identification Systems (LPIS) also within the EU agri-environmental (AE) programmes, schemes, and measures.

The Agri-Environmental Policy started with the definition of the Less Favoured Areas in 1975 and the Objectives 1, 5a, 5b Areas in 1988, passing through the IACS milestone (Reg. 3508/92, and 3887/92, amendment 1593/2000), and the more aimed regulations 797/85, 1760/87, 2078/92 on Agri-Environmental Measures (AEMs), and 2080/92 on afforestation, and concluding with Agenda 2000, and regulations 1257/99, and 1750/99 in support to Rural Development. The last two state that AEMs are required as compulsory part of all rural development programmes submitted to the EU.

Managing and monitoring the adoption, implementation and achievements of the agri-environmental programmes in accordance with existing EU Regulations can be a geomatics-oriented exercise. Whether a measure concerns "nature and landscape protection", "economic support of marginal agricultural activities", "regulation of farm-based pollution", or "agricultural modernisation and structural reform", there is a substantial spatial/geographic GIS component. It is this component that the MARS project line is assessing.

This year the activity has actively participated in the work of the AE Cluster at the JRC (<http://agrienv.sti.jrc.it/>). This has involved making the ARIS unit of SAI, the "hub" for all the projects at the JRC which include AE issues. These add up to 20, out of the total 100 projects, which define the 5th Framework Programme (1998-2002). Furthermore, for the AE Cluster, a GIS exercise has started with the aim and interest to cross-spatial uptake of AEMs with data available in the AE Cluster, at different scales (e.g. data on landscape/land conservation/biodiversity, water, soil erosion, soil quality, air and climate change). The



▲ Interpreting AEMs on Ikonos Carterra stereo imagery. The use of anaglyph stereo glasses is recommended. (2000, Space Imaging Inc.; Courtesy of Space Imaging Europe).



▲ AEMs on Lago di Garda, where grass is grown between vine rows (green covering) to avoid erosion. (Courtesy of RSDE, Italy).

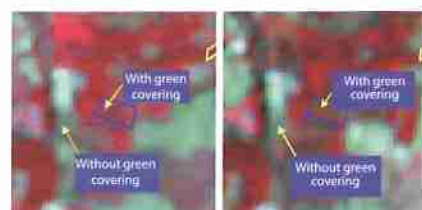
goal is to check whether uptake and targeting fits the sensitive area. A first test case has been defined as testing soil erosion measures in some different Member States. More generally, the activity has proceeded in establishing contacts with Member States Administrations, and responsible DGs, and agencies in the fields of Agri-Environment and Rural Development. However, since the beginning of the season, work has focused on key agri-environmental issues in real environments. Two pilot tests were conducted in Italy and the UK at the second half of the reporting year. Preliminary results were presented at this year's conference on Control with Remote Sensing of Area-Based Subsidies, held in Dublin on 16-17 November (<http://mars.aris.sai.jrc.it/control/meetings/dublin2000/>).

The Italian test site was situated on Lago di Garda, where a GIS system has been set up containing a time-series of data for the monitoring of chosen AEMs and farming practices of the Italian Lombardy region. Examples of such AEMs are crop rotation, green covering of vineyards and olive groves, extensive grassland issues, maintenance of hedgerows, wood strips, and restoration of dry stone walls and ditches, maintenance of abandoned farmland, and long term set aside. In the UK, three areas of interest were chosen presenting some potential to develop the operational use of remote sensing, and GIS data. Here similar issues as in the Italian case were studied: small-scale landscape features (hedges, walls), specific features of arable land (grass margins), farm management practices (hay cutting, heather burning), and nutrient status in arable and grassland systems.

The way forward involves final reporting and presentation of the two pilot test results in early 2001, as well as participating to the upcoming AE Cluster workshop in spring 2001. Information dissemination between Member States at local level also constitutes a priority. There is a lot of useful information that Member States may benefit from. The analysis on which AE attributes that fit into IACS will continue, and the work on specifying a GIS needed for the policy needs of the Commission services (top-down GIS), versus a GIS needed for the Member States Administrations (bottom-up GIS) is to be initiated.



▲ Good results in the detection of permanent crop and parcel boundary. Detection of green covering between vine-rows has been fairly good. 1m panchromatic orthophoto and 1m colour orthophotos. (Courtesy of RSDE, Italy).



▲ Detection of green covering between vine-rows: slight spectral difference on the multitemporal SPOT XI sequence. (Courtesy of RSDE, Italy).



▲ AEMs in East Anglia, England. Countryside Stewardship Scheme. (Courtesy of ADAS, UK).

GTS

Galileo Technical Support

The Galileo Technical Support project was initiated in late 1999. The objective of the project is to provide technical support to the proposed European navigation system, Galileo, during its Definition Phase and beyond. This serves the Communication *"Galileo – Involving Europe In A New Generation of Satellite Navigation Services"* (COM 1999 54 final), and the consequent Council Resolution of the 2191st Council Meeting of the 17th June 1999.

The development of a very close and successful working relationship with the Satellite Navigation Systems (Galileo) Unit of DG Energy and Transport (TREN), who are responsible for the Definition Phase of Galileo, led to the Framework Administrative Arrangement signed by the Directors General of DG TREN and DG JRC on the 9th August 2000. The immediate objective is to prepare a Council Decision for the Transport Council concerning the development of Galileo, to be held in December 2000.

Involvement in the definition of Galileo has given the SSSA Unit the opportunity to build on their technical skills in strategy, systems and application development. This is will no doubt be an invaluable asset for further work on Galileo and other pan-European initiatives on Space such as Global Monitoring for Environment & Security (GMES).

The project is split into three main areas:

- **Applications & pilot projects** - technical management of pilot projects within the Galileo Overall Architecture (GALA) contract; cooperation with on-going Trans-European Networks (TEN) and other 5th Framework Programme (FP) activities; co-ordination of development and demonstrations of applications in relation to supporting the market uptake of potential Galileo based services in synergy with TEN and other FP activities.
- **Systems definition and implementation** - assistance to technical management of GALA contract and liaison with the Galileosat project; technical support to the management of the development and implementation of the Galileo system.
- **Service Definition and market related assessments** - technical management of the Galileo service definition contract (GEMINUS); support in the undertaking of market assessment, cost-benefit analysis, industrial analysis and Public-Private Partnership (PPP) definition.



PROJECT LEADER
Peter N. Churchill

Applications and Pilot Projects

Technical Management of Galileo Pilot Projects:

On behalf of DG Transport and Energy (TREN) the project staff managed the Pilot Projects conducted during the Galileo Definition phase as part of the Galileo Overall Architecture (GALA) contract. These projects addressed a range of potential applications of Galileo with the aim of:

- Demonstrating innovative applications in different thematic and geographic areas, often in combination with other technology advances,
- Underpinning and exploiting European innovation from industry, research and small and medium size enterprises (SME's),
- Building on and contributing to other tasks of the on-going work on standardisation and certification.

The application examples investigated include:

A vehicle fleet management system independently connects to the hub and downloads all the data for a fleet into the fleet management software. This enables the fleet manager to respond to client enquiries regarding the location and status of any vehicle and subsequently estimate the time of arrival at its destination. Current fleet management systems perform adequately and allow fleet managers to manage and control their fleet. However, the market will benefit from a second satellite navigation system (Galileo) that will increase availability of signal and will be supported by unique service level agreements. For instance, the Galileo controlled access signal with defined levels of service will enable users to operate at optimum levels -globally, regionally and locally. Guaranteed levels of service as a vehicle security measure create confidence in service providers and end-users and also reduce risk for insurance companies.

An agriculture system has been demonstrated where the farmer can locate and monitor the position of machinery or personnel and receive geo-referenced field data such as yield or moisture measurements in near real time. These functions obviously are useful in times of intense farm activity, when efficiency and safety are paramount. Provision of defined levels of service and performance guarantees from GALILEO will enable this application to expand and develop. Use of the system for adherence with future environmental or safety legislation will require the certification and approval of the satellite positioning system. GALILEO is well positioned to meet these requirements and serve this application.

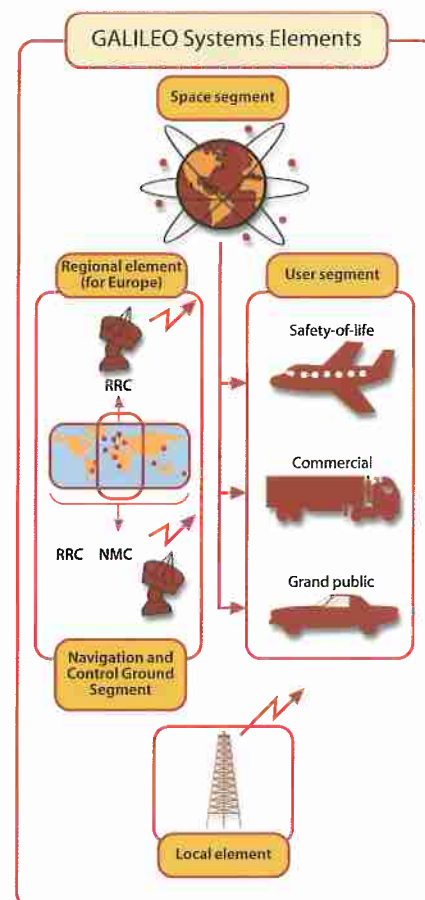
Advanced car driver assistant has been simulated. Similar systems are expected to be operating in the mid-term on motorways and main roads. Galileo performance levels (often augmented locally with terrestrial components) will enable such applications. The reliability of Galileo in terms of guaranteed continuity and integrity plus its improved refresh rate will permit an efficient and effective implementation of advanced driver assistance systems (ADAS). These systems are considered 'safety of life' applications and therefore require the maximum degree of integrity, accuracy and reliability.

Intermodal transport of hazardous goods is an application area where the Galileo integrity service combined with close bundling with communication will enhance the safety conditions. It is also expected that precise localisation of vehicles in the European transport network may lead up to a transfer of up to 10% of traffic load from roads to inland waterways or rail resulting in a significant pollution reduction and cost savings.

Railway Safety is an area where Galileo can assist by decreasing the number of accidents. Railway operations are a safety of life application. Accidents may involve hundreds of persons. Hazardous materials are often in transit through densely populated areas. To control such risks a high level of accuracy is required together with high levels of integrity, reliability, availability and guarantee of service. Certification of the service is a "sine qua non" requirement to deploy a system to meet the safety needs of rail applications. Galileo will be able to fulfil these requirements. Satellite navigation is not currently used by trains and can therefore become an interesting area for Galileo deployment in the mid-term.

CONTACT

Michalis Ketselidis (Task Leader),
Francesco Pignatelli





Traffic surveillance and law enforcement is an application area where Galileo could help reducing the road accidents in Europe by assisting monitoring of traffic violations and speed control through on-board navigation recorders. Vehicle data can always be stored together with an exact time stamp and with the precise position information, determined from the navigation signal. To use the recorded data at court or for insurance companies, the data has to be highly reliable and it has to come from a certified system. These requirements can only be fulfilled by GALILEO.

Crisis management situations require reduced intervention times and improved efficiency of resources usage. Effective response to forest fires for example, is achieved by early warnings and also reliable accurate positioning information about the location of the incident and the deployed resources. In support of police and fire authorities. Satellite positioning with Galileo levels of service could prove very useful to police and fire authorities which need a reliable and accurate knowledge of the location of deployed forces in order to co-ordinate them efficiently. Beyond fires, other crisis situations may include maritime emergencies, fight against oils spills, support for humanitarian aid operations.

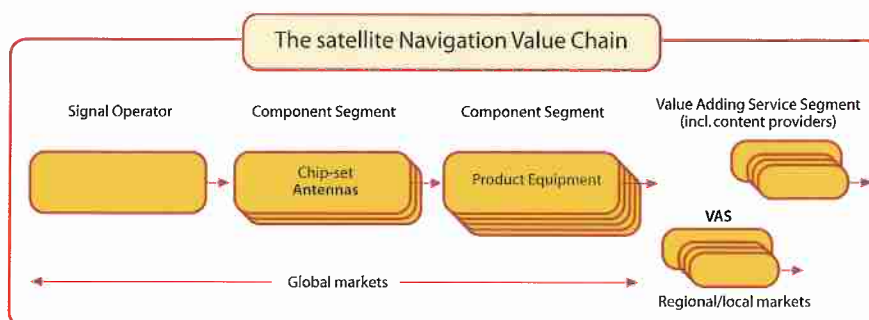
Future Galileo Applications and Pilot Projects will come in a coordinated manner through different EC and ESA programmes. This support will initially concentrate on exploitation and dissemination of the European Geo-stationary Navigation Overlay Service (EGNOS) signal. The first pilot project to use the EGNOS Test Bed signal concerns Maritime Vessel Traffic Management and will be conducted between December 2000 and February 2001 (under the GALA contract). As the Galileo system components become available pilot projects based on the Galileo System Test Bed will also be supported. Other activities will include support of application simulations, showing for example how the Galileo signal can improve the coverage in urban areas. In all cases however and in the context of the pilot projects, Galileo will be considered as one valuable information source which together with other information / positioning sources and bundled with communications / Internet technologies can support the creation of value added services in Europe aiming at the creation of new jobs and wealth, support of EU policies and preservation of the ecosystem.

Communication With Other Navigation related Application Projects:

The aim of this activity is to coordinate applications and pilot projects with other ongoing work on Navigation application development at the European Space Agency (ESA) or national level. In the frame of this task two meetings with ESA were organized and resulted in the delivery of a draft plan for common European Commission (EC) and ESA applications, which is now the subject of further discussion between DG TREN and ESA.

Coordination Of Information Exchange At EC Level Of GNSS Application Projects:

This involved preparing, disseminating, reviewing and updating technical notes that serve as a baseline for discussion and decisions on future EC support for GNSS application projects. Following a number of meetings with DG TREN and DG Information and Society (INFOS) the Galileo Technical Support project produced a document entitled "future pilot projects" which was very well received and appreciated.



Systems Definition & Implementation

Assistance to the Technical Management of the GALA Contract:

SSSA Unit staff provided technical support to the management of the Galileo Overall Architecture Definition Contract (GALA). Their specific role was to provide advice to DG TREN to confirm that progress was in line with Commission objectives. This included supporting the evaluation of the proposals for the GALA contract, and the resultant Technical Annex negotiation, participating in the GALA contract progress meetings, and identifying issues requiring DG TREN attention.

Assistance To The Development And Implementation Of The Overall Galileo System

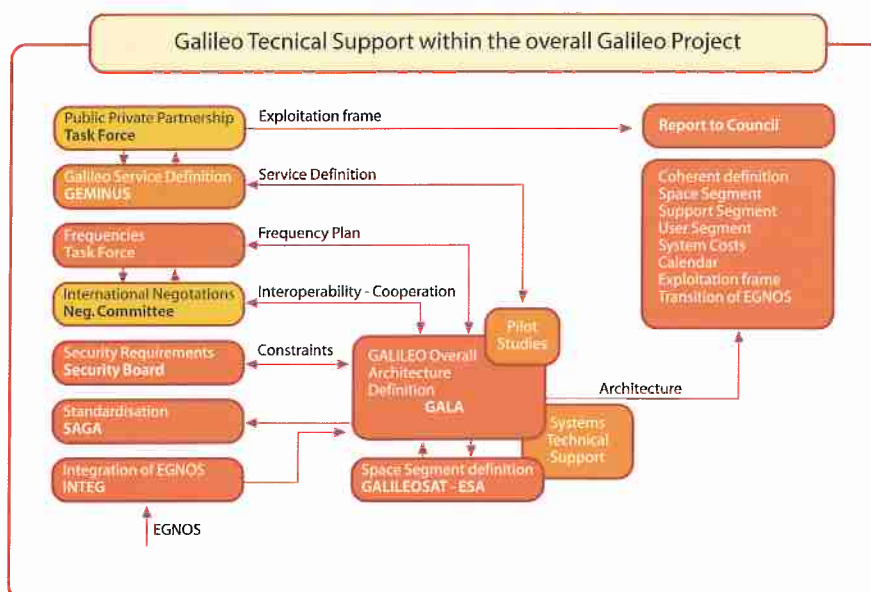
SSSA Unit staff provided input to review draft Mission Requirements and System Requirements for subsequent phases of the project and to consider the interactions with terrestrially based navigation systems. In addition, this work has involved the review of outputs from GALA in order to understand the interactions required with other systems to optimise the available navigation infrastructure for European citizens. This will include interactions with Local Components (e.g. differential stations, pseudolites etc.) and other systems (LORAN-C, UMTS etc.).

Assistance To Liaison With The ESA Galileosat System Definition

The ESA Galileosat and EC GALA contracts ran in parallel, with GALA responsible for generating space segment related requirements for Galileosat, which responded with cost and compliance information. SSSA Unit staff attended reviews and participated to the evaluation of the Galileosat study and provided technical support to co-ordination meetings between the EC and ESA.

Assistance In International Liaison

SSSA unit staff provided technical support to International negotiations, in particular discussions with the Russian Federation (concerning Industrial Co-operation and frequency sharing), Canada (North American Regional Augmentation), Nordic Countries (performance at high latitude) and Israel (Local Augmentation). This involved participating at plenary sessions, working groups and internal EC Task Force meetings and to monitor related activities within GALA.



ASTRON

Applications on the Synergy of Telecommunications with Earth Observation and Navigation

<http://www.sai-jrc.it/astron/>

ASTRON (Applications on the Synergy of Telecommunications, eaRth Observation and Navigation) aims to investigate the synergies between the three space technologies and terrestrial mobile technologies in order to introduce innovative and sustainable services and applications based on the convergence of digital information from satellite and terrestrial sources. These key objectives of ASTRON are 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 III.3 "Underpinning European Competitiveness" under which ASTRON is supported.

For the entire Fifth Framework Programme, the activities of ASTRON are co-ordinated 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; GNSS and Info-mobility applications) and Key Action 2 of Theme 3 (Promoting Competitive and Sustainable Growth / Sustainable Mobility and Intermodality; Galileo pilot projects). The project has close links with the European data and communication providers, space industry and space agencies as well as with other Directorates-General, namely DG TREN (Transport and Energy) and DG INFSO (Information Society).

For each activity undertaken within the project, the relevant stakeholders were identified leading to the definition of the rationale and expected results for Europe from the collaboration with the stakeholders. At the end of the reporting year, and according to the project plan, the results of the "monitoring and analysis" activity were made available and formed the basis of the work to follow. Most potential applications were grouped into four market segments, which were studied by industrial teams, supported by ASTRON with a view to defining demonstration projects. The market studies results confirmed that the synergy between Earth observation (EO), Telecommunications and Satellite Navigation (SATNAV) could be effective in an innovative fashion in a number of application areas, namely personal info-mobility, safety of life and resources, big events or crisis situations, and mobility. Demonstration projects, so called "proof-of-concept showcases", were initiated, aiming to demonstrating the vision and opportunities arising from the synergy of space technologies. The first demonstration project, which was successfully concluded in the framework of personal info-mobility, was entitled Personal Assistant (City Navigation).



PROJECT LEADER
Michalis Ketselidis

Communication With Stakeholders

Since 1999 ASTRON has established formal collaboration frames with the three relevant EC services: DG Enterprise, DG Transport and DG Information Society for the provision of technical support and coordination of work (with particular emphasis on market studies and demonstration projects) in the timeframe 2000-2002. In the year 2000, this collaboration was intensified. In particular, the ASTRON project staff supported DG TREN for the technical management of the Galileo pilot projects (under the GALA contract) and DG INFSO for the evaluation procedures of the GNSS specific call. In return, DG INFSO and DG TREN assisted in the evaluation of proposals of the ASTRON tenders. The ASTRON project team also maintained, in coordination with the other services, the list of all GNSS projects that the EC funded in the period 1994-2000. Communication with OLAF, the EC Anti-Fraud service, confirmed the potential of synergistic satellite technologies to be useful for a number of their needs. Collaboration is expected to develop in year 2001.

Discussions for technical collaboration also proceeded with the European Space Agency (ESA). In particular collaboration started with the ESTB (EGNOS System Test Bed) team of ESA for the better exploitation of the EGNOS signal leading into concrete projects and with the Galileo Applications team for the better coordination of EC and ESA application projects. Communication continued with the ARTES 3 "multimedia applications" group of ESA aiming to find ways of closer collaboration.

With ASI, Italy, an agreement is expected to be signed foreseeing collaboration for the development of demonstration projects on the combined use of satellite navigation, communications and Earth observation together with terrestrial mobile technologies.

With BNSC, UK, a bilateral three-day working session took place in Ispra at the end of 1999 investigating mechanisms and application areas for collaboration. As a result it was proposed that such collaboration could be based on the take-up by BNSC of the ASTRON results (market analysis and demonstration projects) by means of supporting pilot projects and/or complementary studies at national level.

With CNES, France, discussion continued for collaboration on synergistic use of space technologies in the Intelligent Transport Services sector. Possibilities of common research projects for fleet management of vehicles in urban areas based on satellite technologies only (positioning, messaging, broadcast) were discussed during bilateral meetings.

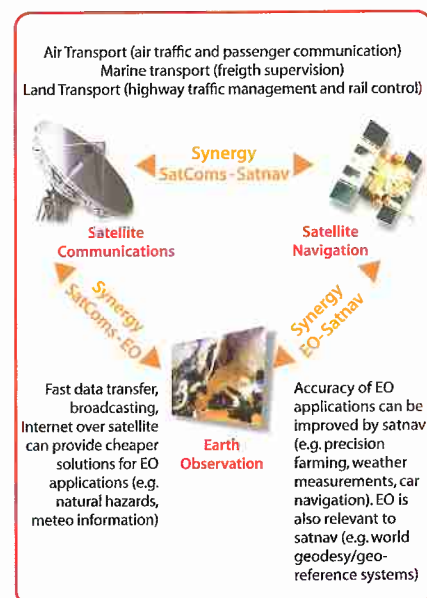
With DLR, Germany, and within the framework of an overall DLR-JRC collaboration agreement on space applications, collaboration was agreed to develop demonstrator projects of innovative applications based on the synergy of space technologies and other Information Society Technologies; to expand and further develop a monitoring network of navigation satellites; to develop geo-positioning simulators based on the integration of existing satellite navigation simulators and Earth observation 3D urban and rural models; and to investigate and promote innovative usage of SRTM data.

An expression of interest for ASTRON was received from the Deputy Minister of Communications and Transport of Greece, confirming the potential of converging technologies for support of Information Society and Transport policies in different EU Member States.

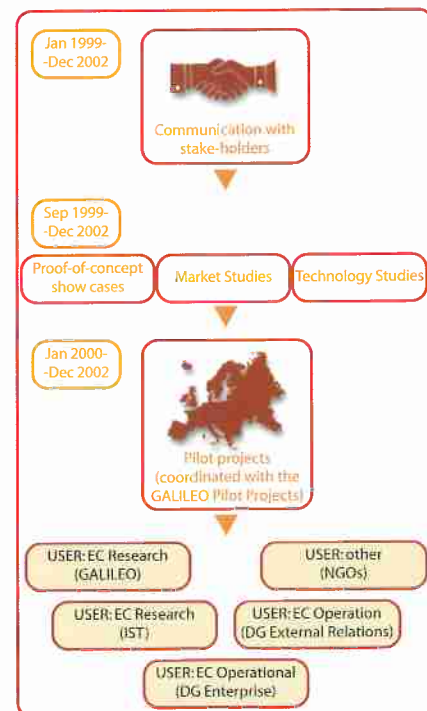
In Finland, the National Technology Agency, TEKES, organised a common presentation for the Finnish community of ASTRON together with the IST Infomobility programme and the Galileo programme.

An invitation of DG INFSO gave the opportunity to present results of an ASTRON study to the wider infomobility community in the IST conference, in Nice, France.

CONTACT
Michalis Ketselidis



ASTRON Concept.



ASTRON Project Plan.

ASTRON organised a workshop on 23 June 2000 in Ispra, where the results of the work of five industrial groups were presented to more than 100 participants coming from EC, ESA, ASI, BNSC, CNES, DLR, industry, research organisations and SMEs. The workshop, which also attracted user organisations like the United Nations and the Olympic Games Committee, presented the results of the four market analysis studies and a first infomobility demonstration. It also served as a forum where the EC, ESA and national agencies presented their current and planned programmes relevant to satellite applications.

Finally, discussions continued with Industry (providers and manufacturers). As a clear sign of the success of ASTRON in underpinning European competitiveness, a group of European industrial and research organisations expressed interest in investing themselves for implementation of pilot projects based on the results of ASTRON - in particular the traffic, mobility and security services relevant to the Olympic Games of 2004 in Athens. Bilateral discussions aiming at information exchange on technology status and opportunities for collaboration were held with Astrium, Bosch/Blaupunkt, Datamat, Nokia, Teletlas, Zeppelin NT and others. As an expression of support, two of these industrial organisations, Space Imaging Europe and ERDAS, offered free use of their products during the reporting year.

CONTACT
Francesco Pignatelli



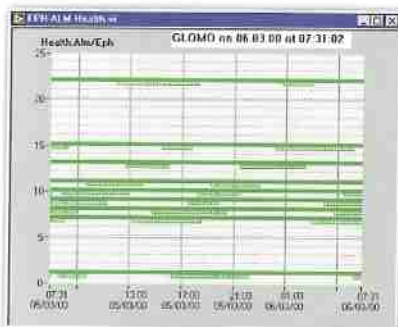
Monitoring and Analysis

Within the context of technology monitoring different reports were published. They are relevant to satellite communications systems services; satellite navigation systems and services; earth observation systems and services; applications of satellite technologies that have been supported by the EC RTD programmes. For more information, look at the list of publications at the end of the paper or at www.sai.jrc.it/astron. In collaboration with DLR, a station - part of a GLONASS satellite navigation monitoring network was installed at SAI.

Within the context of market analysis, four market studies concluded. These studies performed a market analysis and proposed mini business plans for the following market segments:

- **Personal Infomobility:** Emerging applications exploiting innovative technologies and addressing mass markets, i.e. personalised infomobility services, media, interactive games, entertainment, tourism, leisure, sports, real estate.
- **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.
- **Big Events:** Emerging applications relevant to Big Events such as 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.
- **Mobility:** Applications in the transport section, such as those related to road, train, air, maritime, and intermodality.

These market studies results, which were presented in the dedicated workshop of June 2000, confirmed that the synergy between Earth observation, Telecommunications and Satellite Navigation could be effective in an innovative fashion in a number of application areas. The examples in the following sections of this chapter are not exhaustive.



▲ GLONASS monitoring: photo of the antenna installed at SAI (top); the status of all functioning GLONASS satellites (only 9) on 06-Mar-2000 is marked (bottom).

Personal Infomobility

Space technologies can be used to complement terrestrial communication and positioning systems (GSM/UMTS) in meeting the needs of the quickly growing trend towards mobile information services at a personal level, through hand-held or vehicle-based terminals.

• Virtual Travel Assistant/Tourist Guide

On-the-fly "pro-active" navigation services ("turn-by-turn") can guide the user on a "tour" of a specific location. A "passive" tour guide can inform the user of local points of interest, events, etc. dependent on their current location (town, city, historic site). Satnav locates the user, satcoms offer broadband information transmission, and Earth observation (EO) enriches location-related content.

• Local Weather Forecaster

Access to weather forecasts for the immediate area where the user is located, can be provided via a fixed or mobile Internet-connected terminal. Satnav determines user position, EO is used to derive weather forecasts and provide images, satcoms can deliver detailed image information.

• Gaming

Fully interactive, multimedia virtual gaming in the "real" world can be envisaged. Two or more global gamers congregate in a virtual anteroom; decide upon which game to play, virtual location, level of realism, etc. Use of EO derived data for the recreation of the environment and satellite-based communications and navigation for the moves of the players.



▲ Personal Infomobility.



▲ Safety of Life and Resources.

Safety of Life and Resources

High-resolution up-to-date EO satellite data (used for 3D real-time visualisation techniques) together with navigation (GPS and eventually Galileo) and satellite communications can provide benefits for planning and monitoring of applications related to the safety of life and resources.

• Logistic Support in Humanitarian Crisis

Logistical support can be provided for the management of population relocation or evacuation in a crisis situation (civil war, refugees, epidemic etc). EO is used for terrain mapping, site selection, monitoring of crop areas. Satcoms are used for overall provision of fixed and mobile communications. Satnav is used to support operations related to relief supply and ground surveys.

• Terrestrial Search and Rescue Operations

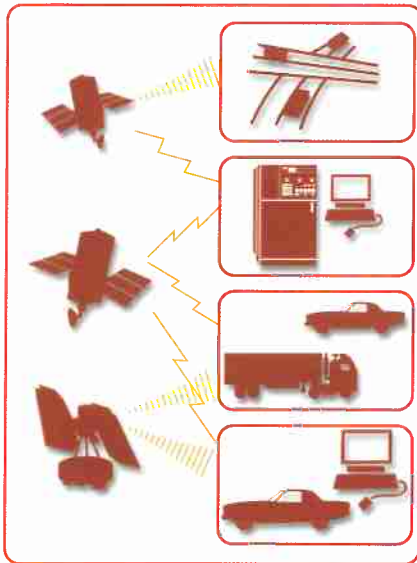
Enhanced co-ordination and support of search and rescue operations on land. Satnav is used to support location of victims and rescue forces operations. Satcoms are used for communication between the management centre and rescue teams. EO is used to visually enhance the operations scenario for the decision makers.

• Oil Spills

Identification and monitoring of illegal pollution of oceans and coastal zones, aiming to alert authorities and support actions to reduce the impact on the environment. Satellite derived radar data are effective to detect oil spills at sea. Once a spill is detected, offending vessel positions are identified with the support of satellite navigation, provided that the vessels are obliged to continuously transmit their position.

Selected Further Reading

- A Market perspective for ASTRON: Benefits for Europe from Integrating Space Technologies, S.P.I. 98.115
- Inventory of projects with a European Dimension, where Satellite Communications are used for Earth Observation Applications, EUR 18675 EN
- Overview of Current and Planned Spaceborne Earth Observation Systems: the Report. EUR 18673 EN
- 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. EUR 19006 EN
- Satellite Navigation Survey - Systems and Synergistic Applications. EUR 19013EN
- Compendium of Space-Technology Applications Projects - Technical Overview 1994 - 1998; Report EUR 18971 EN
- Proceedings of the ASTRON Workshop (23 June 2000), www.sai.jrc.it/astron/, select *Presentations*
- ASTRON paper - an introduction, www.sai.jrc.it/astron/ - select *Documents*
- Application Leaflets (20 applications), results of the ASTRON Market Analysis studies, www.sai.jrc.it/astron/, select *Documents*



Big Events or Crisis Situations.



Mobility.

Information Dissemination

ASTRON published the following documents:

- Satellite Communications Survey 1999, 3rd edition
- Satellite Navigation Survey 1999, 1st edition
- Earth Observation Handbook, version 1.2
- Space Compendium

ASTRON was presented in the following conferences:

- Mercator Park (German Applications Park) Conference, 3 March, Munich
- British Association of Remote Sensing Companies, Annual Conference, 16 March, London
- GEOMARK 2000, 10-12 April, Cannes
- GNSS 2000, 2-4 May, Edinburgh
- 20th EARSSEL Symposium, 14-16 June, Dresden
- 6th GI & GIS workshop, 28-30 June, Lyon

Articles about ASTRON were published in the:

- Galileo Newsletter, GENESIS Office, June 2000
- Galileo's world, Volume 2, Number 2, Summer 2000
- GPS World, annual "Directions" essay, December 2000

Big Events or Crisis Situations

Satellite technologies in combination with terrestrial technologies can provide innovative solutions for mobility applications relevant to big events (e.g. Olympic Games) or crisis situations (e.g. earthquakes) when large population densities occur in metropolitan areas for limited periods of time.

• Traffic Monitoring and Fleet Management

A Fleet Management System can be used to manage several accredited or public transportation vehicles (heavy-goods trucks, mini-buses and public transportation buses), commuting to pre-determined spots through the least congested routes.

• Emergency Services Operation

Crisis situations (such as earthquakes or terrorist attacks) require an emergency system with a high degree of integrity and reliability for coordination of all security and support measures. Satellite technologies could support real-time surveillance of the incident area and could provide direct links between the headquarters and the officers in the place of incident.

• Personalised Tracking

The position and status of every high security-rated group of visitors during great events, or out-door security related employees can be monitored in real time, through an interactive system used to track the individual person and to establish voice or data communication (one-way or two-way).

Mobility

Navigation techniques bundled with Communication means and EO-derived products can be used for the development of innovative systems for road guidance-assistance to private vehicles and fleet management of public transportation vehicles. The three satellite technologies might also support specific applications in rail, air and maritime navigation.

• Dynamic Route Guidance

An interactive car navigation system enables on-the-move updating of the road database within the car, with data on preferable routes to selected destinations, according to real time traffic information (e.g. blocked roads, traffic jams etc) and up-to-date meteorological and environmental information.

• Law enforcement – Professional Drivers

A satellite-based law-enforcement system could provide a wide-area monitoring of traffic violations by professional drivers. This might allow actions at different authorisation levels mainly contributing to enhancing passive safety. Such a system could be particularly beneficial for hazardous goods transport and car rental companies.

• Small Aircraft Navigation Support

Private small plane (or helicopter) navigation might be enhanced achieving increased air safety under visual flight rules (VFR). EO is used for improved and updated flight charts and terrain models. Terrains may include airport areas (where small planes do not have all necessary information) and also areas away from airports where helicopters might need to land.

Development and Demonstration

Demonstration projects were initiated in early 2000. They are called "proof-of-concept showcases", because they aim to demonstrate the vision and opportunities arising from synergy of space technologies. They focus on environment and security or infomobility services.

The first demonstration project was developed for ASTRON by the Swedish firm OM&M; it targeted personal infomobility in Stockholm and was entitled Personal Assistant (City Navigation). Based on this development, the ASTRON team implemented a virtual reality world of the JRC/Ispra site and developed the geographical content for the navigator to be used at the Ispra site.

Future developments (in 2001) include real implementations (on palmtops and laptops) of pre-operational services at the Ispra site in the areas of:

- Search and Rescue
- Personnel Security
- Rapid Response to Emergencies (Forest Fires)

This work, which builds upon the results of the work of 1999 and 2000, will be based on collaboration of the ASTRON team with industry but also with other SAI projects and in particular Population Dynamics and Security (for urban geographical content and humanitarian aid operation); Natural Hazards (for geographical content and information relevant to fires) and GI&GIS (for visualisation and standardisation). Results of this work will be tested and validated in collaboration with operational services of the JRC. In particular, a collaboration frame with the JRC site Security Service was agreed that would allow the JRC guards to be test users of innovative space-based infomobility and navigation services.

Other activities will include further investigation of the potential of the synergies between satellite and terrestrial communication, positioning and surveillance technologies. In this context, ASTRON will specifically investigate the potential of emerging terrestrial mobile technologies (GPRS, UMTS), their potential synergies with Galileo/EGNOS and also imagery of sub-meter accuracy. It will further develop a monitoring network of navigation satellites to cover GPS, EGNOS and GLONASS. It will look into geo-positioning simulators based on the integration of existing satellite navigation simulators and Earth observation 3D urban and rural models. Finally, with a view to the EC Framework Programme VI, pathfinder activities will be initiated on bundling of mobile communications with local augmentation of navigation signals; and standardisation relevant to mobility applications.

CONTACT
Michalis Ketselidis



JRC/Ispra Navigator: The 3-dimensional world implemented in VRML (top); and the simulated terminal (bottom).

Highlights

- Invitation To Tender for development of demonstration projects, June 2000
- Invitation To Tender for supporting studies on mobility technology analysis and pilot projects implementation, June 2000
- Release of the updated ASTRON web-site, June 2000
- ASTRON Workshop, Ispra, Italy, 23 June 2000
- Conclusion of four market studies and the first demonstration project, July 2000
- Conclusion of the JRC/Ispra site navigator demonstrator, September 2000
- Award of demonstration projects and supporting studies, December 2000

Supporting the development of a European GI policy (EGIP)

Activities carried out in support to EGIP:

- The establishment of EGIP mailing list;
- Workshop on National and Regional GI Policies in Europe (15th November 1999, Amersfoort, the Netherlands)
- Workshop on the role of GI as a tool to facilitate the accession into the European Union (16-17th November 2000, Brussels);
- Position paper "Towards a GI data policy for the Commission", which was adopted at the second meeting of COGI (20 September 2000, Brussels).

The workshops were organised by the JRC and the General Directorate "Information Society" of the European Commission, in partnership with EUROGI, the European Umbrella Organisation for Geographic Information.

Who contributed to the GI&GIS project in 2000?

JRC Staff	Topics
A. Annoni	Project management
S. Christensen	I&CLC2000, Natura2000, spatial analysis
J.F. Dallemand	Thematic network, EU enlargement
A. de Jager	Data modelling, GIS technology
K. Fullerton	Dissemination, metadata
J. Gallego	Spatial analysis, GI and statistics
R. Hiederer	Catchment Information System
I. Kanellopoulos	3D visualisation, advanced methods, data fusion
G. Liberta	WEB mapping, GIS technology
A. Munro	Interoperability, GIS technology
R. Meneses	Interoperability, IT technology
V. Perdigao	I&CLC2000, EEA, land use/cover, integrated assessment
S. Peedell	Natura2000, GIS technology
P. Smits	Standards, data fusion, modelling
J.M. Terres	Meteo, Agri-environment

Visiting scientist

M. Craglia	Data policy, Metadata
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Links

- GI&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: <http://www.eurogi.org/>
- CORINE land-cover/land-use project 2000: <http://www.ec-gis/clc2000/>
- Consortium of the European National Mapping Agencies (MEGRIN): <http://www.megrin.org/>
- PANEL-GI: Pan-European Link for Geographic Information: <http://gisig.ima.ge.cnr.it/panel-gi/>
- Pre-ANVIL: A Networked Virtual Interoperability Laboratory: <http://www.ec-gis.org/preanvil/>
- ETeMII: European Territorial Management Information Infrastructure: <http://www.ec-gis.org/etemii/>
- IEEE Geoscience and Remote Sensing Society's Data Fusion Committee: <http://www.dfc-grss.org/>

Good relationships are maintained with European institutions. The collaboration with the European Environmental Agency (EEA), for instance, was consolidated through a work EEA. The collaboration puts institutional activities on land cover, spatial analysis and GIS in general, in relation with and in complement to the ones of the EEA and its Terrestrial Environment (formerly Topic Center on Land Cover).

As opposed to EGIP, the creation of a *European GI Infrastructure* (EGII) involves aspects that have a more technical nature, referring to issues such as standardisation, interoperability, and metadata.

The promotion of GI standards is considered paramount for a future cost-effective collection and combination of pan-European GI. Europe consists of more than 30 countries, and each country uses different "types" of national geodetic co-ordinates, distributed in adjacent or overlapping spatial, and/or temporal, and/or resolution domains. As a consequence it is difficult to build a seamless data set with the various national and regional data sets.

A common reference system for GI is an important first step to ensure that data is compatible across Europe. This problem was tackled at the workshop on a Spatial Reference System for Europe (29-30 November 1999), organised by JRC in collaboration with MEGRIN, representing the European interest of the European National Mapping Agencies. The workshop established that a suitable candidate for a European Spatial Reference System already exists: ETRS89 (European Terrestrial Reference System 1989). It has been adopted by COGI and should be required for all new data collected and for updates to existing data. Consequently there is a need for the Mapping Agencies to make public the transformation algorithms and parameters for transforming data between national systems and ETRS89.

GI interoperability is a form of standardisation, but encompasses more than just data. Incompatibilities in data formats, software products, spatial conceptions, quality standards, and models continue to create barriers amongst constituent parts of operating geospatial technologies. The GI&GIS activity on Interoperability aims ultimately at the identification of a set of measures to foster the deployment of a set of common ubiquitous pan-European services, through the use of interoperable technology, and the harmonisation of a set of common practices and a sub-set of user requirements. This would help georeferenced information to flow border-less across Europe, leaving the actual flow of data to policies alone instead of being dependent on technology constraints.

As a result of the work carried on in 2000 - which included a technology observatory, service-driven showcases and discussion forums conducted on the Internet - the need for a catalyst initiative aimed at facilitating the exchange of information and experience amongst players in Europe was clearly identified. With the provisional name of ANVIL (A Networked Virtual Interoperability Laboratory for GI/GIS), the initiative has drawn the interest of national bodies, international organisations and European projects. After a Workshop organised in November in Sevilla, Spain it became clear that ANVIL has the potential to assist industry, users (including EC services and National bodies), and service and data providers. Industry can see their development effort reduced through the harmonisation of a common set of user requirements; users may have access to pan-European information at reduced costs; data and service providers would benefit from the reduction of costs on technology procurement and on the deployment of new integrated services.

Organisations such as the OpenGIS Consortium (OGC), have actively supported the ANVIL initiative, as a means for Europe to create critical mass, namely with respect to Location Based Services, peering their effort in the US. Aware of the fact that the success of ANVIL is dependent on the support of industry and on the involvement of users, a business plan has been drafted. During 2001, work will concentrate on formalising the commitment of key players to the business plan, and the integration of ANVIL into a European Research Area policy.

The standardisation of metadata is another aspect of the EGII that is being addressed at a European level. Metadata at its simplest is information about information resources, which may include data, reports, meetings, people, etc. As more and more resources become available through the Internet, it is of crucial importance that they are made visible and searchable. This requires documentation, i.e., metadata. Through direct and indirect participation in competitive action projects such as ETEmII (European Territorial Management Information Infrastructure), the GI&GIS project follows the developments in major metadata standardisation processes such as those of CEN/TC287, ISO/TC211, and OGC. Where needed and possible, the GI&GIS project contributes to emerging standards. The JRC contributes indirectly to OGC through its contacts at OGC Europe, and is a category A liaison at ISO/TC211.

Good communication between the key players in GI is of utmost importance for the creation of a European Reference Centre for Geographic Information. Active *dissemination of information* about spatial data and technology is essential if new markets for European developed products and services are to be exploited fully. The GI&GIS project plays an active role in this dissemination through a number of initiatives.

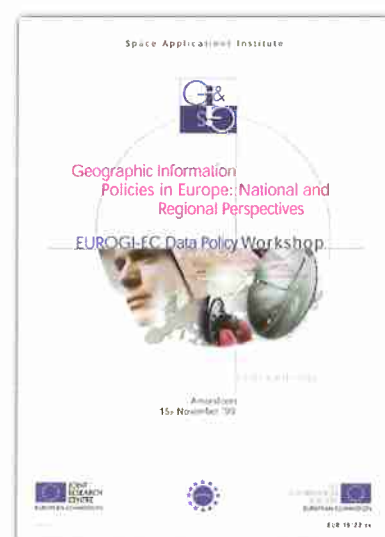
An example is the Annual EC-GI&GIS Workshop. The European Commission is an active user of spatial data and technology, as well as a focal point for funding of projects involving development of new spatial technologies. The annual EC GI&GIS Workshop is a major forum for many of these projects to announce the results of their research and development efforts. This year's workshop, entitled "*The Spatial Information Society - Shaping the Future*" was hosted in Lyon, France, and brought together researchers, industry, data providers and representatives from the Commission to discuss many aspects of the future of the Information Society from the perspective of spatial information.

Another dissemination activity regards the creation of an EC-GI&GIS Web Portal (www.ec-gis.org). It serves as a single entry point for information on all European Commission related GI and GIS topics and allows people to look for information about GI or GIS in the context of the European Commission across Commission-funded projects, documents, individuals, companies involved in projects, events and a number of other topic areas. All topics in this database are cross-linked to all other relevant entries; for example, retrieving working on the project, the organisations for which those people work, other projects with which those organisations have been involved, etc. In addition, web sites for Commission activities relating to GI and GIS, e.g., COGI or GISCO, are hosted through the web portal.

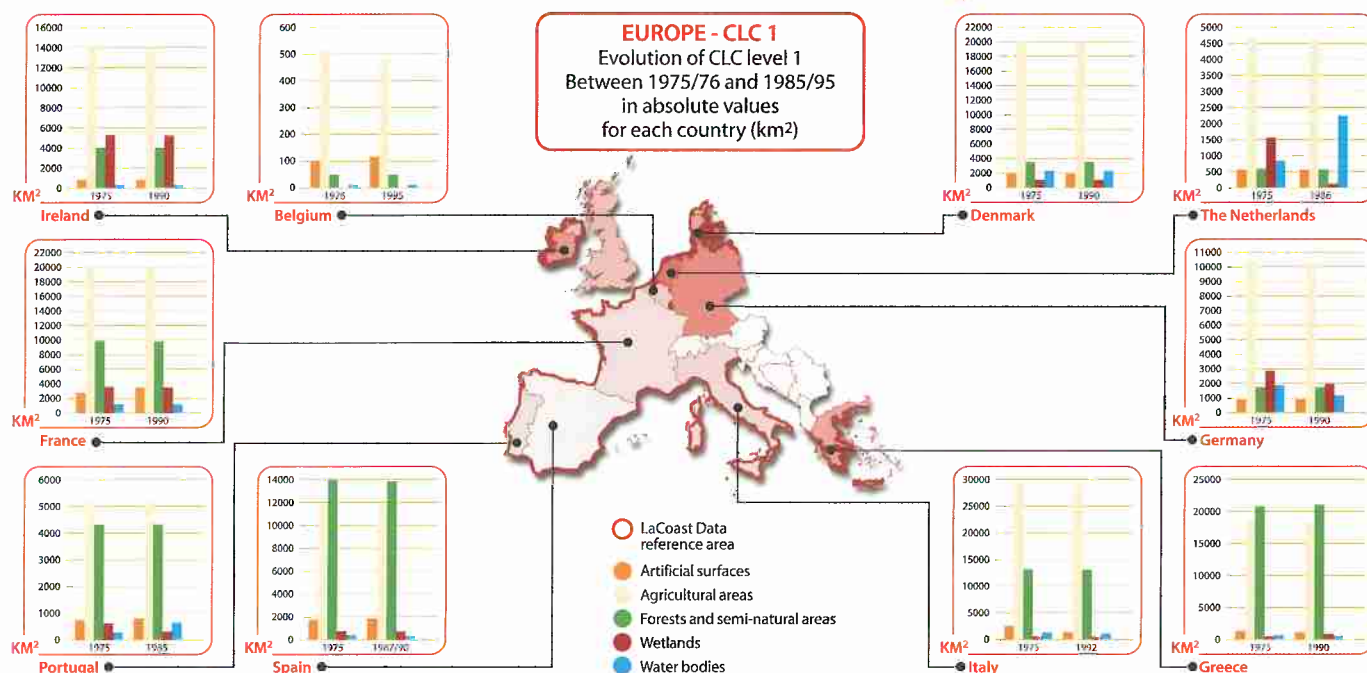
IEEE Geoscience and Remote Sensing Society's Data Fusion Committee

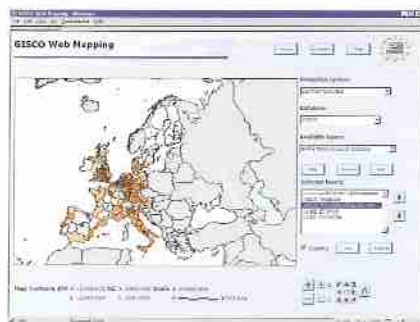
The GI&GIS project maintains strong links with the remote sensing data fusion research community. As of 1999, the chairman of the IEEE Geoscience and Remote Sensing Society's Data Fusion Committee (DFC) is a GI&GIS Staff member.

The DFC (www.dfc-grss.org/) is an established committee of the Geoscience and Remote Sensing Society (GRSS) with the primary purpose to provide a special focus on the research and technology area of data fusion, to assist in bringing it to maturity, and in fostering specific applications; all with a view toward encouraging and promoting the technical activities of the GRSS. Examples of activities are the organisation of workshops, the creation of benchmark data sets, and the contribution to emerging standards like ISO 19119 (Geomatics - Geospatial Services).



The LACOST atlas.





▲ GISCO's Web-mapping testbed.

Development of Pan-European Geospatial Data Sets

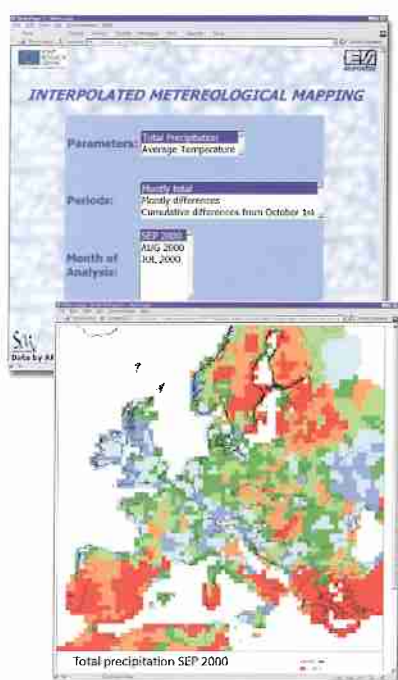
The European Commission and other institutions of the European Community will increasingly take the spatial component of policies and regulations into account when it comes to decision and policy making. In 2000, staff of the GI&GIS project have been involved in a number of activities for the creation and harmonisation of pan-European data sets, which include the creation of data models for efficient data storage in information systems.

Support has been provided to the GISCO (GIS for the Commission) office of Eurostat. Data models were developed and maintained. In addition, JRC and GISCO have initiated the process of creating an interoperable database making available a set of European geospatial databases based on OpenGIS standards. A prototype Web Mapping Testbed has been implemented that allows data sets, stored in an Oracle Spatial database, to be distributed via the Internet in an OGC-compliant configuration.

The EEA and the JRC co-manage a project aimed to update the CORINE Land Cover (CLC) database for the year 2000 (CLC2000). This project defines a European spatial reference based on ortho-rectified satellite images used to update the database (IMAGE2000). The JRC, through the GI&GIS project, provides methodological guidance and the management for both activities. In this framework a feasibility study was carried out to verify the implications on the CLC database if 5ha were taken as a minimal mapping unit of land cover changes. The study revealed that inconsistency would be introduced if this rule were applied. Therefore a 25ha minimum mapping unit, already used in the previous version of CLC, will remain valid, as will the other updating rules previously defined.

In 2000, the GI&GIS project reached a number of milestones related to land-cover and land-use databases. An example is the LACOAST atlas, which reports on the land cover changes in European coastal zones between 1975/76 and 1995/96. Land cover changes are analysed at European, regional and national levels and include statistics.

At the same time a study was finalised on methods to analyse the interactions between nature and society in coastal areas, developing models to use biophysical and socio-economic data. On the bases of that study the publication "Project Alencoast" was prepared. In addition, changes in land cover and land use in the Odra catchment were documented and analysed in collaboration with the Natural Hazards Project. The changes were interpreted, taking into account the socio-economic situation at the periods of the inventories.



▲ Web dissemination of meteorological data.

JRC-SAI has developed an extensive database of daily meteorological data for its activity on crop monitoring and yield forecasting. This unique database, covering 25 years, is often requested by different users in- and outside the Commission. In particular, the development of various land management policies (agriculture and rural development, environment, civil protection) requires standard (agro-) meteorological products for EC programmes as well as for national or regional administrations. As the GI&GIS project has the mandate to harmonise and ensure interoperability of European databases describing fundamental JRC meteo data, to query data through a simple interface and to produce "on the fly" maps or tables to download. At the present the prototype is being used by Eurostat.

Based on the experience with this application, the objective is to develop a structured Internet GeoData server to easily access various pan-European geographic databases and to contribute to the EC geo-referenced databases, using GISCO as an entry point for providing geographic data to the services of the Commission.

On a more general term, continuous discussions take place between the JRC-SAI and the European Meteorological community to establish collaborations as well as for contributing to the debate on the distribution of meteorological products in Europe.

The increasing public concern about the state of the environment and the effect of human activities thereupon call for appropriate actions to be taken. Required are the assessment of environmental conditions, investigations into detrimental effects of human activities and the provision of guidelines in support of protective measures. The processes to be observed and the parameters to be assessed are mainly related to the hydrological cycle. Hence, the suitable entity to perform agri-environmental studies is the catchment.

The development of a Catchment-based Information System (CIS) was initiated in 1998 with the aim of addressing the consequential impact of agricultural activities on environmental conditions. The principal methodological approach of the CIS is based on the arrangement of catchments and sub-catchments in a functional hierarchical system, the design and implementation of an integrated data structure and management system, and the development of CIS applications. The CIS catchments consist of five hierarchical layers, which differ in size and spatial cover. The first three levels completely cover the area of interest and are mainly used for assessing the impact of European Union policies and for supporting environmental protection measures. Primary European catchments and sub-catchments of 1000 km² nominal size were made available to Eurostat to be included in the GISCO database. The lower levels define a set of sample catchments and focus on monitoring activities and detailed analyses of environmental conditions.

A study demonstrated that re-mapping statistical data from NUTS regions to catchments poses some technical challenges, which can, however, be overcome with existing tools. Less apparent is the choice of the transfer method to be used. The simple weighted areal method is fast, requires no additional data and provides consistent and repeatable results. Using ancillary data could potentially improve the identification of problematic areas. Nevertheless, it requires additional information and, in particular, local expertise on how this information can be translated into a transfer function.

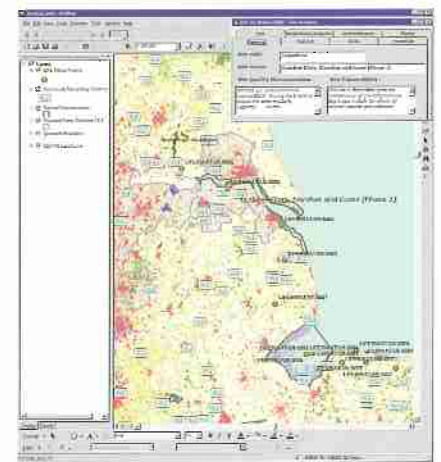
Natura2000 is the cornerstone of the European Union Nature Conservation Policy, involving the creation of a network of sites designated at European level in order to protect rare and endangered species and natural habitats. The creation of this network requires the integration of existing designated sites with proposals from Member States in order to define a Community List of sites, which should be finalised by 2004. The GI&GIS project is tasked with providing support to Directorate General Environment in order to create a GIS for Natura2000 which is scheduled for completion at the end of 2001.

Natura2000 has two basic data collections – the map archive and the alphanumeric database. A priority activity is to integrate these two discrete systems into a single spatial database. The Natura2000 alphanumeric database contains several elements of explicit spatial information (site centroid, area), as well as implicit spatial information (relationship to NUTS administrative regions, altitude, relationship to CORINE biotopes, relationship to other Natura2000 sites etc). Often, when the digital site boundaries are analysed, anomalies are detected between these spatial data and the alphanumeric database. An initial analysis has been performed of the types of anomalies that could be detected, which led to the specification and development of a software tool, called "GISVAL", to automatically process the sites. Any anomalies between the validation database and the Natura2000 database can then be used as the basis for reporting back to the Member States in order to resolve them.

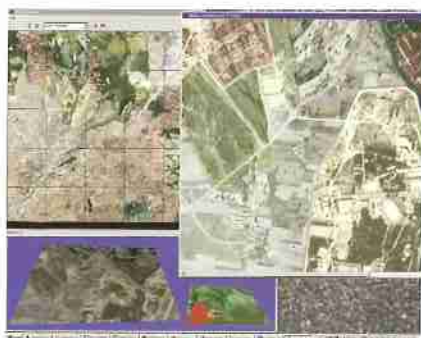
The second phase of the project has now been initiated, focussing on applications. Initial reviews of user requirements indicate a high priority to develop simple GIS applications that allow rapid identification of sites, and the presentation of their geographical context and the thematic information (habitats, species, etc.) contained in the database.



European catchments (5000 km² nominal size).



GIS for Natura2000.



3-D visualisation of geospatial data sets.

Spatial Analysis, Integrated Assessment, and Visualisation

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, and the enlargement process. Integrated policies cannot exist without a territorial reference.

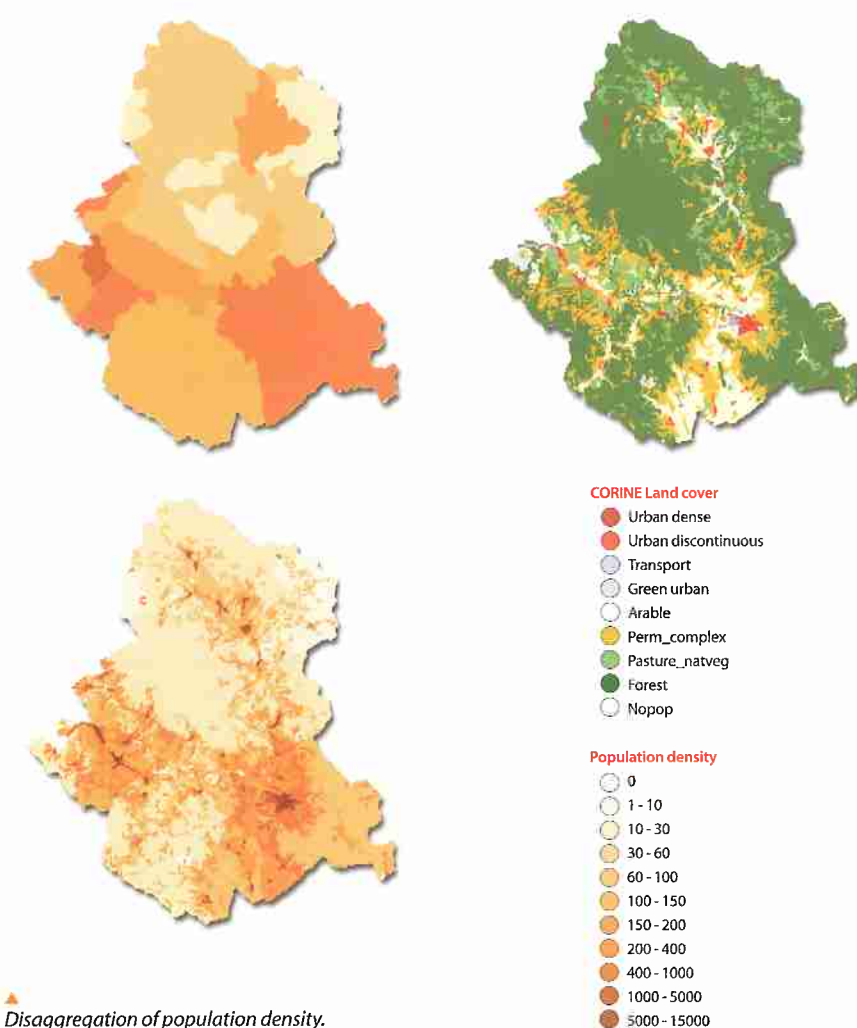
Statistical data are generally available for administrative regions at a certain aggregation level. For many applications, data with this aggregation level is insufficient for analysis, for instance in studies on the environmental impact of agriculture (fertilisers and pesticides pollution). A similar problem exists with other types of statistical data. Users often do not have access to the individual statistical measurements because of confidentiality issues; still a reasonable geographic distribution can be obtained through a disaggregation procedure of official statistics if suitable georeferenced ancillary information can be integrated. To overcome these problems, a modified areal weighting procedure has been developed in the GI&GIS Project and applied to the particular case of combining population data by commune with CORINE Land Cover. This problem had been previously tackled by the EEA, with subjectively selected coefficients. The procedure uses EEA coefficients as a starting point and improves them with an iterative algorithm based on objective criteria.

The quality of CORINE Land Cover can be assessed for specific sites where a more detailed land cover map with a compatible nomenclature is available. A confusion matrix obtained by simple overlay of both land cover maps gives a strongly biased impression because of the effects of co-location tolerance, different scales and thematic disagreement. A method to isolate the thematic disagreement component has been defined and applied for a test site in Arezzo (Italy) where a more detailed land cover map is used as pseudo ground truth. The result indicates that for this test site CORINE Land Cover essentially respects its specifications and the quality announced. Some potential interpretation problems have been detected and analysed.

Applications for the Catchment Information System (CIS, see above) were developed in two principal phases. During the initial phase, applications were implemented in the form of pilot studies. The second phase consists of the implementation of ensuing CIS applications in response to specific customer demands. One application study performed for Directorate General Environment was the estimation of nitrogen in animal manure by sub-catchment. The task required transferring statistics available in tabular format at NUTS units to spatial layers. The relatively coarse spatial resolution of the NUTS units was improved by using ancillary information derived from the CORINE Land Cover data set.

In the Fifth Framework Programme, the JRC has several projects in various Institutes dealing with Agri-Environmental activities. The Programme Directorate required that these activities were grouped in a Cluster to generate synergies, to strengthen the technical support to the Commission and to improve JRC's visibility by networking with multi-disciplinary research organisations. The GI&GIS project provides the Cluster with spatial modelling tools such as assessing the impact of agricultural activities on the environment (for instance, the estimation of nitrate leaching) and the consequences of the induced environmental changes on natural resources (for example, soil erosion). Furthermore, GI&GIS staff participate in the preparation of the Commission Communication on "Statistical Information Needs for Indicators of the Integration of Environmental concerns into the Common Agricultural Policy" in collaboration with Eurostat, DG AGRI, DG ENV and EEA, providing an in-depth analysis of capability of geo-spatial information for establishing relevant pan-European Agri-Environmental indicators.

In the subject of visualisation of GI in a dynamic 3-D environment, a prototype tool has been developed allowing for 3-D navigation around remotely sensed imagery, geographic data such as land use maps and the display of complementary statistical data. Based on freely available public domain open source software, the tool uses two steps: 1) Construction of the 3D model based on a Digital Terrain Model (DTM) of the area under study; 2) Texture mapping and creation of 2D and 3D views of the datasets. The functionalities of the tool include navigation in the 3D dataset, selection and zoom in/out of areas of interest both in 2D and 3D views, visualisation of statistical information through point interrogation, and can be implemented in order to provide visualisation services across the Internet.



Selected Further Reading

- Annoni A., C. Luzet (Eds.), 1999. "Spatial Reference Systems for Europe", Proceeding of the Spatial Reference Workshop, Marne-la-Vallée, 29-30 November, EUR 19575, (73 pp).
- Annoni A., M. Littlejohn, 2000. "The project GI&GIS a key action of the EC Joint Research Centre to support the creation of a European Geographic Information Infrastructure", 4th Global Spatial Data Infrastructure Conference "Engaging Emerging Economies", Cape Town-South Africa.
- Craglia M., A. Annoni, I. Masser (Eds.), 1999. "Geographic Information Policies in Europe: National and Regional Perspectives", Proceeding of the EUROGI-EC data policy workshop, Amersfoort 15 November, EUR 19522
- Craglia M., 2000. "Metadata: European needs and user perspectives," in: Proceedings 6th EC-GI&GIS Workshop. Lyon: 28-30 June.
- Christensen S., V. Perdigão, S. Annoni, 2000. "Evaluation of Landsat 7 Panchromatic and ETM+ multispectral for updating of CORINE Land Cover" Procs. ASITA Conference, Genova, 3-6 October.
- European Commission, 2000. Proceedings 6th EC-GI&GIS Workshop. Lyon: 28-30 June.
- Frank A.U., M. Raubal, M. van der Vlugt (Eds.), "Panel-GI Compendium - a guide to GI and GIS". Vienna: Geo-Info Series No. 21. EUR 19630 EN, 2000. 142 pp.
- Gallego F.J., 2000, Disaggregating official statistics with ancillary georeferenced information. Methodological issues in official statistics, Stockholm, 12-13 October 2000.
- Lourenco N., at all., 2000. Land Use Changes: methodological approach to understand the interactions nature/society in coastal areas (Alencocast), EUR 19592 En.
- Meyer-Roux, J. (1998) A Catchment-based Information System. *Third SAI Annual Users Meeting, 19-20.05.1998*, Baveno, Italy. 6pp.
- Perdigao V., S. Christensen (Eds.), 2000. LACOAST Atlas: Land Cover Changes in European Coastal Zones, S.P.I. 00.39.
- Smits P.C., A. Annoni, 2000. "Towards specification-driven change-detection," IEEE Trans. Geoscience and Remote Sensing, 38 (3), p. 1484.
- Smits P.C., 2000. "IEEE Geoscience and Remote Sensing Society's Data Fusion Technical Committee - Technical Committee Report", IEEE Geosc. Remote Sensing Newsletter, Issue 116, pp. 13-14.
- Steenmans C., V. Perdigao, 1999. "CLC2000 - emerging needs for a standard European reference system", In: Proceeding of the Spatial Reference Workshop, EUR 19575, (73 pp).
- Steenmans C., V. Perdigao, 2000. "Update of the CORINE Land Cover database (I&CLC2000)", In: Proceedings of Workshop on Land Use, Eurostat.
- Terres J.M., D. Al Khudhairi, 2000. Possible contributions by JRC to meet the needs of the Commission on Agri-Environmental Indicators. Report EUR 19639 EN. 18p.
- Terres J.M., 2000. Agri-Environment Cluster. Progress report (October 1999 - September 2000). Report EUR 19660 EN. 31p.

Annex

Contact List

Winter Rudolf

Director
rudolf.winter@jrc.it
Tel.: +39 0332 789765
Fax: +39 0332 789536

Meyer-Roux Jean

Deputy Director and
Head of EGEO Unit
jean.meyer-roux@jrc.it
Tel.: +39 0332 789514
Fax: +39 0332 785230

Aschbacher Josef

Scientific Assistant to
the Director
josef.aschbacher@jrc.it
Tel.: +39 0332 785968
Fax: +39 0332 789536

Crandon Raymond

Assistant for Project and
Quality Management
raymond.crandon@jrc.it
Tel.: +39 0332 789828
Fax: +39 0332 785988

Jerabek Albert

Head of MSU
albert.jerabek@jrc.it
Tel.: +39 0332 786395
Fax: +39 0332 785988

Sieber Alois J.

Head of TDP Unit
alois.sieber@jrc.it
Tel.: +39 0332 789089
Fax: +39 0332 785469

Belward Alan S.

Head of GVM Unit
alan.belward@jrc.it
Tel.: +39 0332 789298
Fax: +39 0332 789073

Schlittenhardt Peter

Head of ME Unit
peter.schlittenhardt@jrc.it
Tel.: +39 0332 789415
Fax: +39 0332 789034

Churchill Peter N.

Head of SSSA Unit
peter.churchill@jrc.it
Tel.: +39 0332 785031
Fax: +39 0332 785461

Auteri Davide

Insitute Systems Manager
davide.auteri@jrc.it
Tel.: +39 0332 789906
Fax: +39 0332 785461

Karamali Lia

Editor
lia.karamali@jrc.it
Tel.: +39 0332 786337
Fax: +39 0332 786369

Achard Frédéric

GVM Unit
frederic.achard@jrc.it
Tel.: +39 0332 785545
Fax: +39 0332 789960

Amsellem Michel

EGEO Unit
michel.amsellem@jrc.it
Tel.: +39 0332 785048
Fax: +39 0332 789074

Annoni Alessandro

EGEO Unit
alessandro.annoni@jrc.it
Tel.: +39 0332 786166
Fax: +39 0332 789936

Åstrand Pär-Johan

ARIS Unit
par-johan.astrand@jrc.it
Tel.: +39 0332 786215
Fax: +39 0332 789029

Barale Vittorio

ME Unit
vittorio.barale@jrc.it
Tel.: +39 0332 789274
Fax: +39 0332 789034

Barbosa Paulo

EGEO Unit
paulo.barbosa@jrc.it
Tel.: +39 0332 786334
Fax: +39 0332 785500

Bartalev Sergey

GVM Unit
sergey.bartalev@jrc.it
Tel.: +39 0332 786396
Fax: +39 0332 789073

Bartholomé Etienne

GVM Unit
etienne.bartholome@jrc.it
Tel.: +39 0332 789908
Fax: +39 0332 789073

Berthon Jean-Francois

ME Unit
jean-francois.berthon@jrc.it
Tel.: +39 0332 789934
Fax: +39 0332 789034

Bulgarelli Barbara

ME Unit
jean-francois.berthon@jrc.it
Tel.: +39 0332 789934
Fax: +39 0332 789034

Carmona-Moreno César

GVM Unit
cesar.carmona-moreno@jrc.it
Tel.: +39 0332 789654
Fax: +39 0332 789073

Casartelli Sara

ME Unit
sara.casartelli@jrc.it
Tel.: +39 0332 789095
Fax: +39 0332 789648

Christensen Susan

EGEO Unit
susan.christensen@jrc.it
Tel.: +39 0332 786013
Fax: +39 0332 789936

Costa Nina

SSSA Unit
nina.costa@jrc.it
Tel.: +39 0332 786324
Fax: +39 0332 785461

Dallemand Jean-François

EGEO Unit
jf.dallemand@jrc.it
Tel.: +39 0332 789937
Fax: +39 0332 789936

Dean John

TDP Unit
john.dean@jrc.it
Tel.: +39 0332 789407
Fax: +39 0332 785469

De Grandi Gianfranco

GVM Unit
giafranco.degrandi@jrc.it
Tel.: +39 0332 789823
Fax: +39 0332 789073

De Jager Alfred

EGEO Unit
alfred.de-jager@jrc.it
Tel.: +39 0332 785760
Fax: +39 0332 789074

De Roo Ad

EGEO Unit
ad.de-roo@jrc.it
Tel.: +39 0332 786240
Fax: +39 0332 785500

Ehrlich Daniele

SSSA Unit
daniele.ehrlich@jrc.it
Tel.: +39 0332 789384
Fax: +39 0332 785461

Eleveld Marieke

ME Unit
eleveld.marieke@jrc.it
Tel.: +39 0332 789365
Fax: +39 0332 789648

Estreguil Christine

SSSA Unit
christine.estreguil@jrc.it
Tel.: +39 0332 785422
Fax: +39 0332 785461

Fullerton Karen

EGEO Unit
karen.fullerton@jrc.it
Tel.: +39 0332 789101
Fax: +39 0332 789803

Gimeno Meritxell

EGEO Unit
meritxell.gimeno@jrc.it
Tel.: +39 0332 786326
Fax: +39 0332 785500

Hervás Javier

EGEO Unit
javier.hervas@jrc.it
Tel.: +39 0332 785229
Fax: +39 0332 789469

Hubbard Neil

SSSA Unit
neil.hubbard@jrc.it
Tel.: +39 0332 785725
Fax: +39 0332 785461

Lemoine Guido

ARIS Unit
guido.lemoine@jrc.it
Tel.: +39 0332 786239
Fax: +39 0332 78 9029

Mayaux Philippe

GVM Unit
philippe.mayaux@jrc.it
Tel.: +39 0332 789706
Fax: +39 0332 789960

Meneses Rui

SSSA Unit
rui.meneses@jrc.it
Tel.: +39 0332 785224
Fax: +39 0332 785461

Eva Hugh

GVM Unit
hugh.eva@jrc.it
Tel.: +39 0332 785110
Fax: +39 0332 789960

Gallego Javier

EGEO Unit
gallego.javier@jrc.it
Tel.: +39 0332 785101
Fax: +39 0332 789936

Gobron Nadine

GVM Unit
nadine.gobron@jrc.it
Tel.: +39 0332 786338
Fax: +39 0332 789073

Hiederer Roland

EGEO Unit
roland.hiederer@jrc.it
Tel.: +39 0332 785798
Fax: +39 0332 789936

Kanellopoulos Ioannis

EGEO Unit
ioannis.kanellopoulos@jrc.it
Tel.: +39 0332 785115
Fax: +39 0332 789803

Léo Olivier

ARIS Unit
olivier.leo@jrc.it
Tel.: +39 0332 789474
Fax: +39 0332 789029

McCormick Niall

SSSA Unit
niall.mccormick@jrc.it
Tel.: +39 0332 789136
Fax: +39 0332 785461

Millot Michel

SSSA Unit
michel.millot@jrc.it
Tel.: +39 0332 786146
Fax: +39 0332 785461

Folving Sten

EGEO Unit
sten.folving@jrc.it
Tel.: +39 0332 785009
Fax: +39 0332 789469

Garcia-Gorriz Elisa

ME Unit
elisa.garcia-gorriz@jrc.it
Tel.: +39 0332 786268
Fax: +39 0332 789034

Gouweleeuw Ben

EGEO Unit
ben.gouweleeuw@jrc.it
Tel.: +39 0332 785589
Fax: +39 0332 785500

Hoepffner Nicolas

ME Unit
nicolas.hoepffner@jrc.it
Tel.: +39 0332 789873
Fax: +39 0332 789034

Ketselidis Michalis

SSSA Unit
michalis.ketselidis@jrc.it
Tel.: +39 0332 789552
Fax: +39 0332 785461

Libertà Giorgio

EGEO Unit
giorgio.liberta@jrc.it
Tel.: +39 0332 785309
Fax: +39 0332 789074

Mehl Wolfgang

EGEO Unit
wolfgang.mehl@jrc.it
Tel.: +39 0332 789072
Fax: +39 0332 789469

Mollicone Danilo

GVM Unit
danilo.mollicone@jrc.it
Tel.: +39 0332 786298
Fax: +39 0332 789073

Fromberg Alan

SSSA Unit
alan.fromberg@jrc.it
Tel.: +39 0332 785809
Fax: +39 0332 785461

Genovese Giampiero

ARIS Unit
giampiero.genovese@jrc.it
Tel.: +39 0332 785260
Fax: +39 0332 789029

Grégoire Jean-Marie

GVM Unit
jean-marie.gregoire@jrc.it
Tel.: +39 0332 789215
Fax: +39 0332 789073

Hosgood Brian

TDP Unit
brian.hosgood@jrc.it
Tel.: +39 0332 789195
Fax: +39 0332 785469

Lavalle Carlo

SSSA Unit
carlo.lavalle@jrc.it
Tel.: +39 0332 785231
Fax: +39 0332 785461

Martin Jolyon

SSSA Unit
martin.jolyon@jrc.it
Tel.: +39 0332 786431
Fax: +39 0332 785461

Mélin Frédéric

GVM Unit
frederic.melin@jrc.it
Tel.: +39 0332 785627
Fax: +39 0332 789034

Montanarella Luca

ARIS Unit
luca.montanarella@jrc.it
Tel.: +39 0332 785349
Fax: +39 0332 789936

Munro Alison

EGEO Unit
alison.munro@jrc.it
Tel.: +39 0332 789331
Fax: +39 0332 789469

Nykjaer Leo

ME Unit
leo.nykjaer@jrc.it
Tel.: +39 0332 789715
Fax: +39 0332 789034

Pavlakis Petros

TDP Unit
petros.pavlakis@jrc.it
Tel.: +39 0332 785105
Fax: +39 0332 785469

Pinnock Simon

GVM Unit
simon.pinnock@jrc.it
Tel.: +39 0332 785608
Fax: +39 0332 789073

Schmuck Guido

EGEO Unit
guido.schmuck@jrc.it
Tel.: +39 0332 785313
Fax: +39 0332 785230

Smits Paul

EGEO Unit
paul.smits@jrc.it
Tel.: +39 0332 786336
Fax: +39 0332 789936

Tarchi Dario

TDP Unit
dario.tarchi@jrc.it
Tel.: +39 0332 785143
Fax: +39 0332 785772

Verstraete Michel

GVM Unit
michelverstraete@jrc.it
Tel.: +39 0332 785507
Fax: +39 0332 789073

Napoli Aldo

EGEO Unit
aldo.napoli@jrc.it
Tel.: +39 0332 786326
Fax: +39 0332 789029

Odijk Martijn

EGEO Unit
martijn.odijk@jrc.it
Tel.: +39 0332 789409
Fax: +39 0332 789936

Peedell Stephen

EGEO Unit
stephen.peedell@jrc.it
Tel.: +39 0332 786153
Fax: +39 0332 789074

Pinty Bernard

GVM Unit
bernard.pinty@jrc.it
Tel.: +39 0332 786140
Fax: +39 0332 785461

Schrimpf Wolfram

ME Unit
wolfram.schrimpf@jrc.it
Tel.: +39 0332 785352
Fax: +39 0332 789648

Somma Giacomo

EGEO Unit
giacomo.somma@jrc.it
Tel.: +39 0332 789409
Fax: +39 0332 785500

Terres Jean-Michel

EGEO Unit
jm.terres@jrc.it
Tel.: +39 0332 785254
Fax: +39 0332 789936

Zibordi Giuseppe

ME Unit
giuseppe.zibordi@jrc.it
Tel.: +39 0332 785902
Fax: +39 0332 789034

Nègre Thierry

ARIS Unit
thierry.negre@jrc.it
Tel.: +39 0332 786102
Fax: +39 0332 789936

Ouberdous Mohamed

ME Unit
mohamed.ouberdous@jrc.it
Tel.: +39 0332 789904
Fax: +39 0332 789034

Perdigão Vanda

EGEO Unit
vanda.perdigao@jrc.it
Tel.: +39 0332 785052
Fax: +39 0332 789936

Richards Tim

GVM Unit
tim.richards@jrc.it
Tel.: +39 0332 789102
Fax: +39 0332 789960

Schumacher Nina

SSSA Unit
nina.schumacher@jrc.it
Tel.: +39 0332 785644
Fax: +39 0332 785461

Sommer Stefan

EGEO Unit
paul.smits@jrc.it
Tel.: +39 0332 786336
Fax: +39 0332 789936

Thielen Jutta

EGEO Unit
jutta.thielen@jrc.it
Tel.: +39 0332 785455
Fax: +39 0332 785500

Nesti Giuseppe

TDP Unit
giuseppe.nesti@jrc.it
Tel.: +39 0332 785922
Fax: +39 0332 785772

Pamela Kennedy

EGEO Unit
pamela.kennedy@jrc.it
Tel.: +39 0332 785978
Fax: +39 0332 789469

Pignatelli Francesco

SSSA Unit
francesco.pignatelli@jrc.it
Tel.: +39 0332 786319
Fax: +39 0332 785461

San Miguel Ayanz Jesùs

EGEO Unit
jesus.san-miguel@jrc.it
Tel.: +39 0332 786138
Fax: +39 0332 785500

Sebastian Ana

EGEO Unit
ana.sebastian@jrc.it
Tel.: +39 0332 786376
Fax: +39 0332 785500

Stibig Hans-Jürgen

GVM Unit
hans-juergen.stibig@jrc.it
Tel.: +39 0332 789513
Fax: +39 0332 789960

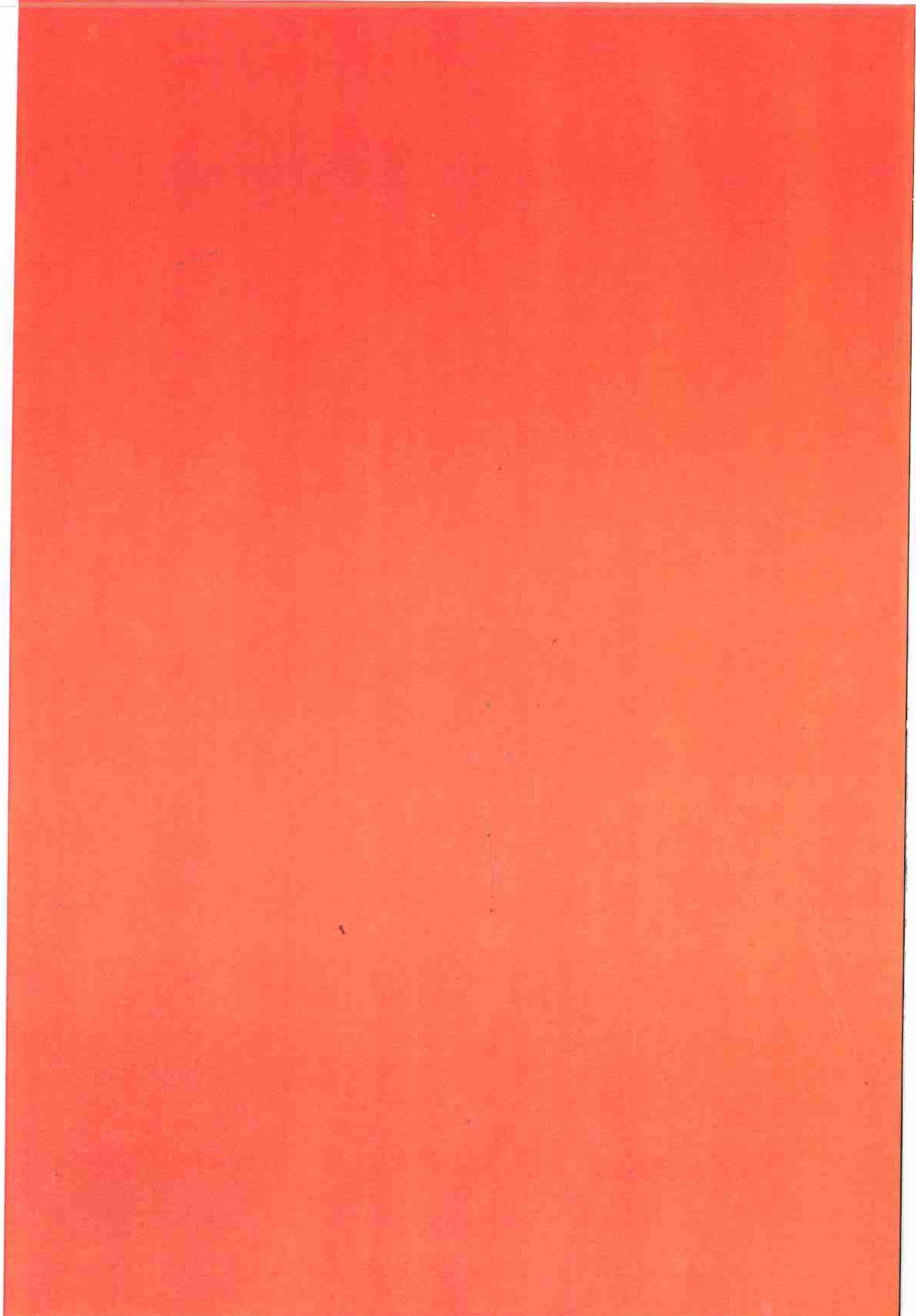
Verdebout Jean

SSSA Unit
jean.verdebout@jrc.it
Tel.: +39 0332 785034
Fax: +39 0332 785461

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