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Space Applications Institute

Annual Report 97

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Space Applications Institute

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EUROPEAN COMMISSION
Edith Cresson, *Member of the Commission responsible for research, innovation, training and youth*

Foreword

The Space Applications Institute (SAI) has the objective of the generation of relevant, timely and accurate information from remote sensing and space systems. The biosphere, lithosphere, atmosphere and hydrosphere are all considered in this context, with work ranging from research to applications of remote sensing.

The Institute's work is mainly driven by the Research & Technological development and Demonstration (RT&D) policy as seen in the Commission's framework programmes. However, the SAI's work responds to the information needs of the various DGs for non-framework programme policies. This has resulted in major projects dealing with forestry (see Chapter 1), agriculture (Chapter 2 describes our Monitoring of Agriculture with Remote Sensing project) and humanitarian de-mining (described in Chapter 7).

The Institute will increasingly focus its research in this way. Indeed our Centre for Earth Observation programme (CEO, Chapter 8) began a major activity in 1997 analyzing the information needs of the European Commission Services. This is consolidating into an activity in common with other European players where the SAI is carefully examining the customer pull that may be exerted by various EU policies, leading to new operational earth observation systems. In this respect we act as an informed "gateway" to elements of EU policy offering opportunities for development of new sensors & new systems.

In collaboration with partners throughout the Member States, the SAI participated in the EC's Shared Cost Actions, Concerted Actions and Competitive Support to the Commission, in addition to non-framework programme initiatives. In this way the SAI provided support to the Commission to a value of around nine million ECU through its work in some 40 individual projects.

Our commitment to education and training saw SAI staff organizing and presenting training courses both on site and at institutions throughout Europe. The SAI itself was host to more than 50 trainees, undergraduates, Doctorate students and Post Doctorate Fellows. Many of our students participated in the Second SAI Annual Users' Seminar, which took place in Baveno, Italy, in May. This provided an opportunity for many of our colleagues and associates throughout Europe to meet in an informal, yet informing atmosphere. The Institute's visibility in the world outside the Commission was underlined at this event, attended by more than 200 participants, and is a good reflection of our role as a partner in evolving European space activities. The success of the CEO Programme is an excellent illustration of this.

SAI has long recognized that earth observation derived information is at its most valuable when used with other sources of data. Furthermore, the Institute recognizes that the true value of any information is getting into the hands of those that need it in an efficient and easily manageable way. To this end the Institute is increasingly developing expertise in spatial information management. This involves increasing our effort in dealing with non-space data, but clearly relies on many of the skills needed for handling earth observation data. End-to-end information systems linking the raw data providers to the final information users are the objective.

In this light the Institute intends to place increasing emphasis on European and global level issues, where questions of environmental security arise and where there is considerable strategic importance. Follow up to the signing of the Kyoto Protocol on climate change is one example. This will lead to work in the coming years that not only concentrates on the derivation of information from earth observation systems, but also focuses on providing the complete spatial information systems required to profit and utilize this information.

This annual report presents the thematic activities in the SAI, and the results achieved. I believe that the work presented here shows the considerable value to be gained from exploiting Space for the benefit of Europe's policy makers, and I would like to thank the 205 staff, students and visitors who have helped make it possible.

Prof. Rudolf Winter
(Director)

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Structure of the SAI

The Directorate

Director
Rudolf Winter

Deputy Director
Jean Meyer-Roux

Scientific Assistant
Alan Belward

Head of Administration
Raymond Crandon

Agricultural Information Systems

Head: *Jean Meyer-Roux*

Monitoring agriculture, agri-environmental issues and natural hazards

Marine Environment

Head: *Peter Schlittenhardt*

Monitoring and modelling ocean and coastal zone environments

Environmental Mapping & Modelling

Head: *Jacques Mégier*

Natural resource and urban development monitoring in Europe and the Mediterranean

Advanced Techniques

Head: *Alois Sieber*

Derivation and application of physical & geophysical parameters from remotely sensed data

Centre for Earth Observation

Head: *Peter Churchill*

Promoting the application & availability of Earth Observation data, information & services in Europe

Monitoring Tropical Vegetation

Head ff: *Jean Meyer-Roux*

Improving our understanding of natural vegetation at regional, continental & global scales

SAI's 200 Staff, students and scientific visitors work in *six Units supported by the Directorate.*
Each Unit has a clear thematic/strategic focus.

SAI's objective is deriving *relevant timely and accurate, policy-relevant policy-sensitive* information from earth observation data sets. This is mainly driven by the information requirements of the *RT&D policy.* In addition, the SAI's work responds to the information needs of DGs for non-framework programme policies (e.g., *Agriculture, Regional Policies, Environmental Policy*). The Institute will increasingly focus research in this way.

1 Forestry

The work of SAI in the domain of forestry covers many diverse activities and geographical areas. In the tropical domain forest monitoring and biomass burning are performed primarily in the framework of the TREES (Tropical Ecosystem Environment observation by Satellite) and FIRE (Fire in global Resources and Environment monitoring) application projects respectively. In boreal, temperate and Mediterranean areas activities are carried out largely within the framework of the FIRS (Forest Information from Remote Sensing) Project.

Other activities include projects in support to the Eastern and Central European PHARE (Poland and Hungary: Aid for the Restructuring of Economies) Multi-Country Environment Programme and the UN-ECE/FAO FRA-2000 (United Nations Economic Commission for Europe/Food and Agricultural Organization - Forest Resource Assessment-2000).

1. Global Activities

The Terrestrial biosphere largely controls the cycling of materials (water, carbon and other substances) and energy within the Earth system at a variety of spatial and temporal scales. The study of global vegetation dynamics is therefore a prerequisite for the understanding of issues such as possible climate and environmental change, and their impact on our societies. Yet, many of the relevant processes (e.g., fire, conversion of forest to agriculture, urbanization) take place at local scales.

Specific research activities undertaken by SAI include mapping and monitoring of vegetation cover in general, with a special emphasis on tropical forests and biomass burning. The results of these activities are of value to a broad range of users, including environmental resource managers, space engineers, policy makers and the global change research community.

Tropical Forests

The TREES Project (Tropical Ecosystem Environment observation by Satellite) was initiated in 1991 with three main objectives:

- Development of techniques for global tropical forest inventory using AVHRR and ERS-1 as the main sources of data supplemented by high spatial resolution optical data (SPOT and Landsat).
- Development of techniques for the detection and monitoring of the active deforestation areas; measurement of deforestation rates in critical areas.
- Development of a comprehensive Tropical Forest Information System to support the modelling of tropical deforestation dynamics.

Current activities focus on supporting the development of a prototype for monitoring tropical rain forests at a pan-tropical scale. In the framework of the TREES-II Project, a group of experts met at the Joint Research Centre in Ispra on the 24th-25th November to collectively identify areas of current (active) and potential (future) deforestation in the tropical belt. The project needed to focus more on areas of active deforestation in order to:

- Refine its method of change detection and measurement;
- Achieve significant progress in explanatory and predictive modelling activities.

The experts from Europe and the three concerned continents had the task of locating areas of current or impending deforestation and characterizing the main drivers or forces behind its occurrence. The resulting "hot spot" map has been produced by continent. The 'hot spots' for South East Asia are shown in Figure 1.1.

The analysis of existing and updated data sets on tropical forest cover and its distribution has led to some new outputs. These are:

- The production of advanced versions of continental forest distribution maps for Africa, Central and South-America and Southeast Asia. The interface between continental fire maps and vegetation cover maps has provided a unique insight into the coincident distribution of these ecosystems' characteristics.

- The comparison of country-by-country forest cover statistics derived from the TREES Project with those acquired by the FAO, WRI and WCMC, shows that there is, in general, good agreement between all sources. It is possible to propose a range of estimates of closed tropical forest area that fits with most of the projects' results. The total area of closed tropical forest is estimated between 1,090 and 1,220 million hectares with the following continental distribution: 185 to 215 million hectares in Africa, 235 to 275 million hectares in Asia and 670 to 730 million hectares in America.

Research and development continued to feed the TREES Projects' core activities, with new advances in the combined analysis of fire distribution and vegetation cover, and in the use of radar imagery for improving the characterization of forest-non forest interfaces.

Links with General Directorates of the Commission have been further developed in the following ways:

1. The link between the Tropical Forest Information System (TFIS) and DG XI for data communication and exchange has been implemented. The Objective of the "Interface with DG XI" activity is to establish and operate a "remote node" of the TFIS in the DG XI/D4 Unit, Brussels. This system puts information produced by the TREES II project at the direct disposal of that service.
2. Collaboration has been initiated with the DG VIII-funded ECOFAC Programme for Central African countries, to provide information on protected areas and to monitor commercial logging.

Pilot projects are being identified and negotiated with Zaire, with Vietnam and the Mekong River Commission for Asia and with the EC Delegation and INPE for Brazil.

Collaboration with the FAO/UN-ECE Global Forest Resources Assessment-2000 (FRA-2000) project has been initiated for the design phase of the FRA 2000 Project, on the following aspects:

i) Forest fragmentation indices and fire distribution as indicators of deforestation;
ii) Criteria for stratification of hot spot areas;
iii) Analysis of high resolution sample sites.

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

Radar remote sensing activities in the tropical domain have continued along three major lines in 1997. These are, large-scale mapping of the tropical forest, studying the evolution of ecosystems over time and radar polarimetry applied to topography. The trend has been to move away from pure research and development to more operational projects, such as:

1. The GRFM (Global Rain Forest Mapping) Africa Project. This is an international project sponsored by the Japanese Space Agency (NASDA). The part, for which SAI is in charge, reached an important milestone in 1997. Major results were presented at the mid-term Principal Investigators' meeting at the Jet Propulsion Laboratory, Pasadena. They are:

   - Production of first regional scale forest classification of West Africa, derived from radar data (Figure 1.2);
   - Processing of over 1000 SAR images, which will be assembled into mosaics of Central Africa.

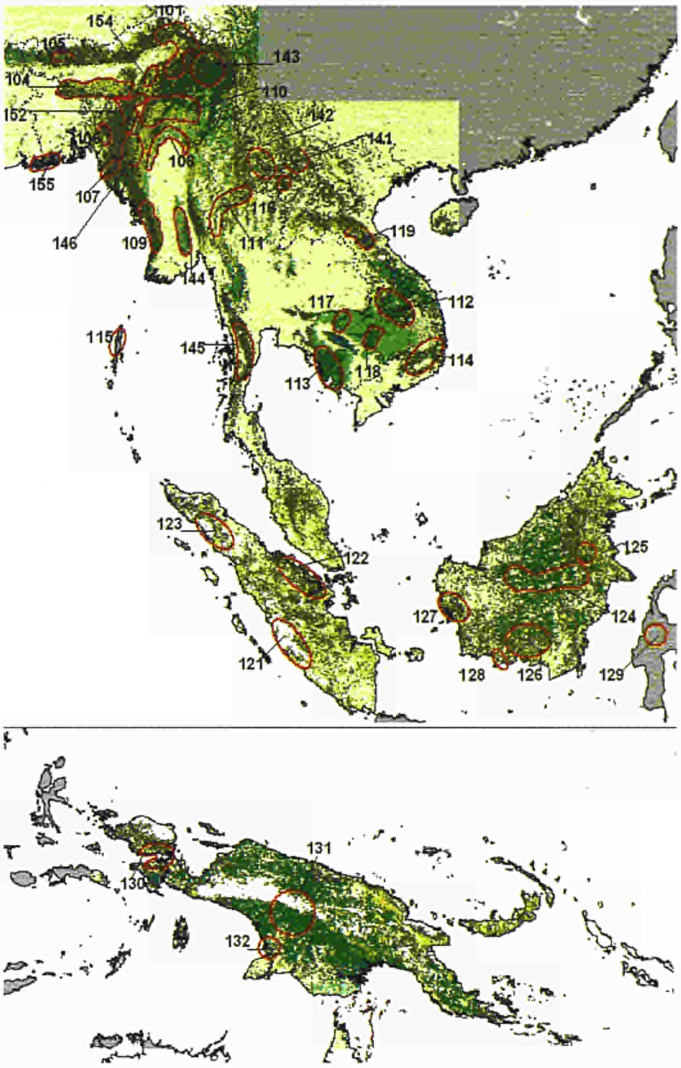

Figure 1.1: Areas of current or impending deforestation located on the TREES forest map for South East Asia. The areas marked in red represent the "hot spots" of deforestation as identified by a group of experts following the methodology described in Achard et al., (in print). The numbers represent the reference system used for the entire tropical belt.

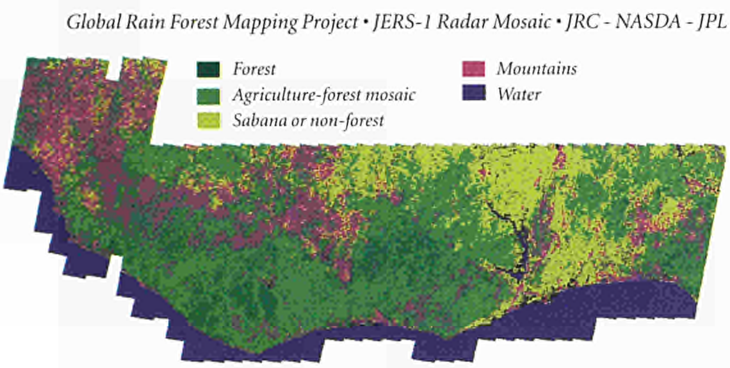

Figure 1.2: Regional scale forest classification map using JERS-SAR data for West Africa

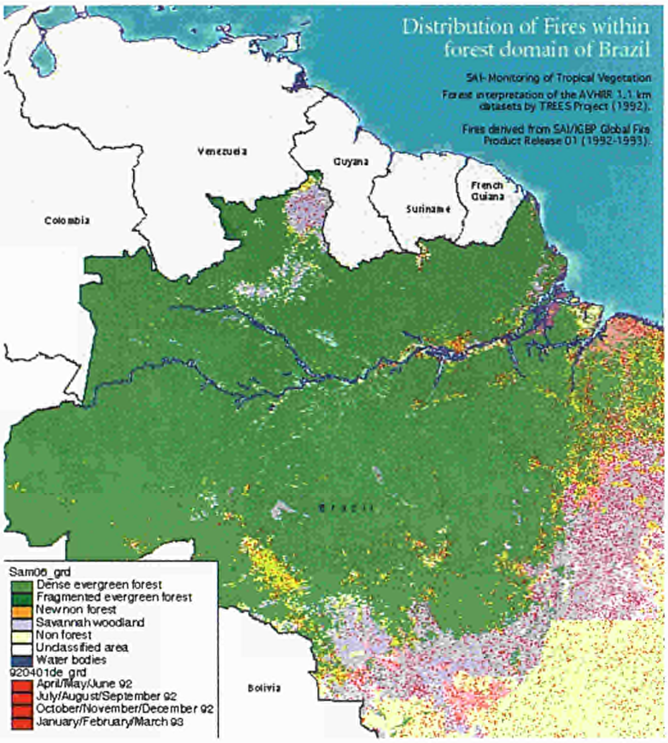

Figure 1.3: Distribution of vegetation fires within the forest domain of Brazil

2. The CAMP (Central Africa Mosaic) thematic interpretation network has been established. This is a framework to coordinate thematic projects based on the multi-temporal continental scale ERS-1 SAR data set assembled by the SAI in 1995. Several projects have been started in collaboration with European and African partners, on themes such as deforestation assessment, geological prospecting, and wetland mapping.

There is an overall consensus in the international geoscience community stating that projects like GRFM and CAMP constitute a landmark in applied radar remote sensing and that they offer a new approach for utilizing remote sensing for environmental monitoring. It is likely that these radar data sets will constitute the foundations for a very rich research and development agenda for many years to come.

Biomass Burning Monitoring

Within the framework of the FIRE Project, a single standardized fire detection methodology, based on space observations from a global 1 km AVHRR data set has been used for the first time. This has enabled the detection and monitoring (on a daily basis) of the occurrence of fires in vegetation communities for the entire globe over a 21-month period. The distribution of fires identified in the forest domain in Brazil is shown in Figure 1.3.

The identification of regions on the Earth subject to burning, and the tracking of so-called "fire calendars" or periods in which burning occurs are just two of the types of information which can be extracted from such a database. Classification of the fire patterns has been undertaken for the main types of vegetation cover at the global scale. Such information is of high value for studying issues related to atmospheric chemistry (e.g., for modelling emission sources of trace gases and the impact of aerosols on the atmospheric radiation budget) and for analyzing the role of fire in land cover dynamics particularly in forested regions. More information can be found on:

http://www.mtv.sai.jrc.it/projects/fire/gfp

To complement the activity on active fire monitoring, a burned area map for the entire African continent has been produced for a 1-year period. This result, if combined with maps of standing biomass, will undoubtedly contribute to the improved understanding of the role of vegetation fires in the emission of greenhouse gases, other trace gases and aerosols into the atmosphere.

A fully integrated software package, dedicated to the monitoring of fires using AVHRR data, has been developed and tested in Vietnam, and made available to a Vietnamese institution. The system, called PANAIS (Processor Adapted to NOAA-AVHRR Acquired *In-Situ*), will offer the possibility of monitoring forest fires at a national level, in support to the management of forest resources.

Future plans for the biomass burning related activities will focus on the design and implementation of the World-Fire-Web Project. This new project is based on a distributed processing network, Internet-based, for the derivation, (in near real-time), of global active fire occurrence maps from AVHRR data. In

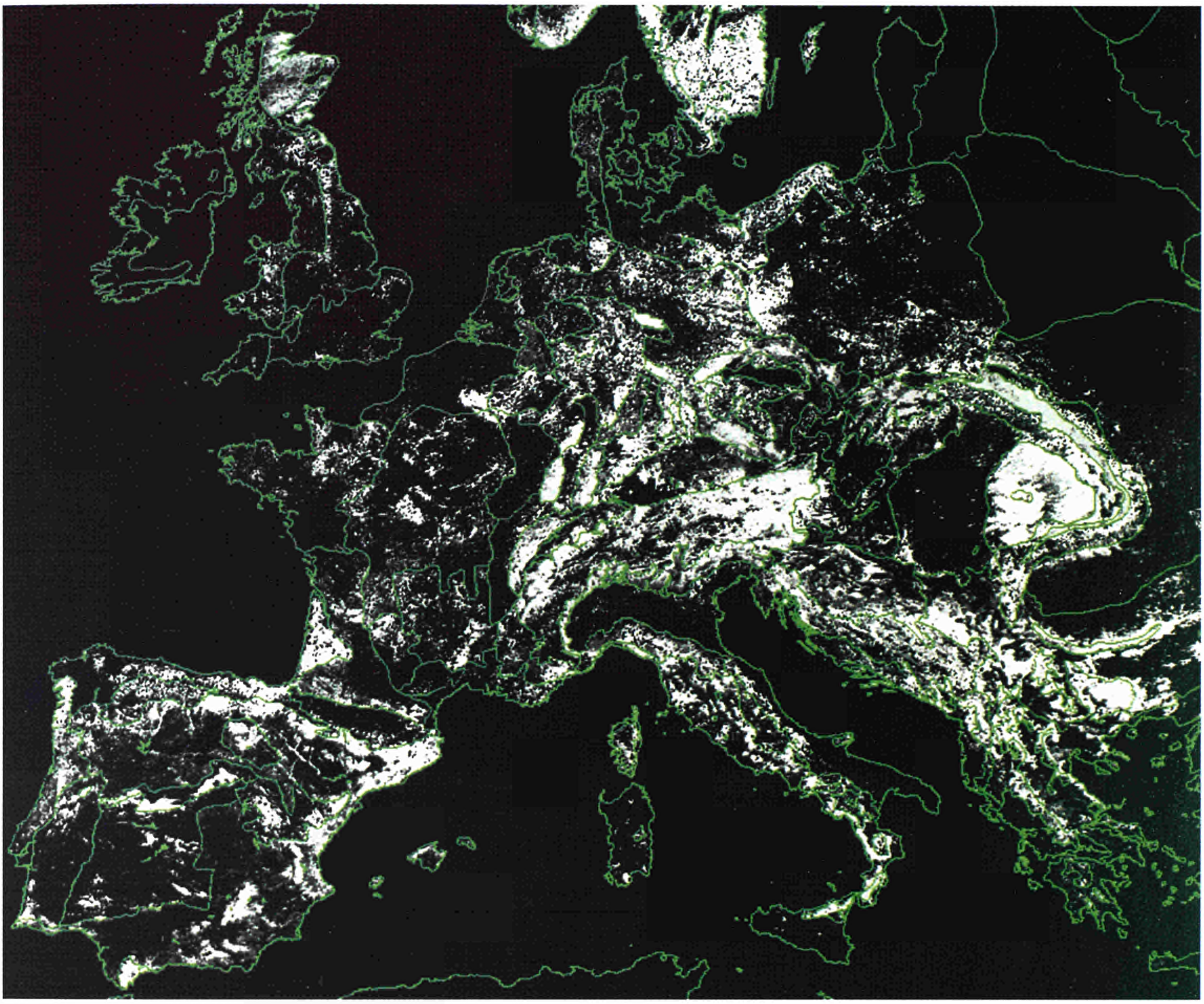

Figure 1.4: Forest Map of Europe from NOAA-AVHRR data. Grey levels are proportional to percentage forest coverage (white=100% coverage)

particular emphasis will be put on the mapping of burned areas and fire scars using Synthetic Aperture Radar (SAR) imagery from the ERS and JERS platforms.

http://www.mtv.sai.jrc.it/projects/fire/wfw/fact_sheet.html

2. Pan-European

The FIRS Project

The FIRS (Forest Information from Remote Sensing) Project was launched in 1994. The Project was originally divided into two main parts, three Foundation Actions and six Application Themes. Although Foundation Actions 1 and 2 were completed in 1995 and 1996 respectively, the results are continuously being fed into all of the ongoing thematic applications. Due to the nature of Foundation Action 3, *i.e.*, the compilation of a geo-referenced database, items are being added all the time, and it therefore remains as an ongoing action.

Currently, emphasis is being placed on the Themes of Forest Mapping (Figure 1.4), Forest Statistics and Forest Monitoring (including afforestation), in combination with Forest Change. The six forest and forest-related variables which are currently the foci of research are: forest area, area of other wooded land (OWL), structure and composition of forest and OWL, volume and biomass estimation, biodiversity and environmental indicators.

SAI's forest activities in Europe are being coordinated by the FIRS project. This role varies in each activity as described below:

1. The FIRS Project assisted DG VI FII.2 with the preparation of the Invitation to Tender for the study on "The Application of

Remote Sensing Changes in Forest Lands" launched on 1st January 1997 for a period of 18 months. The FIRS Project provides scientific and technical advice within the Steering Committee throughout the duration of the study.

2. The FMERS (Forest Monitoring in Europe with Remote Sensing) Project, funded by the CEO was started in September 1997 and will run for a 12-month period (see Chapter 8). It deals with the utilization of remote sensing data for mapping and monitoring of forests at a European scale. The technical management of the project is being undertaken by the FIRS Project. The results and products will contribute to long-term Commission forestry strategies.

3. The MERA (MARS and Environmental Related Activities) Project is funded by DG I under the PHARE Multi-Country Environment Programme. The sub-projects on Forest Ecosystems Mapping and Land Degradation Mapping have been co-ordinated by the FIRS Project. Foundation Actions 1 and 2 were implemented at a national scale in Eastern and Central Europe. Satellite-based forest maps and digital databases, describing both the environmental conditions (e.g., forest type, health, biodiversity) and production characteristics (e.g., tree species, age, growth rate) have been produced for the PHARE countries. Products include small-scale (1:500,000) maps showing the major forest regions and strata, and medium-scale (1:100,000) forest maps of representative test areas. Software for parcel-based forest classification (SILVICS), developed within the FIRS Project, was installed and demonstrated in Hungary, Poland and Rumania.

Results from FMERS, PHARE-MERA and the DG VI study will all assist in evaluating the full potential of satellite remote sensing, GIS and new technologies for the provision of standardized statistical and geo-referenced forest information in Europe. Such an evaluation will contribute to the DGVI EFICS Programme, and assist in meeting the needs of international agreements, such as the resolutions of the Helsinki Ministerial Conference on the protection of Forests in Europe.

Since 1995, the FIRS Project has also been involved in the planning phases of the FAO/UN-ECE FRA-2000 (Global Forest Resource Assessment-2000) and the UN-ECE TBFRA-2000 (Temperate and Boreal Forest Assessment). Throughout 1995 and 1996 the FIRS Project led one of three Working Groups, *i.e.*, "Change Detection and New Methods" set up by the Team-of-Specialists to prepare for the year-2000 Temperate and Boreal Forest Resources Assessment. Subsequently, in 1996/97 the FIRS Project has participated in the preparations for FAO FRA-2000 Global Forest Resource Assessment.

The foci for the FIRS Project for the next three to four years will remain as forest mapping, monitoring and statistics in the Pan-European area. Grassland mapping and monitoring, and modelling of the dynamics of Eurasian ecosystems will be introduced as a new and complementary activity. New technologies will be investigated for the provision of standardized and up-to-date information for the six key forest variables. More emphasis will be placed on the integration of data from different sources to provide a digital forest database for Europe which would then directly serve the needs of EFICS, the UN-ECE/TBFRA-2000, and the follow up to the Helsinki Conference, *i.e.*, the "Helsinki Process".

More information about the activities of the FIRS Project can be found at:

http://shadow.jrc.it/firs/

Selected further reading

Tropical forests

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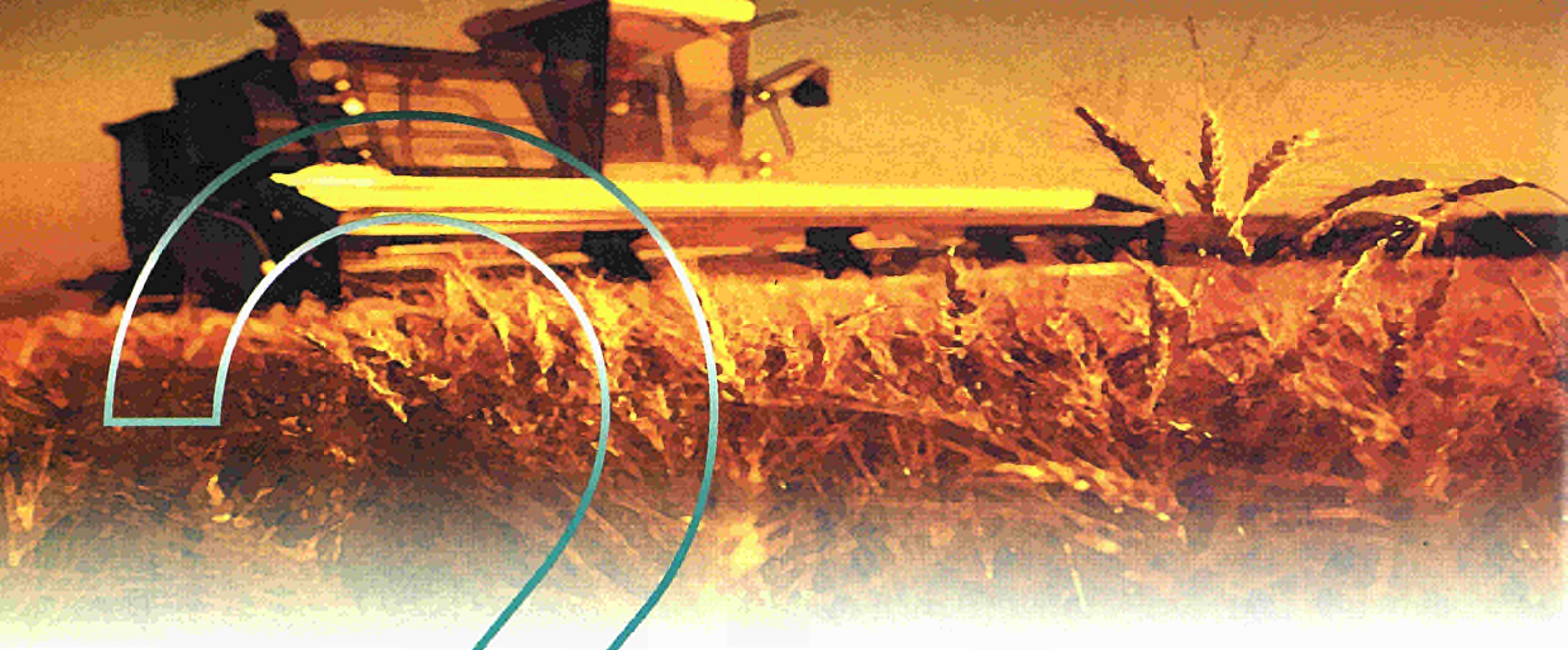


Agriculture

SAI's activities in the field of agriculture, have, over the past eight years been almost exclusively undertaken in Europe within the MARS (Monitoring Agriculture by Remote Sensing) Project, and focused on institutional support to the Commission, following an agreement with DGVI. The three main fields of expertise, which have developed and evolved over this period, are:

- Agricultural statistics using area-frame sampling and high resolution remote-sensing;
- Yield monitoring and prediction through crop growth models and meteorological satellite data;
- Controls of agricultural land use associated with the CAP.

In addition, vast databases (e.g., daily AVHRR data, Landsat-TM and SPOT scenes) have been created and archived. These are currently being valued and evaluated in terms of future commercial dissemination.

In 1997, activities have led to:

- the development of new axes towards more environmental activities and topics:
  - Natural hazards, such as flooding, forest fire, droughts, linked to land uses and meteorological conditions (Chapter 4);
  - Land cover and environment mapping: Characterization of the landscape and parcel patterns in rural areas;
  - Environmental statistics and definition of key indicators, linked to agriculture and land use;
  - Agri-environmental and CAP: definition, management, control/evaluation of the regulations linked to agriculture and environment: extensive cropping and pasture, re-afforestation, environmentally sound practices, etc.
- a diversification of the field of expertise:
  - SAR satellite data, as a complement or substitute for optical satellite data;
  - Digital photogrammetry (use of 1 m pixel ortho-photography), preparing the use of very high resolution satellite;
  - Parcel identification systems and cadastre, large scale mapping over rural areas;
  - Hydrology, water-basin management and erosion, linked to natural hazards, meteorology and land-use (see Chapter 4);

These developments have been towards re-orientating activities to the future horizon of 2000 and to realign priorities to those of the 5th Framework Programme. In the field of agriculture this will mean to comprehensively cover the information requirements and interactions between the environment and agriculture (*i.e.,* the so-called "agri-environment") in Europe.

More information about the activities described in the following sections can be found at:

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

1. Activities related to Agricultural Statistics

Estimation of crop area with remote sensing

High spatial resolution satellite images are, (as has been the case since the initial definition of the methodology for the MARS Project), combined with area frame sampling techniques. The experience acquired in agricultural statistics has proven to be invaluable for the application of the methodology to other environmental problems. Geographic extensions of the surveyed area are thus:

- National or sub-national: SAI is involved in several activities both inside and outside the EU, developing methods ("Activity A") that are much easier and cheaper to set up than previously existing procedures (for example the approach by the United States Department of Agriculture).
  Methodological studies are ongoing, such as the feasibility of diachronic regression estimators using ground surveys and the latest classified high resolution satellite images available, or the links between area frame surveys and CORINE Land Cover.

- The European Union: Operational rapid estimates of crop area change ("Activity B") are being produced for the European Commission (DG VI: Agriculture) on the basis of high resolution satellite images, ground surveys and expert reports on a sample of 60 sites of 40 km x 40 km. For each site, up to four satellite images are photo-interpreted and classified. The information is used to produce regular updates of crop area change estimates at the EU level during the agricultural year. The results are published in the MARS bulletin. Additional research ("Re-actB") points towards the improvement of the results and/or the reduction of the costs. Some studies try to optimize the sampling scheme (for example, through a higher number of smaller sites or using remote sensing to optimize point sampling inside each site) and to better integrate the use of SAR images or data from other sensors.

- Supra-continental: SAI is involved in the definition and the optimization of the sampling scheme for the temperate and boreal areas in the frame of the FAO/UN-ECE's TBFRA-2000.

Vegetation Monitoring

Low spatial resolution images, mainly NOAA-AVHRR, are used operationally to monitor the state of vegetation in Europe and to map areas of concern every ten days. Operational reception, archiving, and processing of data is made in Ispra and a monthly analysis is included in the MARS bulletin. The pre-processing software (SPACE, under UNIX) has been upgraded through a collaboration with OSS (Observatoire du Sahara et du Sahel), and a PC version has been developed. An evaluation of NOAA and METEOSAT data for quantitative estimation of crop yields in the MARS project is underway in the MARIE-C (Monitoring and Assessment of Resources in Europe - Crops) Project.

The VEGETATION instrument on-board SPOT 4 (to be launched in 1998) will be a major advance in the field of low spatial resolution sensors. In order to take full advantage of the new VEGETATION data, a new SPACE-VEGETATION pre-processing software will be developed. In addition, the inter-calibration of the VEGETATION-based and NOAA-based vegetation indices will be performed to ensure continuity between the two sources of data.

Radar applications

In 1997, a second pilot project on the use of ERS-SAR data for the generation of crop area estimates in winter and spring demonstrated the operational use of these data in Activity B. Approximately 300 SAR images were analyzed using similar methodologies to those used for the optical data.

The use of extended ERS-SAR series is currently being tested in a research project that focuses on the estimation of crop parameters for cereals. In this project, synergy with optical sensors and ancillary data is a central theme. High resolution RADARSAT data have recently become available and are also being investigated.

Investigations are currently underway to evaluate if very low spatial resolution active microwave sensors (e.g., the ERS Scatterometer) could be used to improve crop yield forecasts and timely drought warnings at regional to continental scales. Based on previous research done at the European Space Agency (ESA) an algorithm for the estimation of the soil water content in the upper soil layer was developed. Validation using actual soil moisture measurements is being carried out in the Ukraine.

2. *Yield Monitoring and Prediction through Crop Growth Models and Meteorological data*

CGMS (Crop Growth Monitoring System) is an operational yield forecasting system developed by the SAI, covering the main European crops. Further improvements are now coming from calibrations of the crop calendar, enlarging the daily meteorological parameters archive database, refinement of soil parameters and completion of the "Knowledge Base System". A sensitivity analysis has helped to identify input parameters having a major influence on outputs.

The application of CGMS is being extended both:

- Thematically - to grasslands or permanents crops like Olive-trees and Vineyards;
- Geographically - to Central and Eastern European countries (including Russia), the Maghreb and Turkey.

Vine and Olive yield forecasts in Europe

The "OLIWIN" project, founded by DGVI-A-2, is aimed at assessing vine and olive yields over Europe, with the use of agro-meteorological data. The method is based on water balance models comparing plant water requirements to soil water availability. Meteorological data, soil water capacity, plant phenology and water requirements are taken into account through the use of European geographic databases.

During 1997, the model has been implemented over the Mediterranean basin (France, Italy, Spain, Portugal, Italy) and calibrated and validated over the last 20 years (1975-1995) by comparing figures with official regional yields. Figure 2.1 illustrates the highest regional correlation coefficient between vine yield and either model outputs or observed meteorological variables. It confirms that the water balance approach has potential for vine yield assessment. In a second phase (1998), the project plans are: (i) to continue model calibration; (ii) to improve the model (especially taking into account frost damage

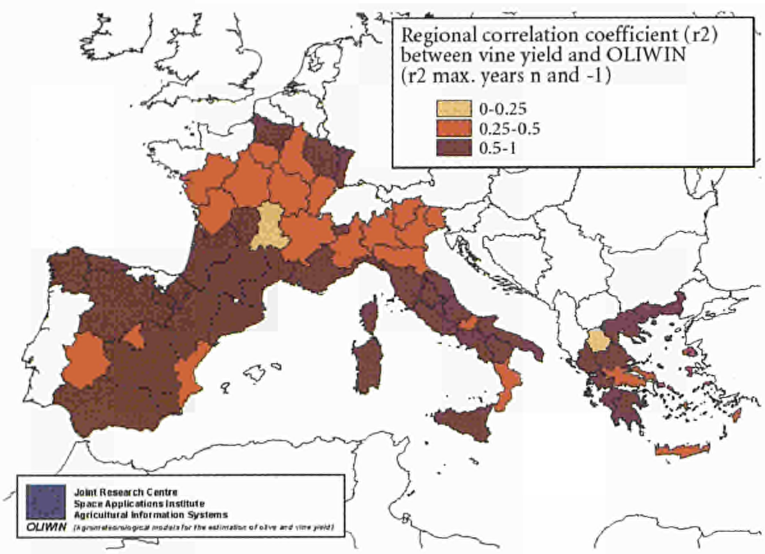


Figure 2.1: Regional correlation coefficient (r^2) between vine yield and OLIWIN

or other meteorological incidents having important consequences); (iii) to extend geographically to East of Europe and North of Africa.

Advanced agricultural information systems

The MARS bulletin integrates information from crop area estimates, vegetation monitoring (with low spatial resolution images), agro-meteorological models and inputs from other sources, including information from national bodies. It has been published seven times during the agricultural campaign of February to November 1997. It provides an overall outlook of agriculture, (mainly in the EU), but also has given indications in Central and Eastern Europe, Turkey and the Maghreb, (Figure 2.2).

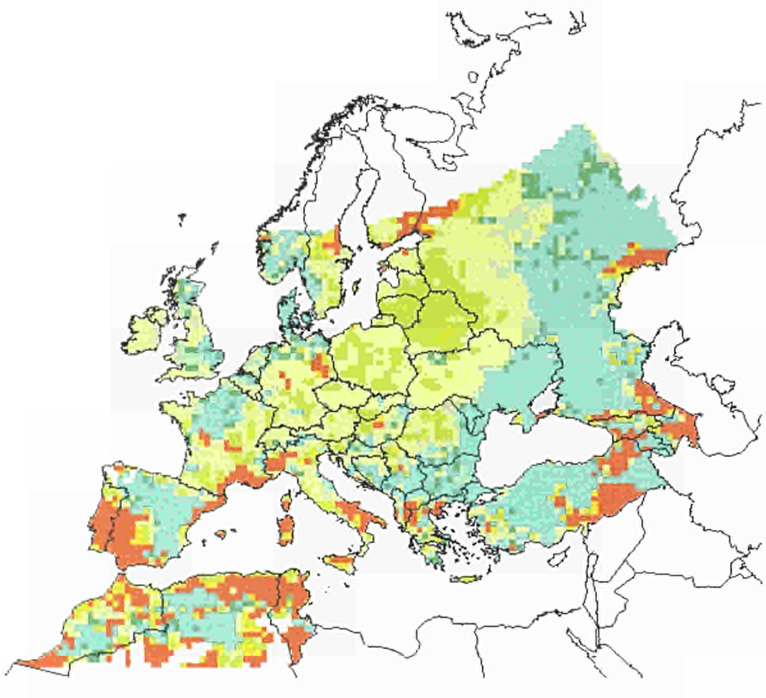


Figure 2.2: Example of crop Monitoring for Wheat, October 97

Extensions of the MARS Project

The expertise developed by the MARS Project and its potential for environmental related applications have been transferred to EFTA and associated countries, adapting the methods and systems to specific national requirements.

The MERA (MARS and Environmental Related Activities) Project, in the framework of a competitive budget from the DG I A, covers 11 Central European countries. It includes an almost complete transfer of know-how of the MARS activities, aimed:

- To create a uniform system of rapid environmental and agricultural estimates;
- To harmonize methods for statistical data collection, vegetation monitoring and crop yield forecasting;
- To implement national and international networking.

The research and development "SOTOARVIO" Project, (Application of remote sensing for the estimation of agricultural crop production in Finland) is a good example of one of several projects realized in the frame of bilateral co-operative agreements. This project, initiated in 1994 and co-financed by the Finnish Ministry of Agriculture and Forestry and the JRC, (before the entry of Finland into the EU) had as its aim the provision of a reliable system for forecasting early crop production in Finland. Although based on the Advanced Information System developed by the MARS project, specific adaptations were necessary to meet the Finnish conditions and needs. Three main tasks were successfully carried out, in co-operation with six Finnish research institutes:

- The calibration of CGMS to the Finnish conditions;
- The improvement of the results by adding several specific input data (Finnish land use database, actual regional sowing dates, new interpolation procedure, possible use of leaf area index derived from satellite data);
- The real time use of the Finnish CGMS to define its best implementation within the agricultural information system of the Ministry of Agriculture and Forestry.

A similar research and development project is still in progress with the Statistical Office of Sweden.

Through such collaborative agreements, technical exchanges and the transfer of know-how, the JRC continues to develop good relationships with national research institutes in non-Member States. Knowledge is acquired on meteorology, soils, agriculture and land use, all of which appear to be strategic issues, especially for the countries that are candidates for joining the European Union (as in the case of several countries covered by the MERA project).

Specific support is now also being provided separately to a number of non-European countries, including Tunisia, Morocco, Kenya, Senegal, Niger, Zimbabwe and South Africa. The development of an advanced agricultural information system for the main annual crops of the Mediterranean region (MEDCROP proposal) has been prepared and is now proposed in the frame of the MEDA Programme (DG I).

3. *Activities related to the Common Agricultural Policy*

Controls with remote sensing of area based subsidies

This activity remains one of the most important fields of application of remote-sensing data (satellite and aerial photographs) in Europe. Controls with remote sensing are co-funded by the Member States who are responsible for the administration and control of farmers' aid applications. In 1997, around 224 000 applications were controlled with the use of remote sensing data (70% with the use of aerial photographs only), for a total expense of approximately 23 M ECU. More than 590 satellite images were used for the 78 control sites using satellite data.

In this frame, the SAI provided technical support to DG VI and the Member States to:

- Define and optimize the methodologies (for instance, studies on the technical tolerances to be applied);
- Carry out quality-checks of ten national contractors' reports being made to national administrations and the Commission.

After five years of controls with remote sensing, in 1997 DG VI prepared a report to the Council proposing the full transfer of controls to the Member States.

Parcel identification system

The parcel identification systems are the core element of the IACS (Integrated Administration and Control systems) for the management of area-based subsidies. After initial implementation of the system, generally limited to the establishment of alpha-numeric databases (depending upon the use of available paper reference maps), an increasing number of Member States have begun a move towards more dedicated and optimized GIS (Geographic Information System) technology. These systems combine digital orthophotos (1 m pixel size) and a block or parcel definition and numbering system, into an integrated GIS environment, including in some cases, the pre-existing land register (cadastre) or topographic map information. Ireland, Finland, Italy, and Denmark, have for example, included the latter information, which appears to be very effective for the whole operation of the IACS, from the field declaration by the farmer to the administrative control and the on-the-spot checks.

In Portugal and Greece, where no land register maps are available, the orthophoto production is co-ordinated between the three sectors: i.e., IACS (arable lands), Vineyard and Olive-tree Registers. In Italy, a fully integrated system is being implemented, despite cadastre data being used as a base reference system.

A third approach, still based upon GIS, is the use of vector information (usually topographic mapping information) without an orthophoto base. The Netherlands, Scotland and (initially) Denmark have chosen this approach.

The MARS-PAC was directly involved in the technical specifications of the orthophotos, the photo-interpretation of the agricultural blocks, and in monitoring of the studies, generally contracted to private companies by Member State administrations.

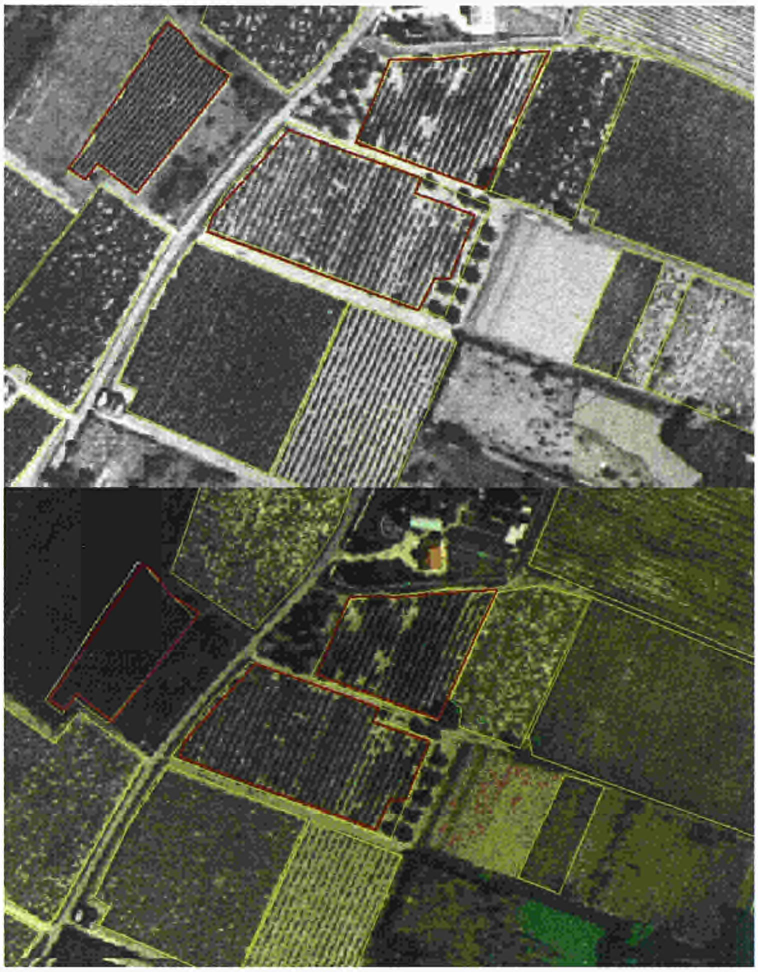


Figure 2.3: Illustration of some of the confusion in the identification of Vineyard ("VINIDENT" Study, Bordeaux Site). Parcels in red are orchards confused with the parcels interpreted as vineyard (yellow). Above, panchromatic photo, below, natural colour (0.6 m pixel), flight 1:25 000 IGN France, June 1996

It is for this purpose that SAI has acquired different high precision GPS equipment (topographical, sub metre or centimetre accuracy). The acquisition of an ortho-rectification system is foreseen for early 1998.

Olive tree and Vineyard Registers

In 1997, studies on the identification and mapping of Vineyards using different types (scale, scanning resolution, emulsion, dates etc.,) of aerial photographs were carried out. These "VINIDENT" projects covered four sites in Spain, Italy and France, and allowed an improved assessment, of the performance and the limitations of 1 metre panchromatic data for this purpose (Figure 2.3). At the same time, other complementary research topics were investigated *i.e.*, detection of structure using a wavelet transform approach and preliminary trials on the performance and utility of an airborne digital-camera.

Close support was provided to DG VI and to the Member States, primarily for the implementation of the Olive-Tree registers in Greece and Portugal, but also for its updating and management in relation to other parcel identification systems.

Countries	Portugal	Spain	France	Italy	Greece	EU
Range of Olive-trees expected (x millions)	20-40	160-220	2.7-3	130-160	90-120	+/-500
Gross area to be surveyed (km2)	50 000	300 000	50 000	170 000	100 000	670 000
Aerial photos (PSU) sampled (number)	1 250	2 500	200	2 500	1 250	7 700
Placettes (SSU) interpreted (number)	10 000	20 000	8 000	20 000	10 000	68 000
Placettes surveyed in the fields (number)	1 500	2 000	320	2 000	1 500	7 320

Table 2.1: 'OLISTAT' sampling plans in a few figures

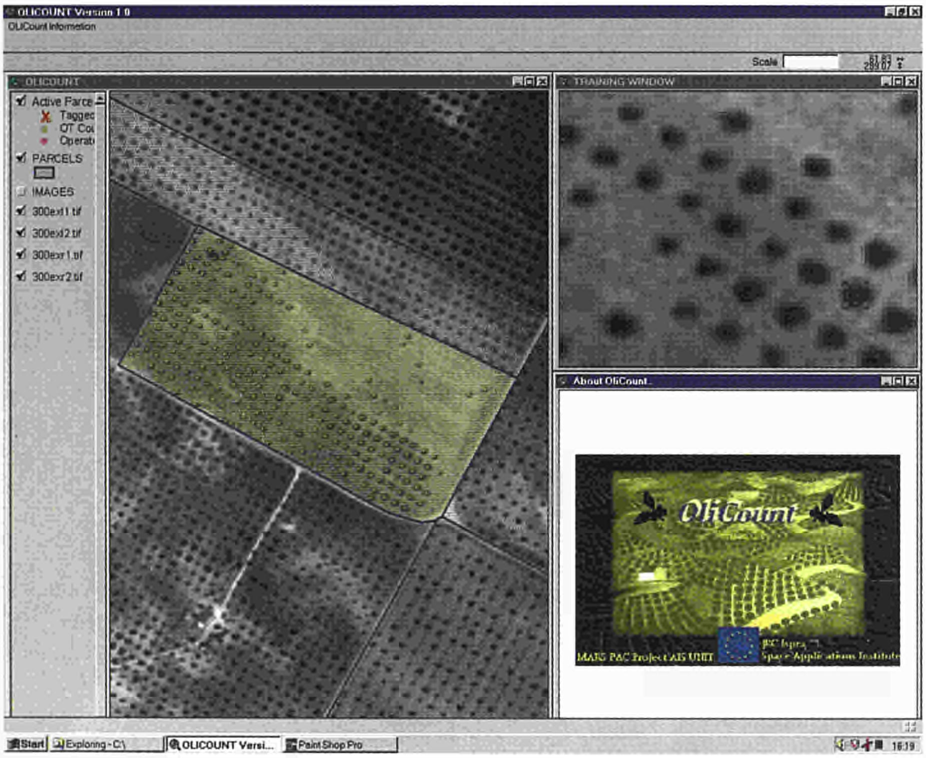


Figure 2.4: Example of the user interface from the OLICOUNT software

At the request of DG VI, the JRC organized technical visits between each of the Mediterranean Member States, in order to illustrate the solutions chosen by different administrations for the management and control of the regulations in these sectors. Visits organized in Italy and France in 1997 were a success, and complementary visits will be organized in 1998 in Spain, Portugal and possibly in Greece.

The MARS PAC Project also developed "OLICOUNT", a computer program to count (semi-automatically) the objects that might be olive trees as recorded on panchromatic 1 m pixel ortho-images. This software was mainly developed as support to the implementation of the Olive Tree Register in Greece and Portugal. To date, it has been formally adopted by the Italians. However, it has also been successfully used by the French, Spanish, Portuguese and Greek contractors for the "OLISTAT" project (Figure 2.4).

"OLISTAT" surveys

The "OLISTAT" study was launched by DG VI in mid 1997 in the frame of preparations to reform the CMO (Common Market Organization). Its purpose was to obtain, at short notice, reliable and unbiased estimates on the total numbers of Olive-trees for the five producer Member States of the EU. The accuracy targets were set at 2% with a confidence interval of 95% for Portugal, Italy, Spain and Greece with a 10% target for France.

The methodology was developed in close co-operation with DG VI and the JRC. It is based on an area frame sample and the use of newly acquired 1:40,000 aerial photographs (except for Portugal, Italy, and part of Greece, where existing ortho-photos will be used). The sampling plan was designed by the SAI with a preliminary stratification, two levels of sampling (aerial photograph positions, "placettes", *i.e.*, 100 m diameter circular segments) and two phases of survey; i) photo-interpretation and ii) field survey on a sub-sample of placettes (Table 2.1).

The operation was contracted to four companies for a total budget of 3.7 M ECU, including a flight campaign and photogrammetry for the relevant sites in France, Spain and Greece.

The "OLISTAT" support to DG VI involves considerable resources from both the MARS PAC and MARS STAT actions of the MARS Project. The SAI has been involved in the whole tender process (specification, evaluation, management etc.,) and is now responsible for the technical follow-up of the project. The latter requires that the project is developed from a technically innovative standpoint, to the transfer of ideas, at the same time as ensuring homogeneity in the applied methods and results for the five projects. For this target, SAI has had:

- To produce detailed specifications, and technical documentation for each of the steps of the project;
- To organize expert groups to discuss and standardize the sampling plan and the extrapolation of the results;
- To manage monthly technical meetings with national contractors and administrations for each of the five projects;
- To carry out quality checks on each of the critical project steps, namely: on the flights, on the sampling scheme, the photo interpretation, the field visits and the statistical processing and calculations.

This project, perhaps a unique example without any such precedent worldwide, was probably one of the most challenging in this field. The first preliminary results, obtained at the end of 1997 on priority zones, confirmed that the accuracy should be reached and the results will be available in time for four countries out of the five.

Mr Jean-Marc GAZAGNES, Head of DG VI C4 (Olive oil, Olive and Textiles crops) underlines the key-role played by the JRC within the 'OLISTAT' projects:

"... When the Commission studied the necessary reform of the Market Organization for Olive Oil (a yearly budget around 2 000 Mio.ECU), it came to the conclusion that a flat rate aid to the farmer, based on the number of olive trees or the hectares under cultivation could be a good option. However, neither the number of Olive trees nor the net surface area of the olive groves were available with a sufficient reliability".

The information on surface area is difficult to define and standardize (importance of the associated groves or scattered plantations) and need anyway to be completed with data on olive tree density. The only information on Olive tree numbers is derived from registers (i.e. an administrative source) and are thus more or less completed or updated, but in many cases, potential sources of discussions and disagreements between Member States...

The possibility of obtaining at short notice, an objective estimate of olive tree numbers, standardized throughout the E.U., was an opportunity for the Commission to consider a new policy which can be discussed on a good basis with the Member States.

The JRC plays a key role in the whole "OLISTAT" project: by defining, in co-operation with DG VI, the methodology, the sampling plan and the rules to follow in order to avoid any bias in the final estimates and to meet the very high precision requirements...

During the project, it appears that both national experts and national contractors, despite their conflicts of interest (politics or economics), agreed on technical choices and rules proposed by the JRC and the DG VI, and on their leading role for the quality checks of the whole projects."

Agri-environment and CAP

The agri-environmental regulations of the CAP, especially regulation (EEC) 2078/92, have been implemented within the Member States already for a few years, and are now entering into a phase of evaluation and re-orientation. The general trend will probably lead to a reinforcement of the part of these regulations within the CAP.

In 1997, the SAI initiated several contacts with national administrations in charge of the management of these regulations and with DG VI. The specific regulations are often limited to restricted areas (e.g., protection of biodiversity, landscape and water resources) so that they are generally decided at regional or even local levels. Member States co-finance the schemes and can therefore integrate pre-existing national regulations within the European scheme. This explains a strong heterogeneity between the 15 Member States, in the modalities and the rate of implementation.

Collaboration has already started in France with the CNASEA on four pilot-sites where high resolution satellite images or orthophotos will be used to implement and monitor these regulations. These first contacts and collaborative efforts confirm that the implementation, management and evaluation of the Agri-environmental regulations represent a high potential use of advanced geographic information systems (remote sensing, GIS, GPS) such that, this activity will be reinforced in the SAI in 1998.

Tropical Agricultural Activities

Within the framework of the SEARRI (South East Asia Rice Radar Investigation) Project, funded by the CEO Programme, the SAI has developed a pilot system for assessing surface water conditions over rice growing areas. The system is based on pattern matching using temporal signatures acquired by a space-borne radar instrument (see Chapter 8). The scope of the prototype was to develop and validate, on a limited scale, the base line technology. An industrial partner in the operational phase to be launched in1998 will use this prototype. This regional scale mapping exercise is of utmost importance, not only for its geo-political connotations linked to economical issues in SE Asia, but also because anaerobic rice cultivation plays a significant role in global land/ atmosphere problems due to the emission of methane (a greenhouse gas).

Selected further reading

Tropical Agriculture

Rosenqvist A., Temporal and Spatial Characteristics of Irrigated Rice in JERS-1 L-band SAR Data. Int. J. of Remote Sensing, (in print).

Land Cover Change, Land Degradation and Soils

The SAI has had a long history in activities related to land cover and mapping changes in the landscape via, for example, the work, which has been carried out to up-date the CORINE Land Cover database. In 1997, activities in SAI have focused on mapping and monitoring the changes occurring along the coastal zones in Europe and in Europe's rapidly growing urban areas.

The principal activity in the field of land degradation in the SAI is mapping and monitoring of Mediterranean ecosystems in terms of changes in the vegetation and soils. This activity was initiated in SAI in response to the European Commission's interest to monitor and mitigate land degradation and desertification phenomena in the European and non-European Mediterranean countries. Operational Earth observation satellites are now being used to map and monitor changes in the vegetation cover and soil characteristics in the region, and thus contribute to quantifying the changes in Mediterranean ecosystems, throughout the Mediterranean basin.

The ultimate goal is to provide decision-makers with a dynamic information system for the planning, monitoring and management of arid, semi-arid and sub-humid areas at national and regional levels. Such goals have been re-iterated by numerous international agreements such as the United Nation's Convention to Combat Desertification (UN-CCD), the Convention on Climate and the Barcelona Convention (Mediterranean Action Plan).

1. Land Cover Change

The Coastal Environment

The "LACOAST" Project is funded by the CEO Programme (see Chapter 8). The main aim of the project is to provide quantitative estimates of land cover changes in European coastal zones. The project was launched at the end of 1996, and now covers all of the European coastal countries except the UK, Sweden and Finland. The study is a component of the Demonstrative Research and Development Programme on Integrated Coastal Management, co-ordinated by DG XI-D2. The first results at a European level will be ready in March 1998.

The "LACOAST" Project provides direct support to the E.E.A., by its participation in the European Topic Centre on Land Cover. SAI's role in assisting in the definition of new fields of research and the development of new applications has led to:

- The development of a methodology and a software to update the European CORINE Land Cover (CLC);
- The definition of environmental indicators derived from land cover information;
- A study on generalization procedures to generate equivalent CLC databases from other land cover sources;
- A proposal for the 4th and 5th levels of nomenclature.

An example of land cover changes in a coastal strip in Belgium is shown in Figure 3.1.

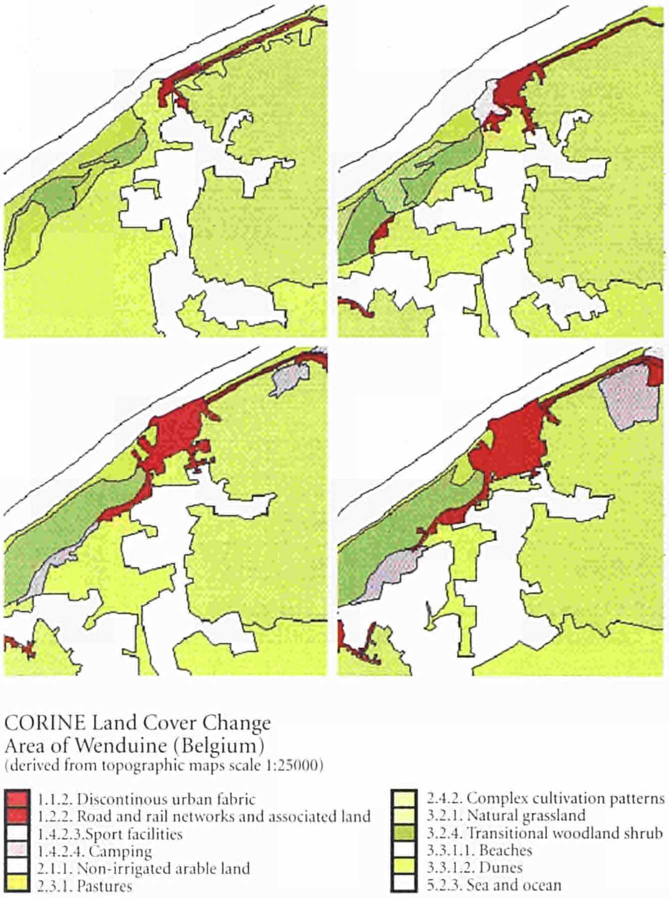


Figure 3.1: Example of the "LACOAST" Project. Land cover changes in the area of Wenduine, Belgium, between 1911 and 1988. (The red and purple colours show a drastic increase of urban [red] and leisure areas [purple] during this period)

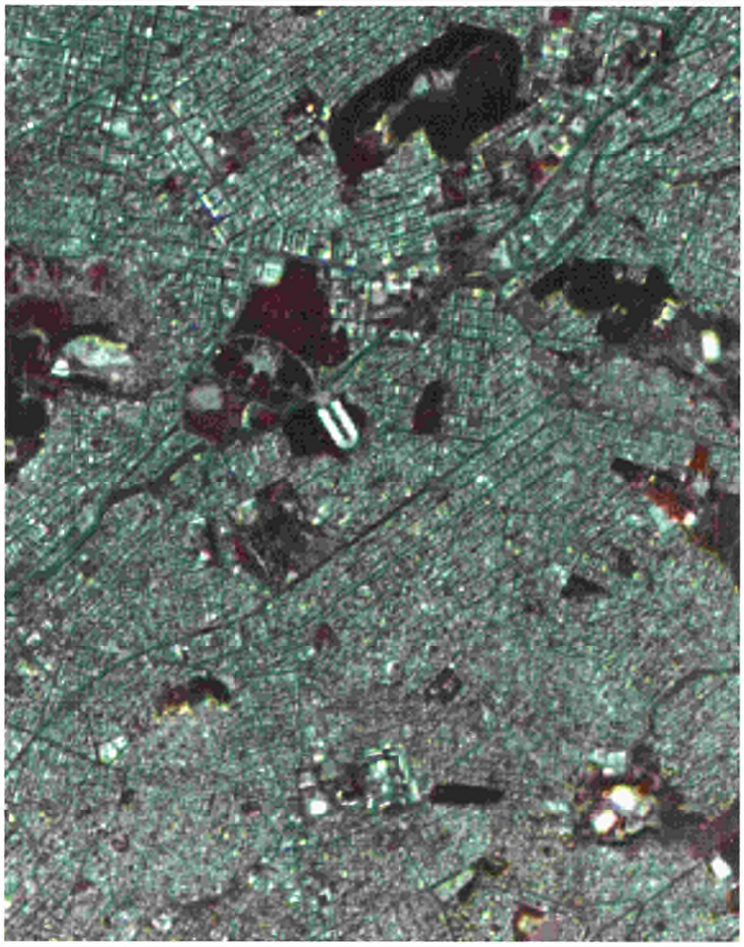


Figure 3.2: Fusion of multi-spectral and panchromatic IRS-1C imagery for the city of Athens, Greece. Spatial resolution is 5 m. (Based on IRS-1C data, copyright by 'ANTRIX SIE', Euromap Neustrelitz)

Urban Areas

A Statistical Atlas of Urban Agglomerations in Europe ("ATLAS"), is a CEO funded project with the focus on two major urban agglomerations (Athens and Berlin) in Europe (see Chapter 8). The aim of the project is to:

- Quantify the contribution (both in technical and financial terms) of very high spatial resolution optical satellite data, according to the CLUSTERS (EUROSTAT) nomenclature;
- Evaluate the need for new algorithmic approaches (e.g., computer visual scene models);
- Ensure the possibility for future updating of the land use maps.

The main source of satellite imagery is multi-temporal, multi-spectral and panchromatic IRS-1C data (Figure 3.2), together with very high spatial resolution panchromatic imagery, (3m or less in terms of spatial resolution).

2. Mediterranean Ecosystem Monitoring

The objectives are:

- Definition of remote sensing based spatial indicators of ecological change in the Mediterranean basin over the full period of existing remote sensing satellites;
- Interpretation of change (land use change scenarios and forecast models);
- Development of a comprehensive processing chain for remote sensing data, able to accommodate future enhancements (new types of sensors, data and algorithms);
- Definition and implementation of a remote sensing based observatory for land degradation and desertification monitoring in the Mediterranean region.

The methodology

The key concept and first step in achieving the above-mentioned objectives is to link, in a "bottom up" manner the spectral (mainly optical) remote sensing data with physical and ecological parameters (e.g., soil organic substance, soil mineralogical components, vegetation cover) measured on the ground. The aim is to obtain spatial information on the ecological condition of the land and its' behaviour over time (Figure 3.3).

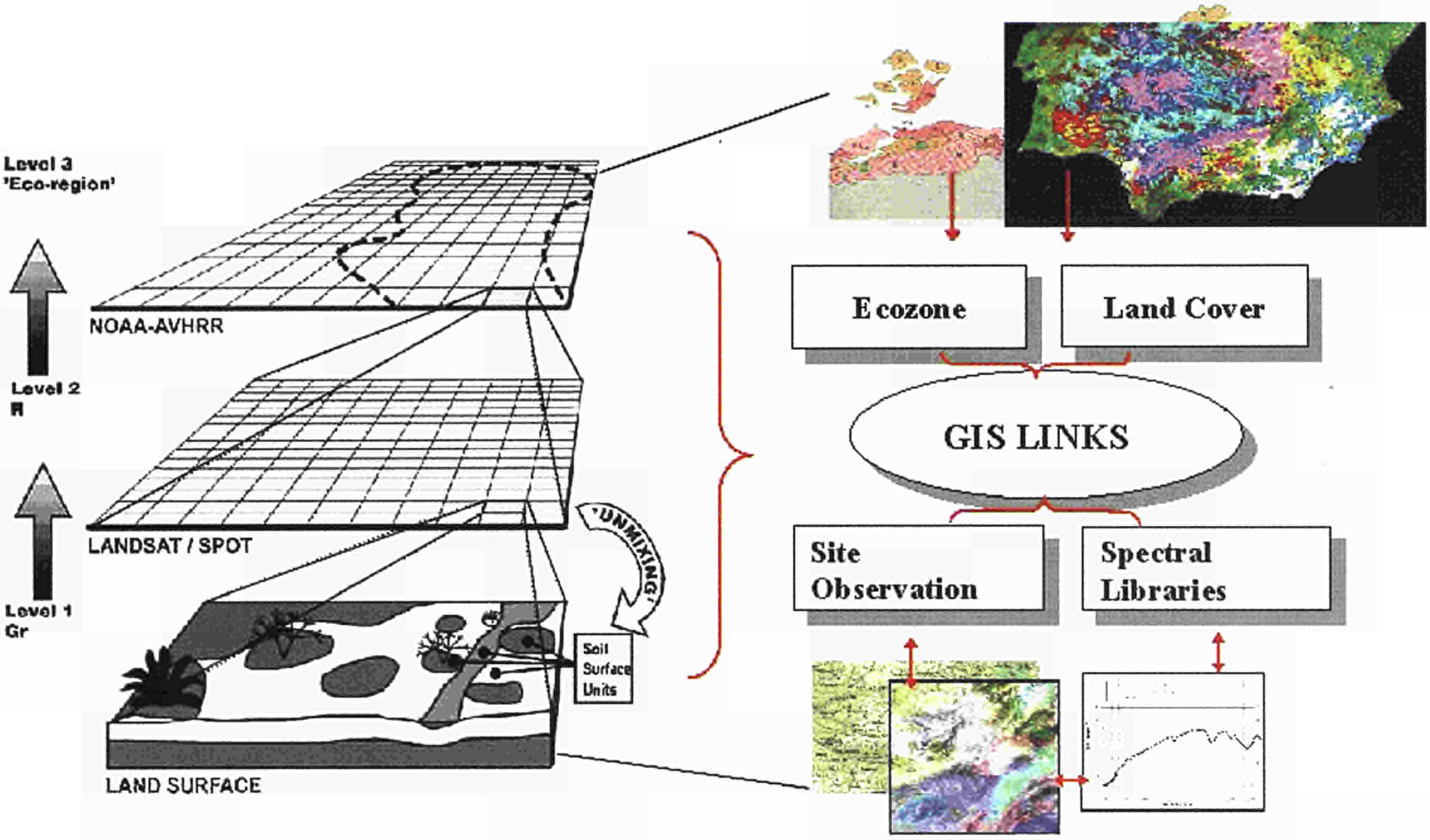


Figure 3.3: Schematic representation of the MECOM bottom-up approach to environmental monitoring in the Mediterranean Basin: Hierarchy and links of the most important components.

Spectral mixture analysis (SMA) is applied to time series of operational Earth observation satellite data (e.g., Landsat-TM/ MSS, SPOT, IRS) to extract the required information both at a suitable spatial resolution (1:100,000) and over the longest possible time period (retrospectively 15-20 years). The use of spectral libraries guarantees that the SMA approach is based on physical parameters of the surface, and thus allows inter-site comparison. In July 1997, a TMR-LSF airborne imaging spectrometry campaign flying a DAIS 7915 instrument took place over test sites in Southern France and Spain.

In the second step, the identified site specific changes are analysed in their regional eco-climatic context using climatic data, topography, lithology, NOAA-AVHRR time series and a regional physiographic and climatic stratification. The main goal is to separate the natural seasonal and inter-annual fluctuations found in local ecosystem functioning, from regional long term trends induced for instance by climatic (e.g., increasing aridity) and socio-economic factors (e.g., land use change).

As a final step, the remote sensing-derived change indicators are calibrated and evaluated against existing long term records at the site level. At the regional scale these indicators will be tested against physical models providing indices of the risk of land degradation as a function of relief, soil, parent material and the evolution of vegetation based on climatic records.

This application-orientated method is complemented and supported by research and development activities such as field spectrometry and the investigation of new airborne and spaceborne systems, such as imaging spectrometers and the SPOT-VEGETATION instrument to be launched in March 1998.

International Partnership and Competitive Projects

For the northern (i.e., European) Mediterranean, the concept described above is being developed on test sites in Southern Spain, Southern France, Sardinia, Sicily, Northern Peleponnese and Crete, together with the project partners of the Shared Cost Action (SCA) projects DEMON-2 and MEDALUS III (see Chapter 11). More information about the MEDALUS Project can be found at:

http://medalus.leeds.ac.uk/medalus.html.

The monitoring approach has been extended to the southern Mediterranean region with participants from Algeria, Egypt, Morocco, Tunisia, Italy and France in the framework of the CAMELEO Project (Changes in Arid Mediterranean Ecosystems on the Long-term through Earth Observation) which is being co-ordinated by the SAI. Co-operation with OSS (Observatoire Sahara Sahel, Paris, France) for North Africa and ACSAD (Arab Centre for the Studies of Arid zones and Dry lands, Damascus, Syria) has also been initiated. Finally, a study contract regarding the Demonstration of an Integrated Concept for Monitoring Desertification in the Mediterranean Basin Based on Remote Sensing Methods (MoDeM-RSM) has been awarded to the SAI by DG XII-D2 to support the EU activities in the implementation of the UN-CCD.

The ongoing projects will continue into 1998. A new focus will be the definition and establishment of a Mediterranean regional GIS, accommodating multi-source and multi-scale data from the level of the test site (*i.e.*, landscape) to the region level. This will support ecosystem change analysis and the interpretation and modelling scenarios in the context of desertification risk assessment.

More details about the activities mentioned above can be found at:

http://alpha.emap.sai.jrc.it/desert/mecomwww/

http://alpha.emap.sai.jrc.it/desert/cameleo

3. European Soil Bureau (ESB)

The activities of the ESB are essentially driven by the demands on soil information by the EU Member States and the European Commission.

The activities of the ESB are implemented by a Scientific Committee, formed by national experts in soil science and operating through small *ad hoc* working groups. Four working groups have been active within the ESB in 1997:

- The 1:1,000,000 European soil database group.
- The Information Access Working Group (IAWG).
- The 1:250,000 working group in charge of the design of a future European soil database at a scale of 1:250,000, following a feasibility study by DG XI (1993). A recommendation was made to establish this database for a sample of pilot zones, in order to develop a common methodology, legends and databases.
- The "HYPRES" working group, in charge of the inclusion of a soil hydraulic parameters database, directly linked to the 1:1,000,000 soil database of Europe. The "HYPRES" database (for Hydraulic Properties of European Soils) will be particularly useful for environmental and water-basin monitoring throughout the European Union.

Selected further reading

Land Cover Change

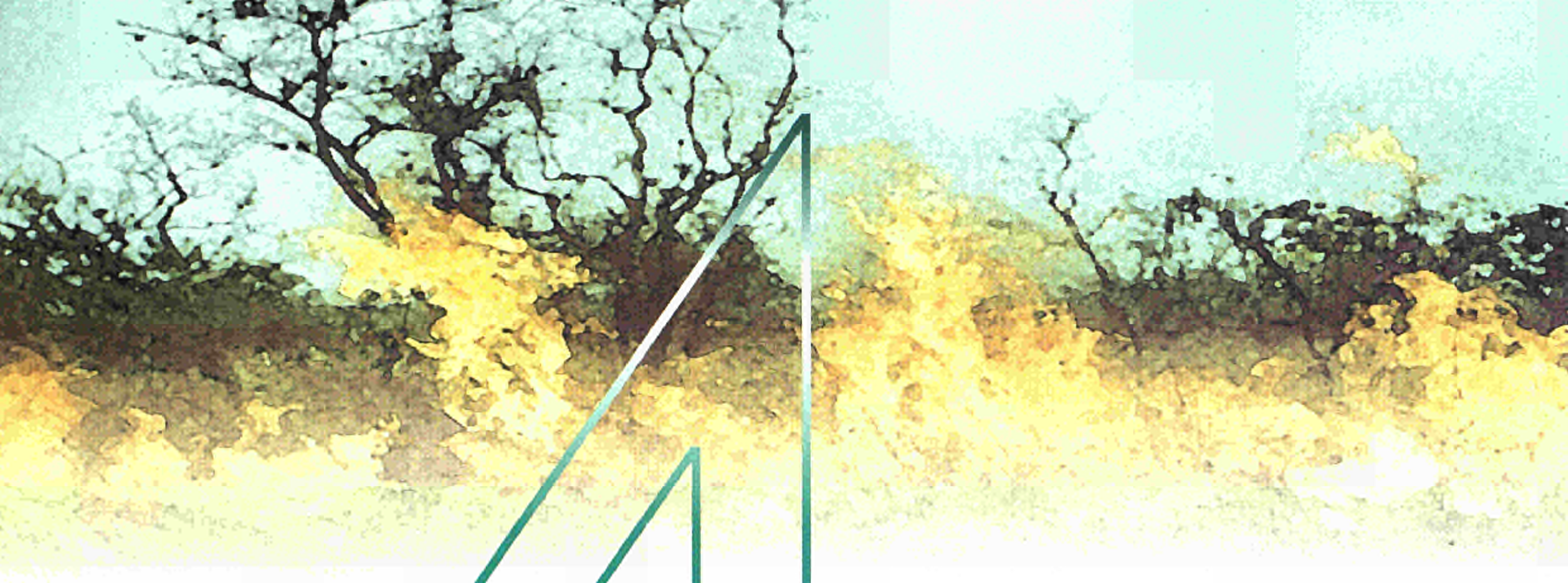
Heikkonen, J., Kanellopoulos, I., Varfis, A., Steel, A. and Fullerton, K. 1997. Urban Land Use Mapping with Multi-Spectral and SAR Satellite Data Using Neural Networks. In: "Proceedings of the International Geoscience and Remote Sensing Symposium" (IGARSS'97), Singapore, IEEE Publications, Piscataway, NJ, pp. 1660-1662.

Mediterranean Ecosystem Monitoring

Escadafal, R., Mehl, W., Bernard, S and Bacha, S. 1997. Potentialités de l'instrument VEGETATION pour le suivi de la désertification: simulation de la détection des mouvements de sables en Afrique du Nord. Comm. 7ème Symp. Intern. "Mesures Physiques et Signatures en Télédétection",.Courchevel, France, 7-11 April 1997. In Proceedings, Guyot G. and Phulpin T., (eds), Balkema Rotterdam, pp.719-725.

Sommer, S., Hill, J. and Mégier, J., 1997. The potential of remote sensing for monitoring rural land use changes and their effects on soil conditions. In: Agriculture, Ecosystems & Environment 67,2-3, Elsevier Science B.V., pp. 197-209.

Sommer, S., Leone, A.P. and Mehl, W., 1997. Application of MIVIS Airborne Imaging Spectrometry Data to the Definition of Soil Degradation Indices in Mediterranean Ecosystems. Third International Airborne Remote Sensing Conference and Exhibition, 7-10 July 1996, Copenhagen, Denmark, Proceedings Volume I, ERIM International Inc, pp 579-587.



4 Environmental Hazards and Risks

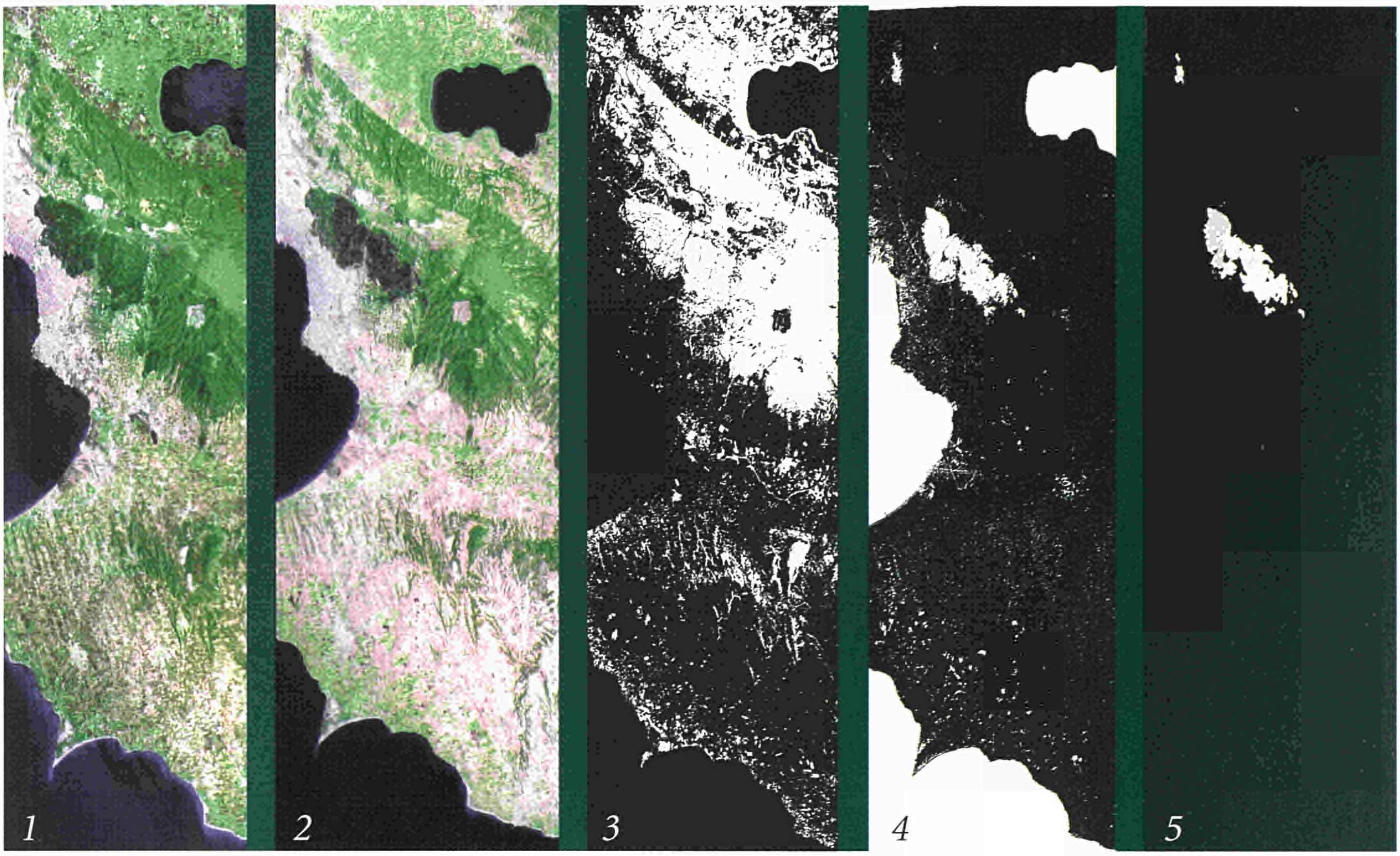
In order to complement existing disaster management practices in Europe (prevention and post-crisis phases) using Earth observation-derived information, SAI activities in 1997 concentrated on the implementation of specific pilot projects on forest fires, floods and droughts. Co-ordination with ongoing initiatives at different levels (Member states, European Commission, international) was established in order to achieve the necessary synergy for these activities.

1. Activities on forests fires

Activities on forests fires were consolidated by setting up a strategy that would result in useful products on fire information at a European scale, covering the area most affected by forest fires, i.e., Portugal, Spain, South of France, Italy, and Greece. Pilot regions were established in each of these five countries. The following products are foreseen:

1. Fire risk cartography;
2. Annual fire occurrence maps, showing the location of fires in the EU after every fire season;
3. Annual maps of the burnt areas with estimates of fire damage and burnt biomass;
4. Research on the integration of remote sensing and GIS for fuel type mapping and fire behaviour analysis.

The first step involved reviewing the NOAA AVHRR image archive held by the MARS project, and establishing collaboration for research activities on forest fire risk analysis. For this latter aspect, collaboration was established with the Forest Department of the University of Turin for computing meteorological fire risk indices using SAI's climate database. Once automated, this procedure may readily produce meteorological fire risk indices for all the Member States of the EU. In parallel to this activity, work on the discrimination of forest fuel types was also started. This activity includes the conversion of the CORINE Land Cover database into fuel types, and the development of remote sensing techniques specifically aimed at fuel type mapping for the purpose of up-dating existing maps.



Description of the images:

1 *RESURS MSU-E image of the area of Thessaloniki before the fire*
2 *RESURS MSU-E image of the area of Thessaloniki after the fire*
3 *NDVI mask of image before the fire*
4 *Burnt Index computed on the image acquired after the fire*
5 *Intersection of the previous two images smoothed with a median filter shows clearly the area burned by the fire.*

Figure 4.1: Preliminary results of burnt area mapping in the region of Thessaloniki, Greece, using an orthagonal transformation of the three bands of RESURS MSU-E image data (45 x 35 m pixel resolution).

An algorithm for fire detection is being developed. This algorithm uses the output channels of the SPACE-2 AVHRR processing chain (of the MARS Project) as input, and detects active fires using a contextual procedure. Recorded data on the location and extent of all forest fires (larger than 200 ha) which occurred between 1992 and 1997 in Andalucía (southern Spain), are being used to refine and validate the algorithm.

A study to assess the potential of new classification algorithms for mapping burnt areas is ongoing. This study is being carried out in joint collaboration with the Spanish National Research Council and the Environmental Agency of Andalucía. The objective of the study is twofold, emphasizing the automatic delineation of burnt perimeters, and providing information on the severity or degree of fire damage within the burnt areas. Figure 4.1 shows preliminary results for a test site in the area of Thessaloniki, Greece.

The SAI has also initiated activities on forest fire behaviour by testing and evaluating tools already developed, and currently in use by the United States Forest Service. Collaboration has been established with the Intermountain Fire Sciences Laboratory, which has provided software for determining fire spread (FARSITE), fire behaviour ("BEHAVE"), and fire effects (FOFEM). These tools are being tested for assessing their suitability to European Mediterranean landscapes.

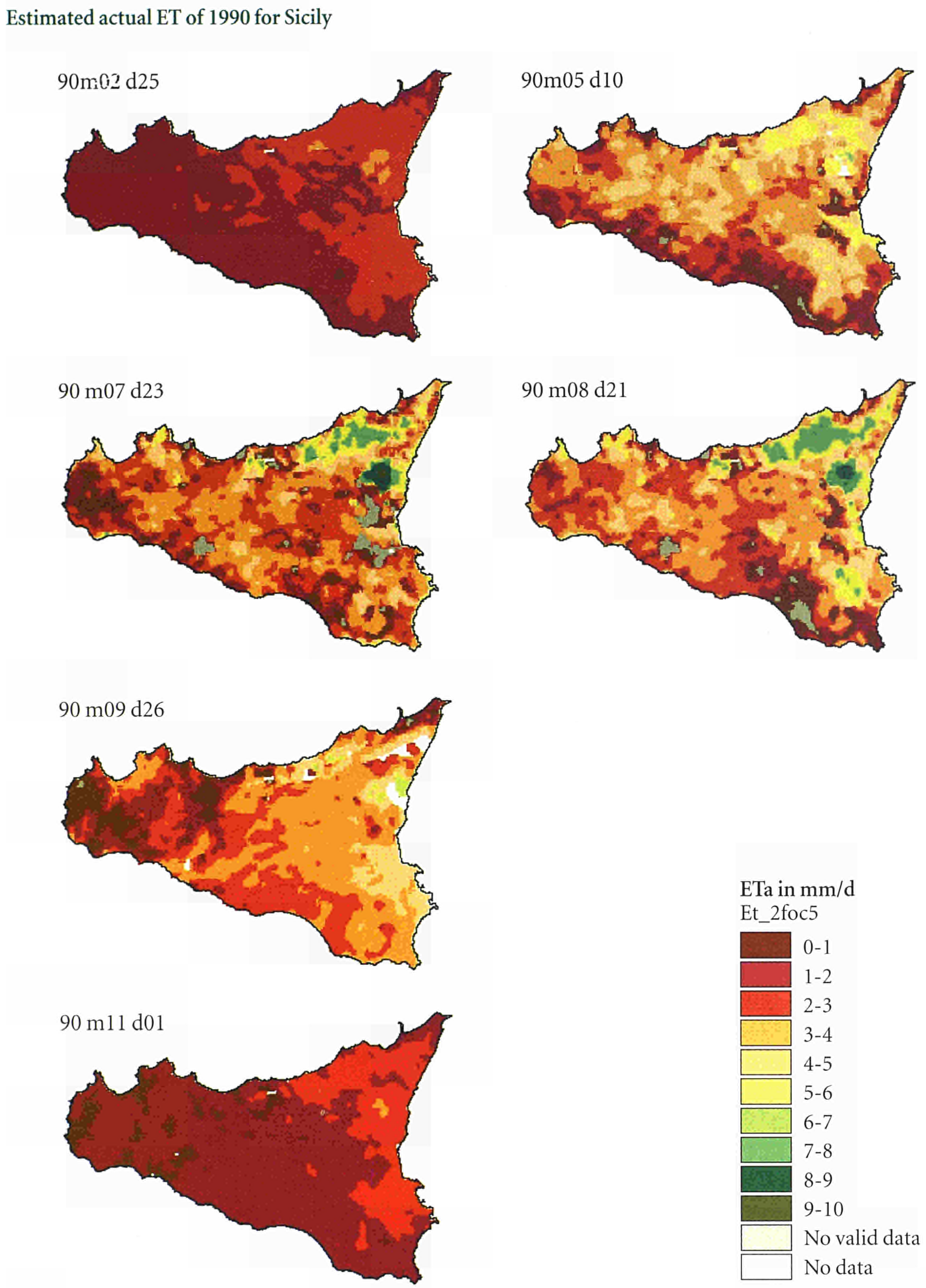


Fig. 4.2: Estimated actual evapotranspiration for selected days in 1990 for Sicily. Model outputs are based on meteorological data, land cover data, digital elevation data, and remote sensing data (surface temperature, surface albedo, vegetation index). The model resolution is 1x1 km. The presented data have been smoothed by a 5x5 pixel moving window filter.

2. *Activities on flooding*

Activities on flooding were started this year. Activities consist of flood hazard and flood damage assessment and general hydrological support to ongoing activities in the SAI.

For the flood hazard assessment activity, a prototype GIS-integrated physically based precipitation/runoff/flooding model - "LISFLOOD"- has been developed. "LISFLOOD" simulates flood events, typically with a 1.5 month duration, (including the pre-flood period), in catchments, using various pixel sizes (1 km or smaller) and with various time steps (1 hour or shorter). By using this model, it is aimed to assess the influence of land use on flooding, and to examine the major source areas of recent European floods. "LISFLOOD" will be tested in two trans-national pilot areas: the Meuse catchment, covering parts of France, Belgium and the Netherlands, and the Oder catchment, covering parts of Poland, Germany and the Czech Republic.

In the Meuse catchment, "LISFLOOD" is being tested and applied to ten flood events. These flood events include the 1993 and 1995 floods. Hourly precipitation and river discharge data are used to run and validate the model. Digital elevation data, CORINE Land Use data, the European Soils Database (Chapter 3) and the MARS Meteorological database are used to run the model. Additional Earth Observation (EO) data will be used to assess land cover and maps of flooded areas. In addition, other models, such as "MIKE-11", will be run to compare the results.

For the Oder catchment contacts have been established with the Oder Commission (IKSO) and German, Polish and Czech Water Authorities. Similar work as for the Meuse catchment is planned, including simulations of the 1997 flood.

For the flood damage assessment, existing work using SAR images for flood extent mapping has been evaluated. During 1998, work in this activity will be intensified.

3. *Activities on drought*

During 1997, the work on drought monitoring has increased. After finalizing a literature search and study on the various approaches to drought monitoring, work on a deterministic approach to the problem has been progressing continuously. A prototype algorithm for the estimation of daily regional evapotranspiration rates based on remote sensing and environmental data has been set up and tested for Sicily (Figure 4.2). Currently, this algorithm is under further development and refinement. It will undergo more extensive testing with an updated meteorological database for Sicily in 1998. The current database was set up in 1997 together with local counterparts, and already holds a large number of daily meteorological data for the whole island.

A detailed work-plan has now been set up for the implementation of a more empirical approach to the problem, using satellite-derived indices. This work will be fully implemented in 1998.

In the context of a European approach, plans to establish a European Network on Drought Mitigation has been supported. This activity is expected to take shape in 1998 when the SAI will propose to host a workshop on the topic.

In addition, discussions between SAI and EUMETSAT have taken place concerning the development of land related applications of the Meteosat Second Generation satellite. Extensive research concerning the regionalization of air temperatures, using satellite derived surface skin temperatures has been undertaken. This research is performed in collaboration with Laval University of Québec and the Ministry of Environment in Andalucía (Consejería de Medio Ambiente, CMA).

4. Activities on Landslide Mapping and Monitoring

The objective of this activity is to develop advanced image processing techniques for landslide recognition and monitoring mainly for Mediterranean regions.

Semi-automatic processing techniques (originally developed for airborne multi-spectral imagery), such as, texture classification of hummocky unstable slopes and vegetation disruption patterns, have been applied to a number of satellite optical data sets including Landsat-TM, SPOT Panchromatic and IRS-1C. A preliminary experiment on the use of photogrammetric techniques applied to stereoscopic SPOT Panchromatic data for recognizing sequential large slope movements was carried out to complement the textural approach. Work is in progress to refine the methods in order to render them suitable for use with selected space-borne imagery of different spatial resolution and spectral coverage.

In 1998 emphasis will be placed on upgrading landslide recognition methods for use with very high spatial resolution satellite imagery and on monitoring both the environmental impact and actual movement of large landslides using time series data sets.

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Activities on forest fires

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Activities on landslide mapping and monitoring

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5 Ocean Dynamics and Coastal Processes

Remote sensing can play a key role in the observation of coastal and marine environments.

The oceans, (covering 70% of the globe), for example, have a crucial influence on all meteorological and climatic phenomena. Coastal areas on the other hand, at least in Europe, support intensive economic and recreational activities. SAI is developing and demonstrating methodologies for the use of data from space observations in both operational applications and scientific investigations related to the coastal and marine environment.

Two parameters which have critical roles in different processes and which can be derived from remote sensing data are foci of activities at SAI. These are:

- Ocean colour as an expression of the substances in the near surface water layer and the biological activity in the surface layer;
- Sea surface temperature as an indicator of the general hydrodynamic processes and for the sea/air exchange.

Support to coastal management through the integration of remote sensing data, *in situ* observations and model simulations is another fast developing field of applications. Advanced computer tools such as GIS are adapted to provide a detailed representation of the processes in the coastal zone.

A Marine Web Server is also being compiled which now provides: i) remote access to data as well as browse products, ii) remote searchable catalogue based on CIP, and iii) information on an international group of experts on Satellite ocean colour. The SAI has also developed, and now hosts a web server on behalf of the International Ocean Colour Co-ordinating Group (IOCCG). More information about these activities and those described in the following sections can be found at:

http://me-www.jrc.it

1. Upper Ocean Layer Dynamics: A Key Feature for the Use and Interpretation of Marine Remote Sensing Data

The information directly deducible from remote sensing data refers to the ocean-atmosphere interface, which represents a kind of fingerprint of the marine processes within the upper ocean layer. Its dynamics represent the transfer function between the remote sensing data on the one hand and the marine processes on the other. Therefore, a profound knowledge of the upper ocean dynamics is of vital importance for the use and interpretation of marine remote sensing data. Research at the SAI on this issue is mainly based on international collaboration within the MAST and ENV Programmes of the Commission and consists of theoretical, experimental and modelling work.

In the framework of participation in the "Combined Action to Study the Oceans Thermal Skin" (CASOTS, ENV), theoretical work on the ocean-atmosphere interface was continued and presented to the scientific community on several occasions. A workshop for the CASOTS community was hosted at the SAI in Ispra.

In 1997, the SAI contributed to three measuring campaigns by undertaking micro-structure measurements and corresponding model validation. Two of the campaigns were performed in the

Baltic Sea, one in collaboration with the "Finnish Institute for Marine Research", (addressing the question of hydro-dynamical control of cyanobacterial blooms), and the second as a contribution to the MAST Programme "Baltic Sea System Study" (BASYS). The third Baltic Sea measuring campaign, the second of the MAST Programme PHASE ("Physical Forcing and Biogeochemical Fluxes in Shallow Coastal Ecosystems") was performed in the Knebel Vig (Denmark). Figure 5.1 shows the micro-structure profiler used for the field measurements. Results of a comparison between measured dissipation rates and those modelled by a K-e model are shown in Figure 5.2.

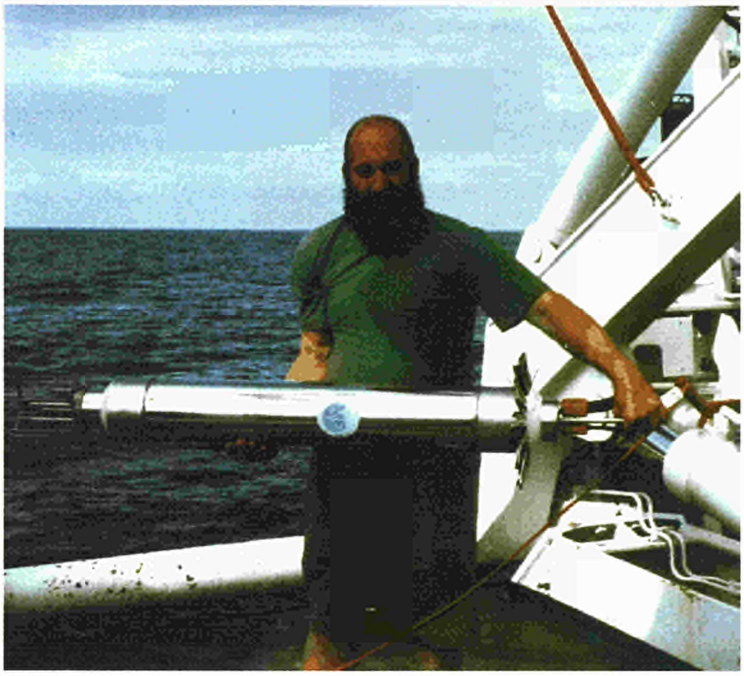

Figure 5.1: Micro-structure profiler prepared for measurements in the falling mode of operation

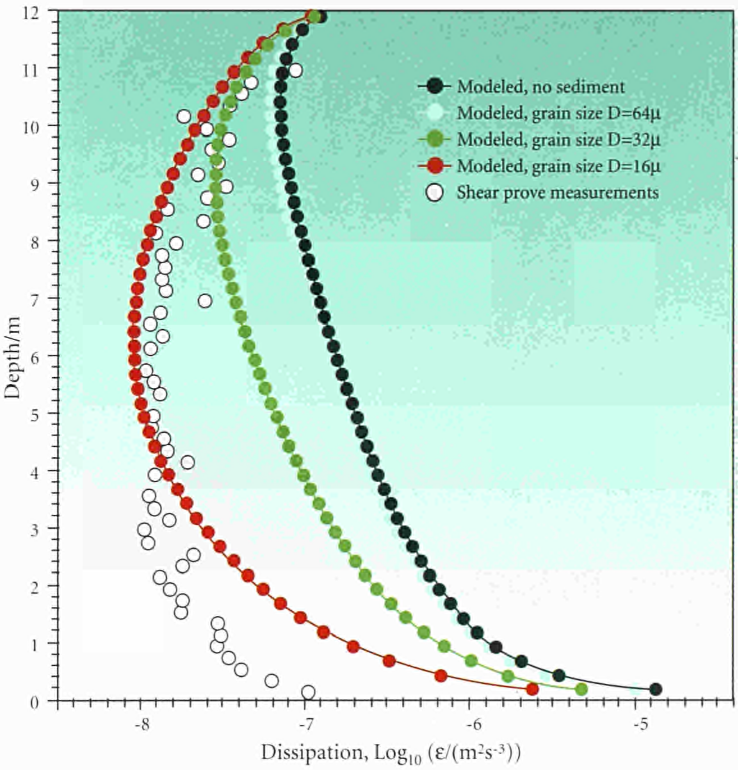

Figure 5.2: Comparison of measured and modelled (using the K-e model) dissipation rates for the Oostercshelde experiment

2. *Data assimilation: A valuable way for integrating Marine Remote Sensing Data and Modelling*

Satellite-borne remote sensing is a valuable tool for generating most synoptic views, (in space and time), of sea surface properties. However, the directly deducible information on marine processes by remote sensing alone has its limitations. Due to cloudiness and limited number of orbits, the satellite data acquired are often incomplete in space and time. They also do not directly show the marine processes in the deeper water, but represent a fingerprint of these processes, requiring further interpretation by the use of suitable tools. Variational data assimilation is a valuable tool for retrieving marine processes in time and space, by combining real observations from remote sensing data on the one hand, and (on the other) a profound knowledge of the ocean dynamics.

In 1997, the in-house ocean circulation model "ISPRAMIX"* and the respective assimilation system have been optimized for large-scale applications. A major achievement is its successful application to the whole North Atlantic basin. As a demonstration example, retrieval of the actual March 1992 SST (Sea Surface Temperature) was performed, based on a SST data set derived from AVHRR-NOAA GAC data and on atmospheric driving forces derived from ECMWF data.

The assimilation is carried out as follows. The circulation model begins a simulation (as assumed here, for a 2-day period) with a 'first guess' 3D initial condition for the temperature field at say 0hrs.am. on the 1st March. In parallel to the simulation, the 'sensitivity' of the considered system with respect to eventual changes in SST, is computed (adjoint model application). Using both results, a specific algorithm is applied for minimizing the difference between the observations (here remote sensing-derived SST) and the model data, by generating a suitable new initial temperature field. This procedure is repeated as often as is required for obtaining a prescribed minimum difference between model data and observations.

Figure 5.3 shows the model-derived SST at 4h.pm on the 1st March 1992, obtained by data assimilation. The temperature field reproduces (with a high degree of accuracy) all the features, which are found in the observations, while the pure model data show large deviations. It is self-understanding that the modelled marine system has not only a retrieved SST, but also a correspondingly adapted temperature and flow field.

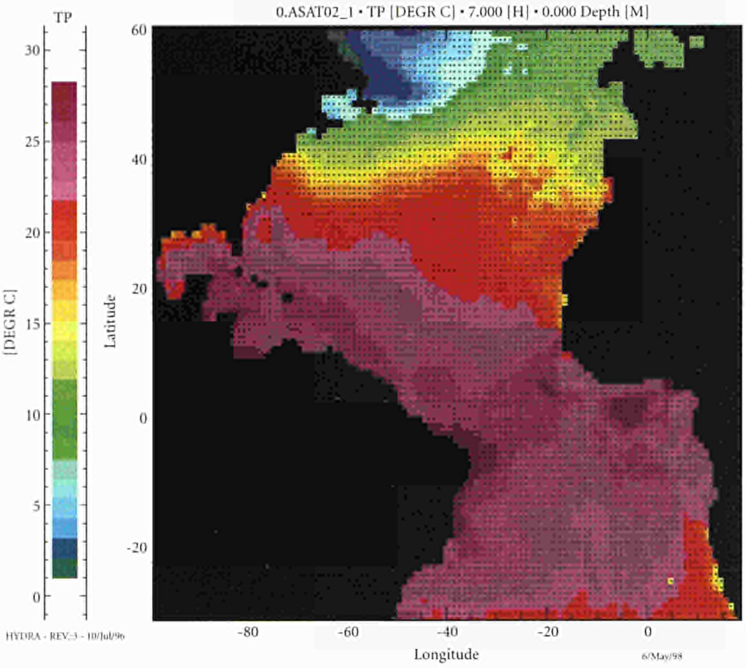

Figure 5.3: Sea surface temperature model simulation after data assimilation procedure

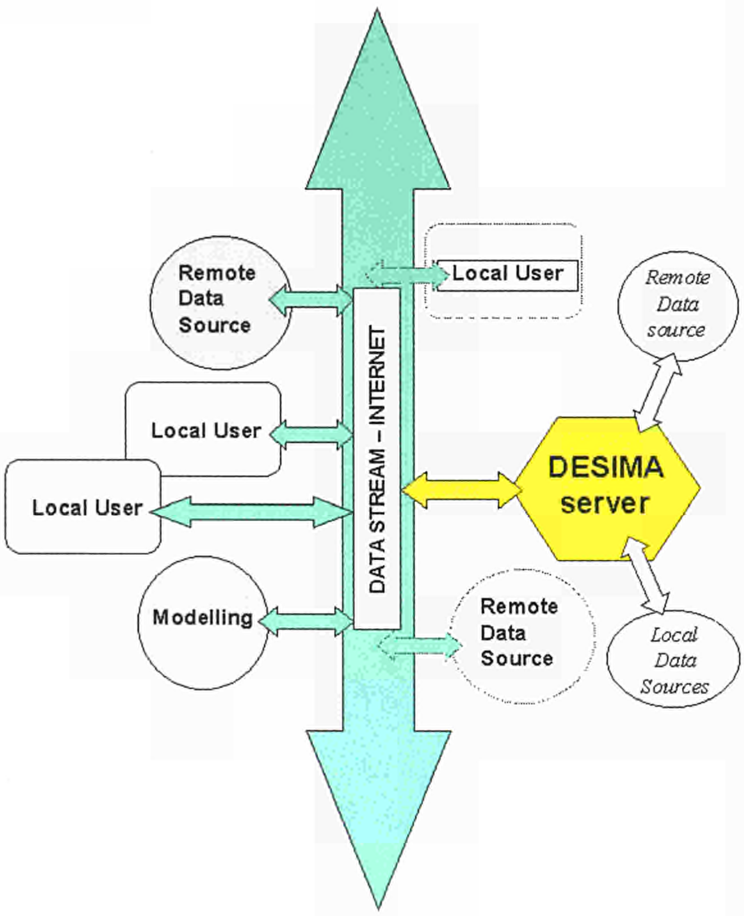

Figure 5.4: DESIMA distributed client/server architecture

3. *Coastal management support: Integrating RS data,* in-situ *observations and model data into information systems*

Decision-makers require reliable, comprehensive, problem-related and up-to-date information, quickly and efficiently. This calls for two kinds of actions:- (1) Development of information systems for the integration of data from different sources; (2) Help to the decision makers to find out how their problems can be traced by available data.

The DESIMA (DEcision Support for Integrated coastal zone Management) Project fits to the requirements of action (1), whist the "Feasibility Study for an Information System for coastal management in Thailand", fits to action (2).

DESIMA

Earth observing satellites have acquired vast quantities of high quality data over a period of many years. Much of these Earth Observation data, and many other types of useful data, are stored in computer archives, but access is not straightforward, also because the data varies widely in format, resolution and density. The DESIMA Project was initiated with these limitations in mind. It is a project funded by the CEO Programme, within the so-called "Application Projects in Support of the Services of the Commission" (see Chapter 8).

The main objective of DESIMA is to design and develop a prototype version of an information system facilitating the integrated use of various sources of geographically related data and information by using GIS techniques and tools. The technical part is done in collaboration with "MATRA" Systems & Information, Mécanique Appliquée et Sciences de l'Environment (ACRI), Hydraulic Research, Wallingford, and Satellite Observing Systems (SOS). The design of the architecture of the system and the selection of data input for two application scenarios has started. The latter applications are (a) oil spill pollution risk management, and (b) support to sea defence. Figure 5.4 shows the concept. The modular structure will facilitate the application of the system for other coastal zone applications. More information about this project can be found at:

http://desima.jrc.it

Feasibility Study in Thailand

This study is executed in the frame of contractual work for DG IB. The aim is to propose a tool for use by local authorities, for the sustainable management of coastal and marine resources. The need arises from rapidly increasing economic activities in recent years, which have put enormous pressures on already scarce resources. GIS and remote sensing technologies will form the cornerstones of the proposed system, the critical part being the integration of these technologies with appropriate management procedures.

The identification of the user's needs, their responsibilities and their functions, turned out to be a rather complex task, as modern management and monitoring practices for the coastal environment are not yet implemented or properly followed. A number of visits and meetings with both the users of the system and potential data providers, were undertaken. Both the Department of Fisheries (DOF), and the Thai Development Research Institute (TDRI) organized EU/Thai workshops. An inventory of data available in Thailand, including an evaluation of their suitability for the proposed system, is the main result of the meetings. The work on the feasibility study will continue in 1998.

4. *Ocean Colour Calibration and Validation*

The CoASTS project

CoASTS (Coastal Atmosphere and Sea Time Series) is a co-operation project between the Joint Research Centre and the Italian National Research Council, which was started in October 1995 and completed in October 1997. The project, which was designed to support calibration/validation (cal/val) activities for forthcoming ocean colour missions, aimed to:

1. Collect time series of atmospheric and marine field data from a single site in the North Adriatic Sea;
2. Process and analyze the acquired data for the development of site and seasonal specific marine and atmospheric algorithms;
3. Apply the acquired data, and develop algorithms in cal/val exercises.

Some values related to the site in terms of "irradiance reflectance" R(l), "diffuse attenuation coefficient" K_d(l) for downwelling irradiance and the "Q(l)-factor" are shown in Figure 5.5.

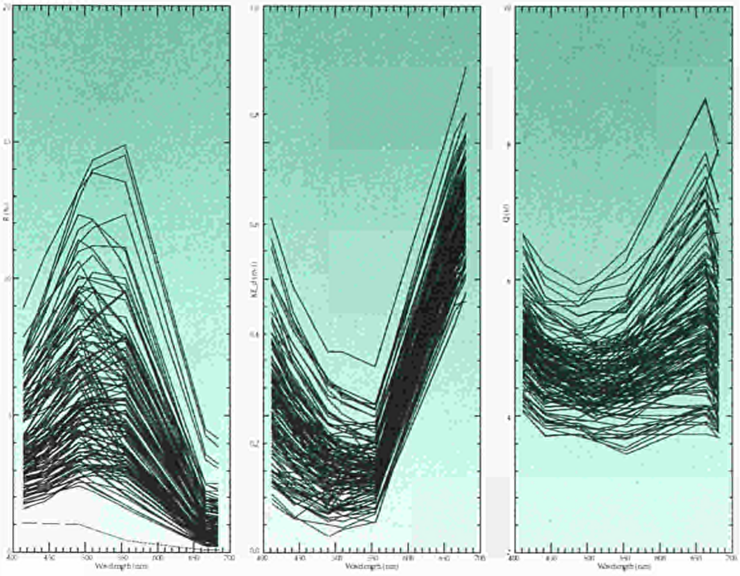

Figure 5.5: Spectra of "R", KE-d and Q-factor

The project CEVEx, (see Chapter 11) which ensures co-ordination between these already existing national long term calibration/validation programs, will provide a better assessment of *in situ* measurement protocols, calibration/intercalibration methods, processing schemes and archiving tools, transferable to future more extended and operational networks.

The main objective of the COLORS Project (see Chapter 11) is to establish a European network of three different representative sites, at which a systematic program of long-term relevant measurements in water, and in the atmosphere can be carried out. The sites providing a cross section of the European coastal waters, are: the Adriatic Sea, the English Channel and the North Sea. All three sites will be equipped with identical instrumental packages and special attention will be given to intercalibrations to ensure compatibility of the data sets collected at the different locations.

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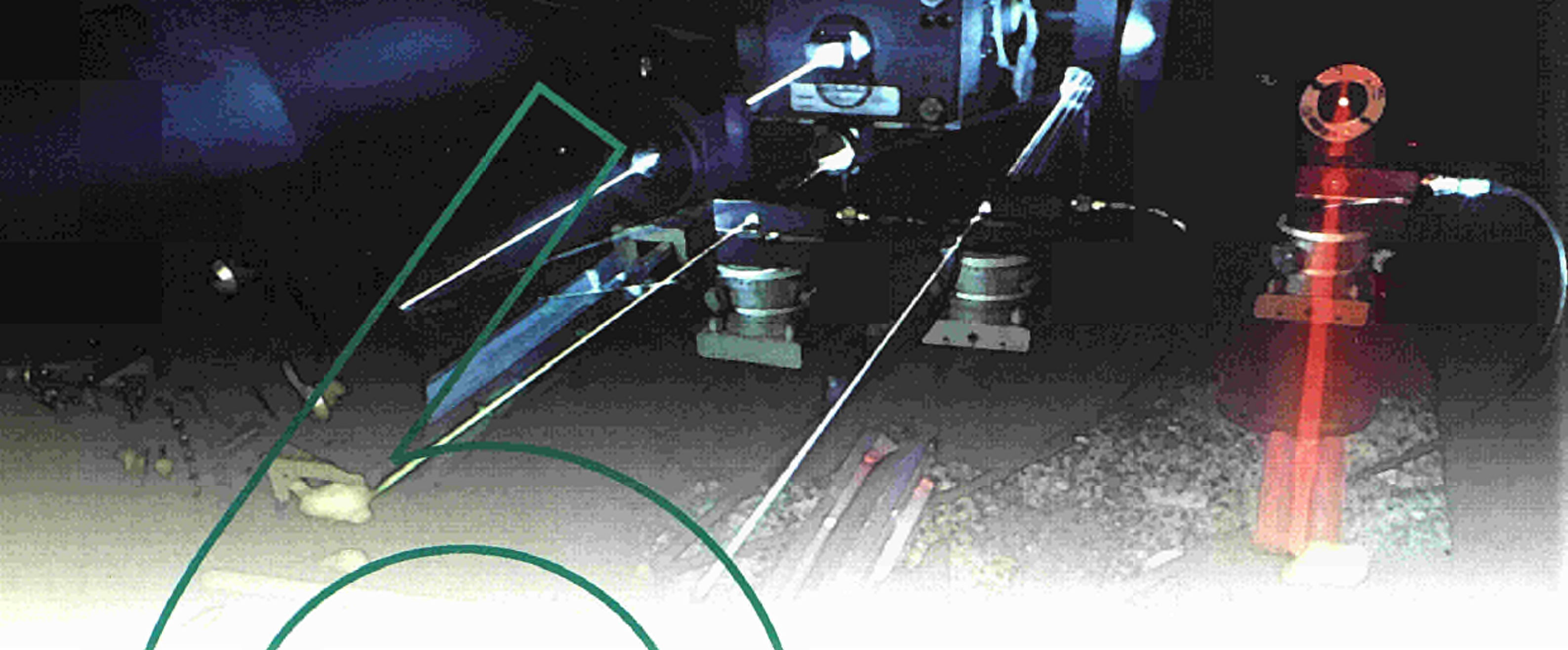

Advanced Methods

for Understanding the Bio-Geophisical Information Content of Remotely Sensed Data For Environmental Monitoring

One of the long-term activities of the SAI is the development of new techniques and new algorithms to better characterize land surface features. This work includes the development of advanced image analysis techniques for Earth Observation satellites, the development of models, and the testing and validation of the methods in controlled conditions and experimental campaigns.

Projects currently contributing to this field of activity fall into the following three categories:-

1. Optical Techniques
2. Radar Techniques
3. Advanced Image Processing Techniques

1. *Optical Techniques*

Reflectance Measurements on Rough Soil Surfaces

Understanding the reflectance properties of terrestrial surfaces, in particular soils, continues to be of major importance for remote sensing applications. In a project in collaboration with the University of "Marne-la-Vallee", Paris, and the "Institut Francais du Petrole", a series of measurements was made in the European goniometer (EGO) on rough soil and sand surfaces. The remote detection of soil pollution by hydrocarbons is of particular interest in the petroleum industry. For example, leaks from pipe lines or from old storage sites can be detected by means of changes in reflectance of the surrounding surface. The aim of the measurements in the EGO was to test the validity of theoretical models of incoherent scattering of light by semi-infinite rough surface granular media, and of the scaling properties on the BRDF of some of these surfaces.

Three main types of soil were used, two sandy soils and one with a higher clay content. The rough surfaces were created using a mould with a known roughness profile. The same soils were used in the past in the EMSL for similar investigations in the microwave range. The measurements in the visible and near-infrared range were repeated for three different angles of elevation of the illumination source, and for smooth soil and sandy surfaces.

BRDF Measurements on Satellite Test Field Gravels

Advanced remote sensing requires reliable BRDF models for the targets being sensed. The development and improvement of these models requires verification against well-characterized targets in controlled conditions. Sample field materials can provide suitable laboratory targets since they are usually stable, easy to handle, and have well known or measurable physical properties. In this particular experiment, the modelling aspect is being carried out in close connection with the EC funded ENAMORS concerted action project (see Chapter 11). Thus, BRDF measurements were made in the EGO using sample materials from the Sjokulla test field of the Finnish Geodetic Institute. The samples included gravel of different colour and size, an aluminium reference plate and fabrics for the calibration of satellite data. The objectives are threefold:- i) to make the Sjokulla test field more useful for quantitative satellite and airborne image calibration; ii) to verify and stimulate the development of BRDF models, and iii) to provide inputs for studying the utility of polarization data in remote sensing.

At the same time as the above experiment, the EGO was also used to contribute to the calibration exercise required for NASA's Mars Pathfinder mission. This was provided in the form of BRDF measurements on reference materials from DLR, Berlin, which were used to calibrate the instruments on-board the Mars Pathfinder rover (Figure 6.1).

Figure 6.1: NASA' s Mars Pathfinder rover

The 'NADIM' Model

The semi-discrete "NADIM" model, a one-dimensional bi-directional reflectance computer code, has been completed at the SAI and applied to generate a global map of land cover using AVHRR GVI data. This map is the first global distribution of biome characteristics derived from the inversion of physically based models against actual remote sensing data (Figure 6.2). It opens new possibilities for characterizing terrestrial ecosystems from space.

2. *Radar Techniques*

During 1997 past work on non-vegetated terrains has continued and been extended to the vegetation layer.

Monitoring soil in frozen/thawed transition

The scattering characteristics of bare soil and their dependence on moisture and roughness parameters have been thoroughly investigated in the SAI in previous years. At the beginning of 1997, the foreseen measurement series was completed with the indoor measurement of radar backscatter behaviour of frozen soil versus temperature. This behaviour has a rapid transition during the thawing process when the surface temperature reaches 0°C, due to the high difference of the dielectric constant between frozen and liquid water. The understanding of such behavioural patterns is essential to the interpretation of radar data acquired for cold regions such as the boreal and Taiga biomes.

Discrimination of soil and vegetation structure

In the soil/vegetation layer, several scattering mechanisms can take place due to the complexity of the geometrical structure and its volumetric nature. For monitoring such complex environments it is therefore important to consider the whole spectrum of probe parameters available in radar measurements, namely frequency, polarization, phase and angle of view. In particular, three techniques have been investigated:

1. Wide Band Polarimetric Signature Analysis,
2. Frequency Correlation Function, and
3. Interferometry.

1. Laboratory experiments have demonstrated that when the polarimetric information is properly used, good discrimination between different soil roughness levels and vegetation types can be achieved. This is shown in the example in Figure 6.3

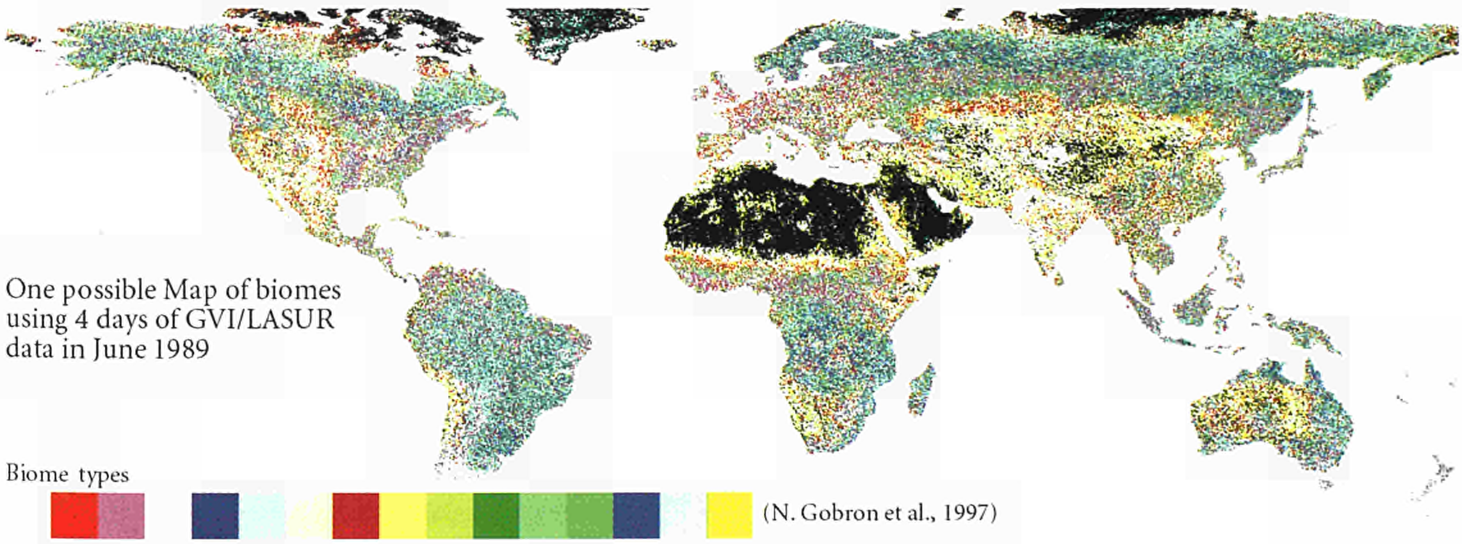

Figure 6.2: Global distribution of biome classes as retrieved from inversion techniques of physically based models and AVHRR-GVI data. (Black – corresponds to non vegetated areas [e.g., deserts, clouds]; Other colours indicate categories of biomes defined by such parameters as, LAI, canopy height and leaf size).

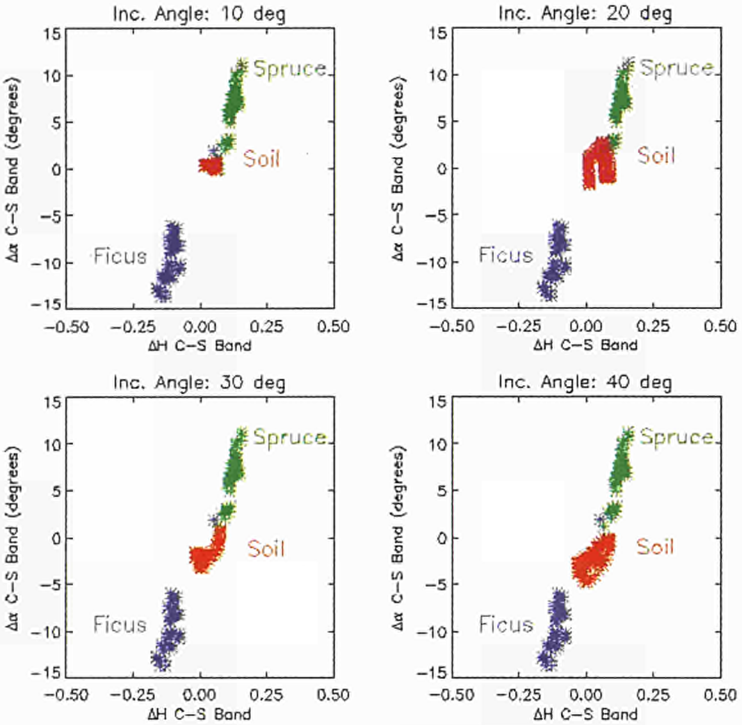

Figure 6.3: Scatterplot showing the separability of two tree species and a smooth soil surface by means of their polarimetric radar signatures

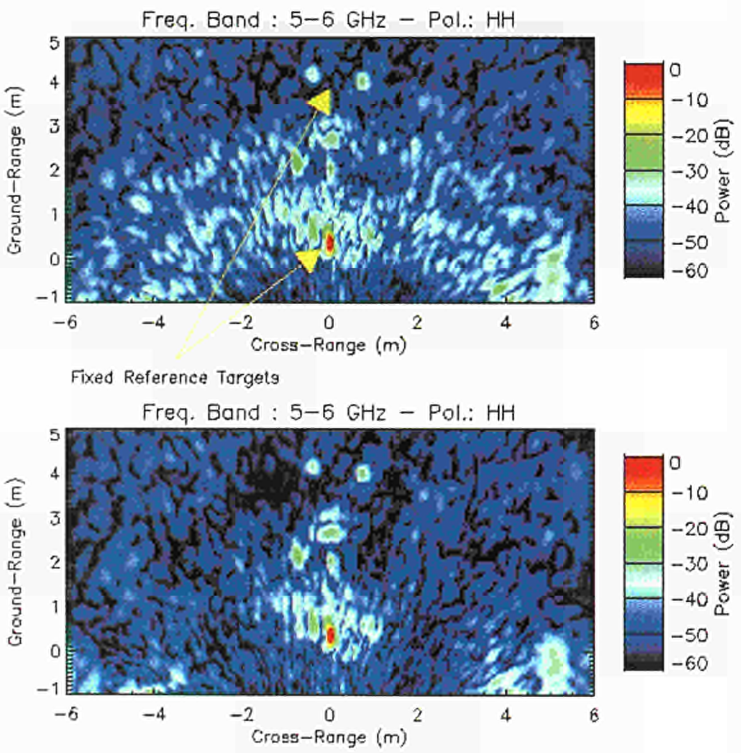

Figure 6.4: Diagram illustrating how the coherent signal averaging technique removes artifacts due to unfocused images of moving parts in vegetation cover. SAR image of a group of trees including 'wind' effect (above). The same image where the artifacts have been removed by temporal coherent averaging (below)

2. The Frequency Correlation Function describes the correlation properties of radar data taken at different frequencies. It can be shown theoretically that these properties are directly related to essential geometrical parameters of the observed object such as the height, the internal layering and the surface roughness. Validation of this methodology has been undertaken experimentally using controlled measurements of bare surfaces, maize and coniferous vegetation in the EMSL facility. The results will be used to verify the theoretical assumptions and assess the applicability of the approach to discriminate different types of land cover structures.

3. SAR interferometry is a powerful tool already widely used in environmental monitoring for the retrieval of Digital Terrain Models (DTM), to visualize surface deformations due to earthquakes and volcanic events, and to monitor crustal movements etc.. An algorithm to derive topographical information from polarimetric SAR data has been developed at the SAI. This new approach, based on two-pass airborne radar observations, allows the creation of terrain absolute elevation maps using only one tie point (as opposed to a whole contour line in the previous one-pass algorithm).

The use of SAR interferometry in the multi-temporal analysis of vegetated areas is however, hampered by the inherent instability of the important parts of the vegetation layer (e.g., leaves, small branches). A possible solution to this difficulty has been experimentally investigated with LISA (LInear SAR), by undertaking field experiments to acquire SAR images of moving vegetation. This has been carried out in collaboration with the "Politecnico di Milano". Coherent averaging of the acquired signal over a relatively long time period (few seconds) has been shown to virtually eliminate from the image the parts of the vegetation which are unstable. The result is the recovery of the required coherency as illustrated in Figure 6.4.

3. *Advanced Image Processing Techniques*

Neural Network Classifiers

Activity 1. The SAI, in collaboration with ISIS, completed an activity on improving satellite image processing techniques for land use classification, as part of competitive support to the Statistical office of the European Communities (EUROSTAT). The project utilized EUROSTAT's hierarchical nomenclature system for urban areas, CLUSTERS, together with Landsat-TM and ERS1-SAR images for the city of Lisbon, Portugal. Statistical, textural and Gabor features were extracted from the imagery, and a regression tree classifier was used to select the most relevant features at each level of the nomenclature. A NNW (Neural NetWork) classifier was then trained with the resilient back-propagation algorithm. Encouraging results were obtained, but more research is required for urban land cover applications if, advantages are to be gained from the newly available very high spatial resolution satellite data.

Activity 2. Considerable efforts have been directed to understanding the classification of mixed land cover pixels. Various visual techniques have been developed in SAI to analyze and represent NNW outputs of mixed pixel classifications seen as mixtures or percentages of "pure" classes. The results confirmed that those mapped outputs, which are, really approximates to *a-posteriori* probabilities can be linked to percentage coverage for each class. The implications of this finding, particularly for land cover classifications will be studied in more detail in 1998. Suitable advanced tools to evaluate the classification accuracies will be developed.

Virtual reality systems

The development and design of a virtual reality system to explore the relationships between fuzzy classification and spectral un-mixing of remotely sensed data has progressed throughout 1997, largely within the framework of the "FLIERS" Project and the "MAVIRIC" concerted action (see Chapter 11). The system makes use of virtual reality technology to create an immersive three-dimensional computer interface, which accepts a large number of channels of data.

More information on these activities can be found at:

http://ams.emap.sai.jrc.it

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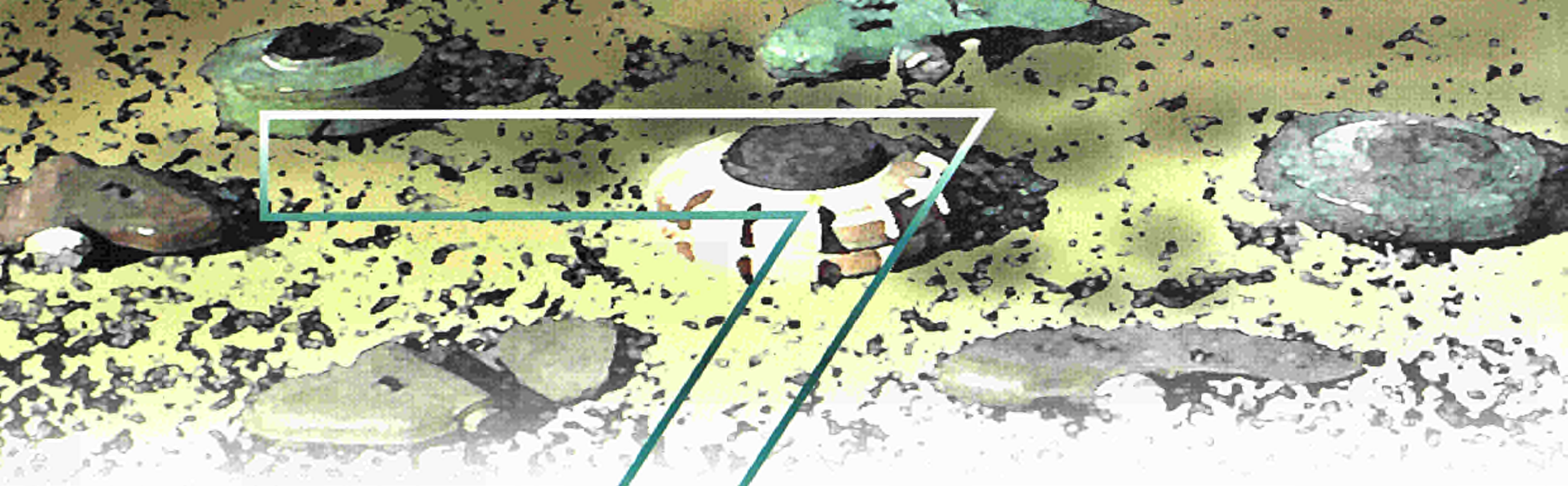

7 Humanitarian de-mining

The SAI has a long and established history in the fields of radar imaging, optical spectrometry and the design of microwave test systems. These skills are currently being utilized in studies to provide technical support to the EC humanitarian de-mining projects.

In 1994, at the request of the European Parliament, SAI started experimental tests on the use of advanced radar remote sensing techniques for the detection and identification of Anti-Personnel Land-mines. The positive results led to a request by the European Parliament, as well as the Board of Governors of the JRC to continue this work. The SAI now actively supports the Mines Clearance Co-ordination Group, chaired by DG 1A. In this context, SAI's role is to give advice and guidance on technical aspects of mine clearance, both for current de-mining activities and for research activities, which may contribute to the R&D programme. In addition, the SAI provides facilities and support to measure the characteristics of sensors identified as candidates for analysis in a feasibility study.

Detection of Anti-Personnel Land Mines

During the last year the JRC established an outdoor test range for validating the performance of mine detection sensors, e.g., metal detectors, GPRs (Ground Penetrating Radar) and thermal infrared sensors. This facility has been used by different producers of mine detection sensors as well as for testing the feasibility of a multi-sensor system for the detection and identification of APMs (Anti-Personnel Mine).

Based on the success of this exercise, the JRC received a mandate to establish standards for the validation of the performance of mine detectors. This action was launched by an expert workshop which took place at the JRC, Ispra at the end of October. Amongst the participants were the United Nations, NGOs, mine clearance organizations, mine detector producers (SMEs), national research organizations and universities as well as the European Commission services responsible for operations in mine clearance. An expert committee (CADMOS) was established under the leadership of the JRC. The defined standards will be applied to tests at the JRC as well as to mine clearance operations in mine infected countries which are supported by the European Commission.

Based on in-house research work, the JRC has received a mandate to combine existing facilities and competencies in order to act as a centre of excellence for mine detection and identification. This initiative will be performed in close collaboration with national groups from EU Member States, NGOs, representatives from mine infected countries and mine clearance teams. The JRC has been awarded a contract (competitive support to the Commission) in recognition by the various services of the European Commission responsible for de-mining actions that it is such a centre of excellence. The contract work involves verification of the performance of mine detection systems, and establishing a mine signature database.

More information of the de-mining activity can be found at:

http://www.ei.jrc.it/landmines/

Contributions from the EMSL

Development of sub-surface 3-D imaging techniques

In the last years, the SAI has developed profound expertise in radar imaging techniques. Recent developments have specifically addressed the near range geometry for the creation of 3-D images of objects embedded in lossy and non-homogeneous media. This technique is particularly suitable for the detection of Anti-Personnel Land mines (APL) which, in many cases are found in the soil, a few centimeters below the surface. The study of optimum sensor configuration and signal bandwidth for this specific application has been carried out both experimentally and by means of numerical simulations in a number of test cases. Promising results have been obtained with the use of back-scattering configuration and wide band signals in the region 0.5 - 4 GHz.

Application of advanced polarimetric analysis

One essential feature of an ideal APL detection system is its capacity to discriminate at least between mines and non-mine objects, and if possible between different types of mines. A good sensitive system is not sufficient if it results in a high rate of false alarms, thus offering no real benefit to the efficiency of the de-mining process.

Polarimetric imaging radars widen the spectrum of signal parameters that contribute to the establishment of unique signatures of the different objects. They therefore maximize the chance of positive discrimination. In 1997, a systematic analysis of such signatures was undertaken in the EMSL for a number of representative objects, including dummy APL's (Figure 7.1). The results are very encouraging and the contract work will be continued in 1998 by taking into account the effect of different environmental parameters such as, soil and vegetation.

Contribution from the EGO

Thermal infra-red measurements

Measurements were also made at the JRC test site at the end of April 1997 using two radiometers operating in the VIS (visible), NIR (near infra-red) and TIR (thermal infra-red) ranges. The first detector used was the Barnes Instatherm, a hand held temperature detector recording in the 6-20 µm range with a sensitivity of 0.1 degrees. The second detector used was the Barnes MMR radiometer which has seven channels in the VIS/NIR range and one thermal channel. These two detectors were used independently over a target containing two anti-personnel mines buried in sand to a depth of 1 cm. The most promising results were obtained with the Barnes Instatherm which was able to locate the position of both mines, due to the difference in the surface temperature (Figure 7.2). To-date this method has only been tested under direct sunlight and over a homogeneous surface such as sand.

Selected further reading

De-mining

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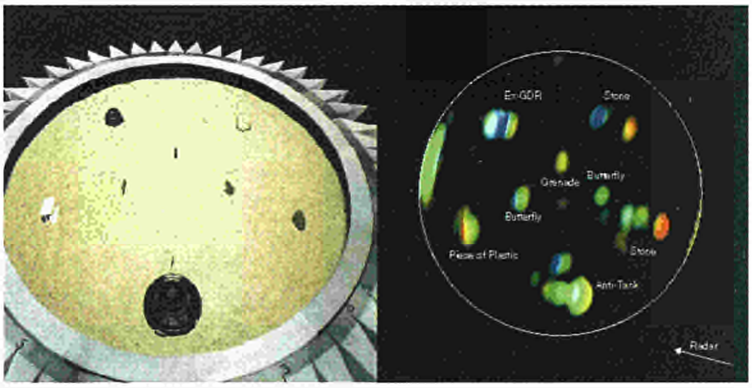
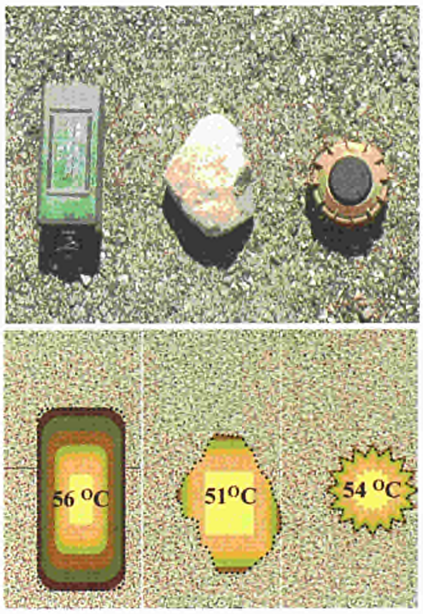


Figure 7.1: Anti-personnel mines identification using high resolution polarimetric microwave imaging. The colour-coded image (right) shows the dominant scattering mechanism for each target in the test scenario (left) which includes different types of mines and non-dangerous objects



Visual image

Thermal image
53°C

Figure 7.2: Thermal infra-red measurements: APL and stone under 1cm sand

The CEO Programme

The CEO Programme has three key objectives which are linked. Firstly, it aims to increase the number of customers using information derived from earth observation. In order to achieve this, there must be a mature service provider base, and therefore the CEO Programme's second objective is to encourage and strengthen the European industrial and research organizations working in the field of earth observation. If this is to succeed the data and information needed by both providers and customers needs to be better known and made more available. Thirdly, the CEO Programme aims to provide an information exchange platform between industry, research organizations and customers, which will make data, information and services available and accessible. 1997 was the CEO Programme's second year of its "Design and Implementation Phase". Good progress was made towards meeting the Programme's aims.

Information on these activities can be found on the CEO web site at:

http://www.ceo.org

1. Customer and Market Development

Increasing the number of customers using information derived from Earth observation data

Customer Workshops for the CEO

At the beginning of 1997, the CEO Programme initiated a number of studies on the customer requirements for five new segments of the EO market, namely travel/tourism, environmental organizations, town/city authorities, insurance companies and civil engineering organizations. The objective was not only to identify the customer requirements of the different segments, but also to evaluate the market possibilities and to match appropriate EO products to the specific professional tasks and requirements of the customer. Companies within the EO industry throughout Europe carried out these studies.

As part of these contracts, the contractors have produced a final report as well as an "Information" paper aimed at their specific customer segment (see the CEO's web site, at http://www.ceo.org and select a Quick Link to Customer Segment studies). The CEO received very positive feedback on these studies from the contractors who ran the studies, from the customers contacted and from the EO industry. As a result CEO decided to commission another nine such studies. The contracts for the first four of these were awarded at the end of 1997. These include studies of water companies, agri-business, the shipping industry and the land navigation/digital mapping industry. The remaining five will be announced during February 1998.

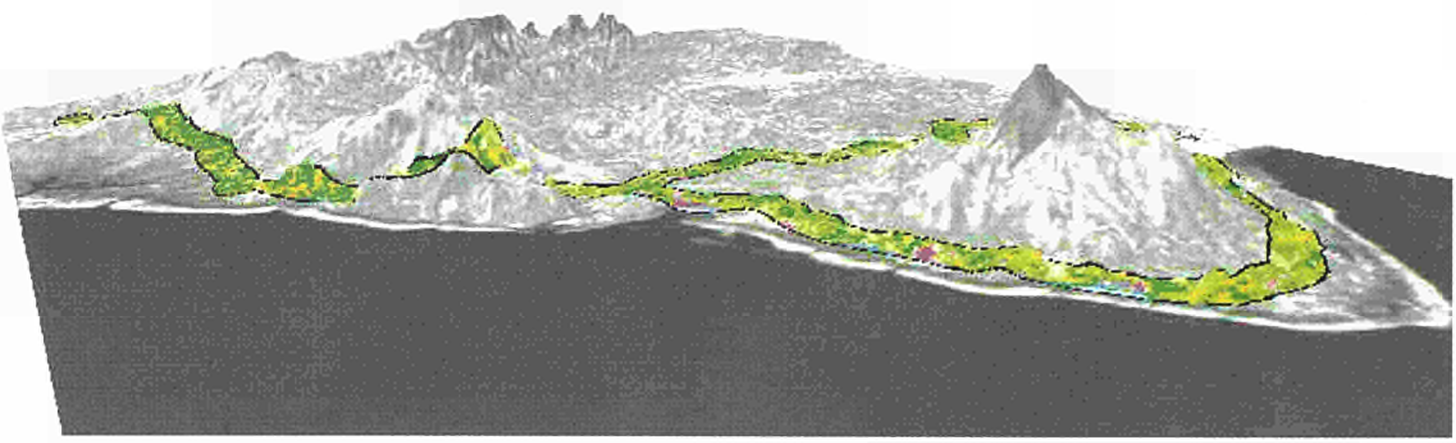


Figure 8.1: An example taken from the CEO's collection of demonstration case studies:- Road Network Inventory and Road Corridor Planning in Indonesia. Copyright Geoimage, France.

Demonstration Case studies

The CEO intends to attract new customers to EO by demonstrating how EO data and information can effectively be used in a wide variety of application areas. Following two calls for such demonstration case studies, the CEO has compiled a library of approximately 180 operational or near operational examples from organizations currently using remote sensing data. Each example contains information on costs and previous customers in order to help a new potential customer to rapidly assess the benefit or otherwise of EO data for his or her needs.

These examples have been made available on the Internet via the EWSE. They cover a broad range of thematic areas such as agriculture, cartography, civil planning, coastal areas, education, environment, forestry, geology, hydrology, ocean weather, oceanography and urban environments. These demonstration case studies will also be made available in 1998 on a multimedia CD-ROM that will include summaries in five languages. An image taken from an example of one of these case studies is shown in Figure 8.1.

Metadata Standards

Metadata are data used to describe the content, quality, condition and other characteristics of data. The CEO started to work on metadata in response to a strong requirement from the Earth observation (EO) community in Europe. Version 1 of the CEO's Recommendations on Metadata *i.e.*, "Describing the data, services and information you have available" was published in May 1997. This guide will be updated in 1998 and complemented by the release of a Metadata Authoring Tool, which will help users to comply to specified standards when describing their information resources. This will also ensure that they can advertise these resources through "INFEO", the CEO's future data and information system for Earth observation.

Education and Training activities

In 1997, the CEO initiated nine projects concerning the development of training material and/or providing training to several professional groups with little or no prior exposure to Earth observation. These projects involve the training of professionals either through courses or workshops, or through the preparation of educational material that is customized to the needs of a particular professional group. The items developed include user guides, videos, web pages, CD-ROMs and demonstration data sets, as well as training workshops.

Encouraging and strengthening the European Earth observation industry

Call for Proposals for Area 3.3 (CEO) of the Specific Programme for Climate and Environment

The CEO Programme is funding projects under its own Shared-Cost Action budget line. This falls under Area 3, Space techniques applied to environmental monitoring and research, of the RTD (Research and Technological Development) programme in the Environment and Climate Specific Programme. This budget line is managed by DGXII.

The CEO kicked off twenty-one large-scale projects during 1997, which are part funded (up to 50%) by industry. These contracts involve 115 organizations, (e.g., research institutes, private companies and public bodies), across the EU Member States or Associated States. A second Call for Proposals opened between June and October 1997, for which 100 proposals were received. The CEO hopes to fund a significant proportion of these proposals.

CEO launches application projects in support of EC Services

The CEO supports a number of application projects with the aim of demonstrating the usefulness of remote sensing to satisfy information needs within the Services of the European Commission. During 1997, the CEO Programme together with technical support from other Units managed five such projects. These are listed in Table 8.1 (next page).

Towards the end of 1997, a sixth project was kicked off called MURBANDY for DGXVI (Regional Policies).

Project Acronym	Thematic Area	Customer EC Service
LACOAST (see Chapter 3)	Land cover changes in European coastal areas	DGXI (Environment, Nuclear Safety and Civil Protection), DGXVI (Regional Policies), EEA (European Environment Agency)
SEARRI (see Chapter 2)	Monitoring of agriculture (wetland rice paddies) in SE Asia	DGIB (External Relations), DGVI (Agriculture), DGXI (Environment, Nuclear Safety and Civil Protection)
FMERS (see Chapter 1)	Forest monitoring in Europe with remote sensing	DGVI (Agriculture)
ATLAS (see Chapter 3)	Statistical analysis on urban agglomerations in Europe	EUROSTAT
DESIMA (see Chapter 5)	Decision support system for coastal areas	DGIB (External Relations), DGIII (Industry), DGVIII (Development), DGXI (Environment, Nuclear Safety and Civil Protection)

These projects are described in more detail under the relevant thematic application.

Table 8.1: Projects in support of EC Services

3. *EO Data and Information Exchange System*

The CEO Programme is the catalyst at the hub of an information system. The system is composed of distributed series of databases (accessible as if they are all situated in one location) intended to allow service providers and customers to provide or find data, information and services.

European users will gain the widest possible selection of information available through this directory which contains worldwide metadata sets.

The European Wide Service Exchange (EWSE)

In 1995 the CEO team developed a prototype information exchange system dedicated to Earth observation data, named the European Wide Service Exchange (EWSE) which, became operational in September of that year. The EWSE is based on the Internet and can be found at:

http://ewse.ceo.org/.

The EWSE is an easy-to-use dynamic database, which can be queried for information about EO by anyone with a connection to the Internet. In addition, registered users submit new information to the system using a WWW browser and, thereby advertise their products or services.

A snapshot of the EWSE at the end of September 1997, showed that it now contains 2000 registered users and over 1750 organizational entries. Among these are 500 registered organizations, 578 EO products, 50 training courses, 92 educational resources, 21 jobs, 74 events, 275 links to other sites and 163 case studies.

Implementation of "INFEO"

Implementation of "INFEO", the CEO's next generation information exchange system, was started at the beginning of 1997. In addition to all the functionality currently offered by the EWSE, 'INFEO' will, for the first time, allow users to simultaneous search many major, remote data collections.

'INFEO', (which will replace the EWSE), will provide European EO users with an easy-to-use system for querying data repositories on geographic, thematic, sensor or temporal subjects. It has been designed such that, although the databases are located in various places across Europe (or even the world), it will be perceived by its users as one integrated system. The system will be based on the CIP, and will for the first time offer users an easy, "one-stop shopping" opportunity for Earth observation data and information. It will mean that users can search for data without needing to know where the data are held.

Global Environmental Information Locator System (GELOS)

In 1996, the CEO Programme developed a prototype virtual library of environmental resources, in support of the G7 Environment and Natural Resources Management (ENRM) Project. In 1997, this ENRM virtual library was further developed and was renamed the GELOS. The GELOS Virtual Library prototype can be accessed via:

http://ceo.gelos.org/.

CEO is proud to announce that GELOS was presented to the participants of the Third Conference of the Parties (COP-3), which was organized by the United Nations Framework Convention on Climate Change (UN-FCCC) from 1st-10th December 1997 in Kyoto, Japan.

CEOS Information Locator System (CILS)

The CEO Programme has also developed an information server for the Committee on Earth Observation Satellites (CEOS), called the CEOS Information Locator System (CILS). CILS is a further development of the CEO's current prototype information service, the EWSE and GELOS.

CILS was developed with funding and management from DLR in Oberpfaffenhofen, and is especially designed to meet the requirements of users of Earth observation remote sensing data in developing countries.

Generic Information Server Toolkit (GIST)

The CEO has developed a generic software tool kit, based on the technology of the EWSE, which may be customized by the recipient host organization according to its own specifications. This tool kit will allow users to easily build their own interactive Web server. A notable advantage of this will be that these servers will use the same meta-information standards and interoperability protocols as "INFEO". This will make searches possible among different customized information servers, as well as full searching of these by users using the EWSE/'INFEO'.

Partner organizations can use GIST to set up and maintain a "community" web site at a small fraction of the cost of a bespoke system. In addition, it will allow these organizations to contribute to the future EO information exchange system of the CEO. GIST will be offered free of charge to organizations, subject to a written agreement with the CEO.

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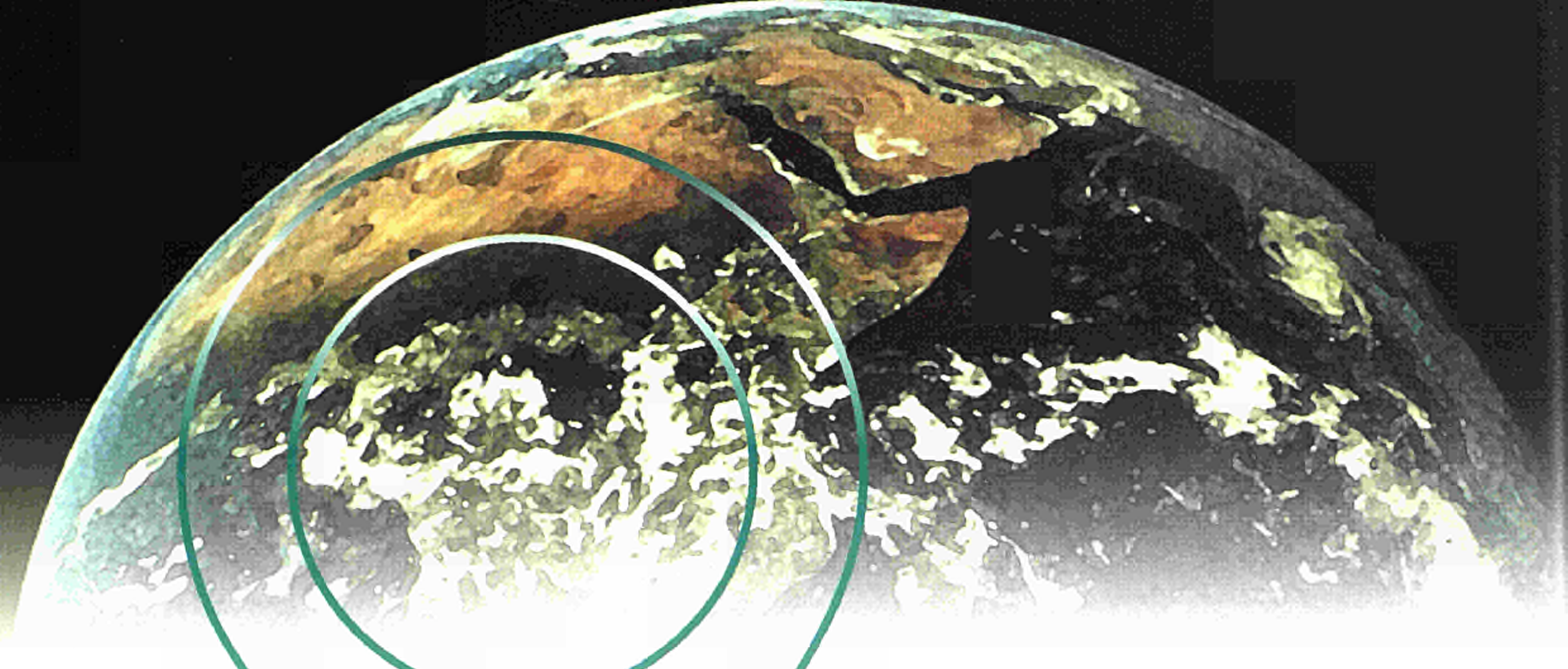

New Sensors

The SAI has dedicated special attention to new sensors in a number of different ways.

Firstly, special effort has been placed on the development of improved algorithms and methods in order to exploit remote sensing data from future Earth observation sensors. New vegetation indices, designed to estimate the fraction of absorbed photosynthetically active radiation have been defined for use with the data generated by the MERIS (on-board ESA's ENVISAT-1), VEGETATION (on-board SPOT-4) and GLI (on-board NASDA's ADEOS-II platform) instruments. These activities fall under SAI's ARSENAL (Advanced Remote SEnsing AppLications) activity.

1. The Arsenal Activity

The ARSENAL (Advanced Remote SEnsing AppLications) activity, has been organized in the SAI to develop improved analysis methods of remote sensing data, in support of various applications. The activity regroups and spans a number of ongoing projects and has set-up some new actions, which all rely on a coherent set of tools such as radiative transfer models and inversion procedures. Initially, the focus of this activity will be on the exploitation of the new generation of optical sensors.

Co-ordination of research

In the framework of the ENAMORS concerted action (see Chapter 11), a major conference was organized in Tusuula, Finland between 17th-19th September 1997. The objective of the workshop was to discuss the future of remote sensing in Europe. In particular the topics covered were the knowledge gap between the scientific and engineering world on the one hand and the user community on the other, and the need for better algorithms, products and services. The conference gathered members from the user, research, and industrial communities together with representatives from space agencies.

Up to date information on the activities of this project can be found on the WWW at:

http://www.mtv.sai.jrc.it/projects/ enamors/web/home.html

Basic investigations

A number of topics have been investigated and presented in publications. These are:

1. The theoretical limits of estimating LAI (Leaf Area Index) with space sensors,
2. The role of the boundary conditions in solving radiative transfer problems,
3. The coupling of radiative transfer models in different geophysical media (surface-atmosphere coupled models),
4. The similarities and differences between the radiative transfer in plant canopies and in the atmosphere.

Development of improved models and tools

The 'NADIM' model, a state-of-the art semi-discrete one-dimensional bidirectional reflectance computer code, has been completed and published (see Chapter 6). The source code of this model is distributed through the ENAMORS web site given above.

"RAYTRAN", the previously developed ray tracing code for investigating the radiative transfer in complex natural surfaces (such as vegetation canopies) is being expanded to the atmosphere/surface system. The upgraded code will be an important element for building a generic end-to-end simulator of remote sensing systems, including all relevant processes contributing to the quality of products derived from space optical sensors.

Development of new processing algorithms and products

Recent advances in the understanding of radiation transfer, as well as in-depth investigations of the nature and interpretation of vegetation indices have resulted in a body of knowledge that can now be used to design spectral indices optimizing for a particular application and a specific sensor. This new approach is being applied to the definition of spectral indices optimized for the MERIS, VEGETATION and GLI sensors.

Two new projects were initiated in this field in 1997. The MAUVE Project (see Chapter 11), is a SCA (DG XII) which aims at documenting the levels of Ultraviolet radiation likely to present harmful consequences for organisms (including humans) in Europe. Another project has been initiated in collaboration with EUMETSAT to provide reliable estimates of surface albedo to the ECMWF and the overall scientific community. The geographical area of study is the African continent, and the time period covered is the past decade. This information is critical for the accurate prediction of weather, or for long-term climatological studies.

2. Land Cover Mapping

Besides the preparation of specific applications for the use of the VEGETATION instrument the SAI has ensured a liaison role with the VEGETATION Programme. The SAI also co-ordinates a VEGETATION Interest Group called VIGIS (VEGETATION Interest Group In SAI) covering the interests and participation of the entire Institute.

The SAI's contribution to the IGBP AVHRR 1 km global land cover map continued in 1997. Extensions to this activity along the lines of the needs of the European Commission services e.g., in the fields of land degradation and desertification (particularly in Africa), are possible and may incorporate data retrieved from the VEGETATION instrument.

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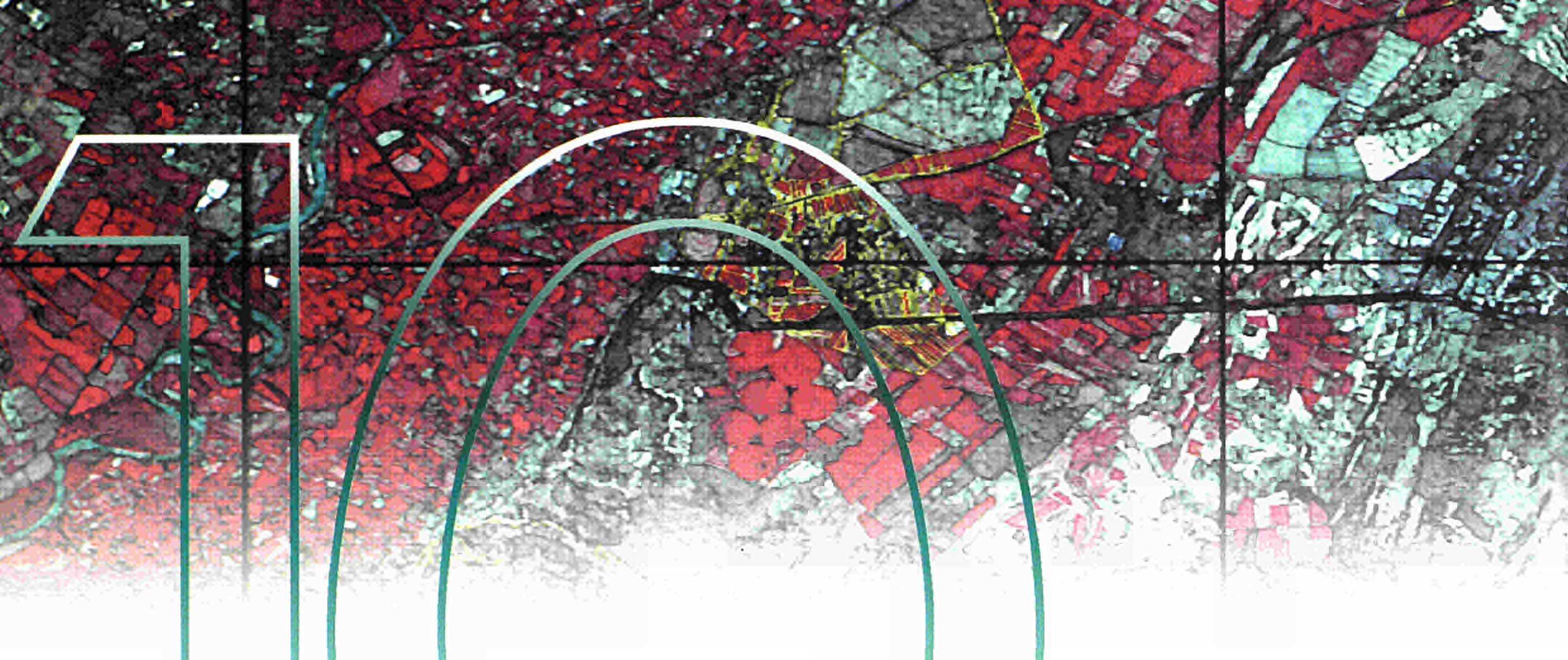


10 Regional Projects

ENVIREG Programme (Sicily, Italy)

This programme, which is being managed by the JRC's Institute for Systems, Informatics and Safety (ISIS), is being carried out on behalf of the Italian Environment Ministry. One of the main aims of the project is to set up an integrated system for monitoring and preventing pollution from three key industrial sites: i) Augusta-Priolo-Melili (Siracusa), ii) Gela (Caltanissetta) and iii) Milazzo (Messina). The SAI, is contributing to these activities with the following two studies.

Development of a Coastal Information System in Sicily

Orbital remote sensing data and conventional cartographic data have been used in an experimental GIS to develop sample information products, describing the main bio-geochemical and dynamic characteristics of marine waters in the coastal zone. Historical time series of remotely sensed (optical) data have been used to cover the various spatial scales of interest in the marine environment, *i.e.*, from regional (CZCS data), to local (Landsat-TM data), where the spatial resolution ranges from 1.0 km to 0.03 km respectively.

The problem of the very short time scales of many marine phenomena has been addressed by analyzing the data from a statistical point of view, for the definition of a reference environmental background. The application of specific algorithms enabled the estimation of pigments (such as chlorophyll) and sediments, as well as an assessment of their diffusion and transportation in coastal plumes.

The integration of remote sensing and cartographic data, through the use of GIS techniques, now renders it possible to compile information products which provide a synoptic view of coastal and marine environmental conditions. The results can be interpreted in terms of coastal runoff dynamics and water quality, sediment transport and coastline accretion/erosion. Furthermore, the information products provide elements useful to define future strategies for environmental monitoring and to exploit new coastal/marine remote sensing systems (Figure 10.1).

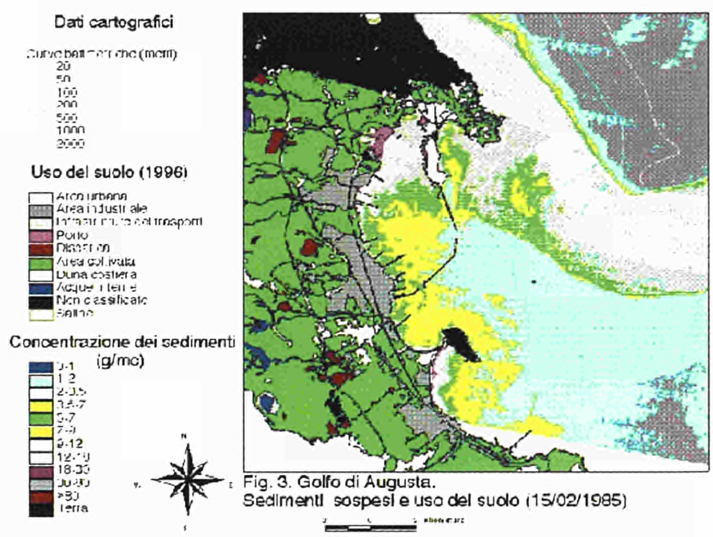


Figure 10.1: Coastal land use and suspended sediments in the Golfo di Augusta (Sicily), from 1985 Landsat-TM and classical cartographic data

Legenda

- Aree urbanizzate
- Aree industriali
- Rete varia (strade, ferrovie, autostrade)
- Aree portuali
- Cave o discariche
- Aree agricole
- Boschi o cespugli
- Aree costiere (spiaggie e dune)
- Acque interne e alvei fluviali
- Non classificato

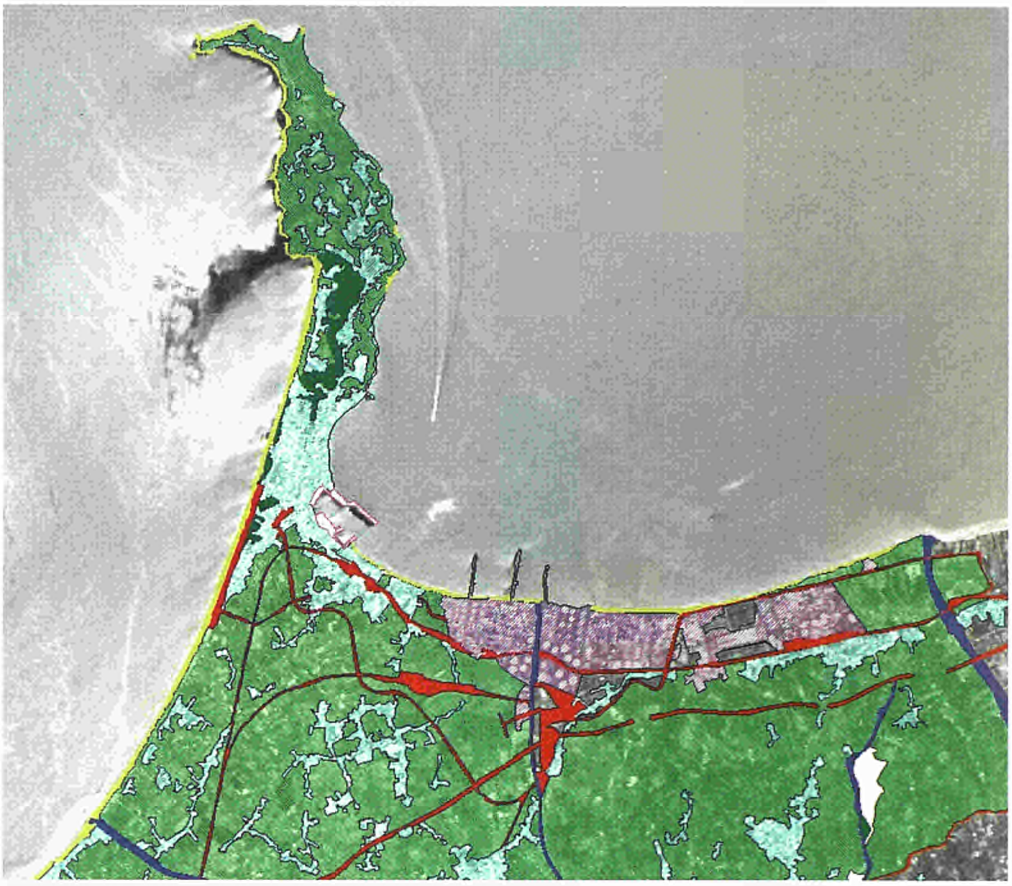


Figure 10.2: Land use map of the Milazzo area, Sicily

Satellite-borne and air-borne remote sensing applications for physical planning and environmental monitoring in petro-chemical industrial areas.

SPOT panchromatic data were used to produce general land use maps for all three of the industrial zones and their surroundings (Figure 10.2). Conventional air-photos were used to give a detailed overview of land use patterns. A procedure was developed to extract major large-scale land cover changes using a time series of SPOT panchromatic imagery. A total of thirty spectral classes were combined and labelled into land cover classes with the aid of multi-spectral SPOT data.

Coastal features were examined using the same data sets. No major morphological changes were detected over the 10-year period. Field work revealed erosion had taken place in the Milazzo area, but the magnitude was not such that it could be detected using the 10 m spatial resolution of the SPOT panchromatic data.

Selected further reading

Minacapilli, M., Paracchini, M.L., Bertolo, F., Folving, S. and Barale, V. 1997. Correlation between run-off and variations of coastal pigment concentration: - A case study from the Sicilian watershed of the Simeto river. Proceedings from MEDcoast, 3rd International Conference on the Mediterranean Coastal Environment, Malta, 11-14 November 1997.

Odone, B., Barale, V. 1997. Sviluppo di prodotti informativi per il monitoraggio delle condizioni ambientali marine nella zona costiera; 1a conferenza nazionale delle associazioni scientifiche per le informazioni territoriali e ambientali, Parma, 1997.

Paracchini, M.L., Minacapilli, M., Bertolo, F. and Folving, S. 1997. Soil erosion modelling and coastal dynamics: A case study from Sicily. In: Proceedings from 23rd Annual Conference of the Remote Sensing Society, Reading 2-4 September, 1997.

Sapio, F., Filippi P., Odone, B. and Barale, V., 1996. Integrating marine and terrestrial remotely sensed parameters at the regional and local scale in a geographic information system for the island of Sicily; European symposium on satellite remote sensing III, Taormina 1996.

11 Services to the Commission

In 1997, the SAI continued to support the Commission and its agencies' services.

In accordance with the Fourth Framework Programme, SAI, in partnership with European entities, participated in the EC's shared cost actions (SCA) and Concerted Actions (CA). In 1997, 26 projects were running. Table 11.1 lists these projects and the customer Commission Services. Some of these activities have already been introduced earlier in the report under the appropriate thematic area.

In 1997, the CEO Programme launched a number of application projects specifically in support to EC Services. These are listed in Table 8.1.

1. Share Cost and Concerted Actions

Table 11.1 lists all Share Cost Actions (SCA) and Concerted Actions (CA), which commenced, continued or were completed in 1997. The final column lists the Commission service who are the clients of the work being carried out.

2. CEO's Application Projects in Support of EC Services

The CEO Programme supports a number of application projects with the aim of demonstrating the utility of remote sensing to satisfy information needs within the Services of the European Commission (Chapter 8 and Table 8.1). Although the Commission is one of the largest single civilian users of remote sensing data in Europe today, there are still many other areas where remote sensing could be applied to collect information for defining, implementing or monitoring policies of the European Union. These include areas such as regional development, environmental monitoring, agriculture or external economic co-operation. Once successfully demonstrated, it is envisaged that the use of Earth observation data will become an operational part of the information gathering required to support EU policies.

Acronym	Title (in full)	Project type	Start date	End date	DG/ Other
APERTURE	Environmental Typological Space Mapper Facilitating the Implementation of European Legislation	SCA	Dec-97	May-00	DG XII
BASYS	Baltic Sea System Study	SCA	Aug-96	Jul-99	DG XII
CANIGO	Canary Islands Azores Gibraltar Observation	SCA	Aug-96	Sep-99	DG XII
CASOTS	Combined Action to Study the Ocean Thermal Skin	CA	Mar-96	Feb-98	
CEVEX	Concentration on European Validation Experiments for Coastal/Shelf Water Remote Sensing	CA	Dec-96	Nov-98	DG XII/ E2C
CLEAN SEAS	Clean Seas: European Marginal Seas - a Study in Pollution Monitoring from Space	SCA	Dec-96	Nov-99	DG XI
COASTLOOC	Development of Algorithms for the Use of Ocean Colour Data in Coastal Waters to Detect Optically Active Material and Assess Biological Processes	SCA	Oct-96	Sep-99	DG XII
COLORS	Coastal Region Long-Term Measurements for Colour R.S. Development and Calibration and Validation	SCA	Dec-97	Nov-00	DG XII/ MAST-III
COMPARES	Connectionist Methods for Preprocessing and Analysis of Remote Sensing Data	CA	Mar-96	Feb-97	DG XII
DEMON-2	An Integrated Approach to Assess and Monitor Desertification Processes in the Mediterranean Basin	SCA	Mar-96	Feb-99	
DESIRE	Development of a European Service for Information on Research and Education - Monitoring the Quality of Information Services delivered to users (MUSIQ) (JRC led work-package)	SCA	Jan-96	Jun-98	DG XIII-C
ECOSIM	Ecological and Environmental Monitoring and Simulation System for Management Decision Support in Urban Areas	SCA	Jan-96	Dec-98	
ENAMORS	European Network for the Development of Advanced Models to Interpret Remote Sensing Data over Terrestrial Environment	CA	Feb-96	Feb-99	
EROS-21	Bio-geochemical Interactions between the Danube River and the North-Western Black Sea	SCA	Aug-96	Jul-98	DG XI
FLIERS	Fuzzy Land Information from Environmental Remote Sensing	SCA	Oct-96	Sep-99	DG XII
ISIS	Interactive Satellite Image Server	SCA	Nov-95	May-98	DG III
MARIE-C	Monitoring of Agriculture Resources in Europe - Crops	SCA	Jan-97	May-99	DG VI-JRC
MARIE-F	Monitoring and Assessment of Resources in Europe - Forest	SCA	Dec-96	May-99	DG XII
MAUVE	Design and Assessment of Global, European and Regional Scale, UV Irradiance Maps based on Satellite Data and Ground Measurements	SCA	Dec-97	Nov-99	DG XII
MAVIRIC	Machine Vision in Remotely Sensed Image Comprehension	CA	Dec-97	Feb-99	DG XII
MEDALUS	Mediterranean Desertification and Land Use, Project 3	SCA	Jan-96	Dec-98	DG XII/ D2
MTP-MATER	Mediterranean Targeted Project II - Mass Transfer and Ecosystem Response	SCA	Jul-96	Jun-99	
NEUROSAT	Processing of Environmental Observing Satellite Data with Neural Networks	SCA	Nov-96	Apr-99	
PAAGE	Pilot Project for Agriculture and Agri-Environment	SCA	Nov-97	Feb-99	
PHASE	Physical Forcing and Bio-geochemical Fluxes in Shallow Coastal Ecosystem	SCA	May-96	Apr-99	
PRONET	Multi-Media Computer Based On-Line Training and Support Service for Professionals	SCA	Jan-96	Jan-98	DG XIII

Table 11.1: Share Cost and Concerted Actions, commenced, continued or completed in 1997

Technology Transfer and Third Party Work

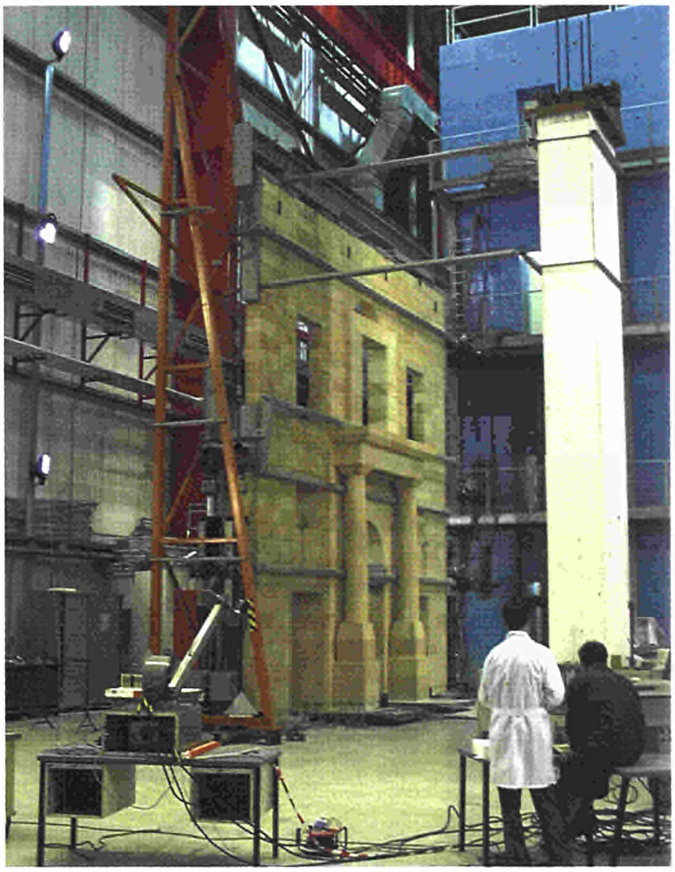


Figure 12.1: The facade of Palazzo Geraci undergoing deformation tests at ELSA while the LISA SAR system acquires radar data to assess the deformation behaviour by means of 3-D SAR Interferometry

Technology Transfer

Structural deformation mapping and monitoring by SAR Interferometry

In recent years, SAR Interferometry techniques have been adopted for a number of practical applications. One such application is the mapping and monitoring of deformations in large structures such as buildings, bridges and dykes. The techniques can be applied using ground-based imaging radars that can achieve spatial resolution of a few centimetres with a sensitivity of a fraction of a millimetre in measuring the position of each pixel.

Following the positive outcome of a feasibility experiment performed at the EMSL using two reinforced concrete bars (May, 1996), a more complex experiment was launched at the beginning of 1997. This involved using a reproduction of the facade of Palazzo Geraci in Palermo, which was under investigation at the European Laboratory for Structural Assessment (ELSA) at the JRC, to evaluate the effects of severe earthquakes. For this test the transportable SAR system, LISA, was installed in the measurement hall of ELSA and configured in such a way as to provide three-dimensional interferometric images of the façade (Figure 12.1). The deformation pattern retrieved from the microwave images was found to be well correlated with the static displacements applied to the structure. This demonstrates that SAR interferometry can be an efficient and alternative approach to monitor and map structural deformations in large structures, where the use of traditional methods (optical sensor and/or mechanical transducers) can be cumbersome, time consuming and expensive.

The next step will be to prove the applicability and utility of this technique on an outdoor large building. This will be carried out in collaboration with an external company interested in developing a prototype instrument. This verification work will be undertaken with the financial support of the Commission's Directorate General XIII, and will be completed by the end of 1998.

Selected further reading

Tarchi, D., Ohlmer, E., and Sieber, A. 1997. Monitoring of Structural Changes by Radar Interferometry. Research on Nondestructive Evaluation, No. 9: 213-225, Springer-Verlag New York Inc.

Third Party Work

Antenna pattern measurement of telecommunication antennas inside a car

The EMSL facility has been used to measure the radiation pattern of new types of antennas for telecommunication applications once mounted inside cars (e.g. automatic road billing systems). This investigation, which was contracted by BMW to the University of Karlsruhe - Institute of High Frequency Techniques (IHE), includes a third party contract to the SAI in which the EMSL is employed to perform the measurements. The measurements have been carried out in four bands, for different types of antennas. Rotating the car in azimuth, as shown in Figure 12.2 retrieves the entire horizontal radiation pattern.

Measurements of paper quality by optical methods

In collaboration with the University of Helsinki, measurements of paper quality were performed in the EGO for the "UPM-Kymmene Company", "Kemira Pigments" and the "ABB Corporation". The measurements, in the 400-2500 nm range, focused on the scattering and transmission of light by paper, the bidirectional reflectance distribution function of titanium oxide (a common pigment in papers) and paper fibres (Figure 12.3). The results will play an important role in developing new methods of paper production which are less demanding on the use of natural resources. The main impact is in the reduced use of cellulose and chemicals, and in a better end product. Improved knowledge of the reflectance characteristics of titanium oxide could lead to a more efficient use of this material in the paint industry. Such results are therefore, of interest to "Kemira Pigments".

For intercalibration purposes, two sets of reference materials (titanium oxide) were measured with the EGO and with the DLR's spectro-goniometer. The spectral measurements made from both these instruments will be useful for quality assurance in the pigment industry.

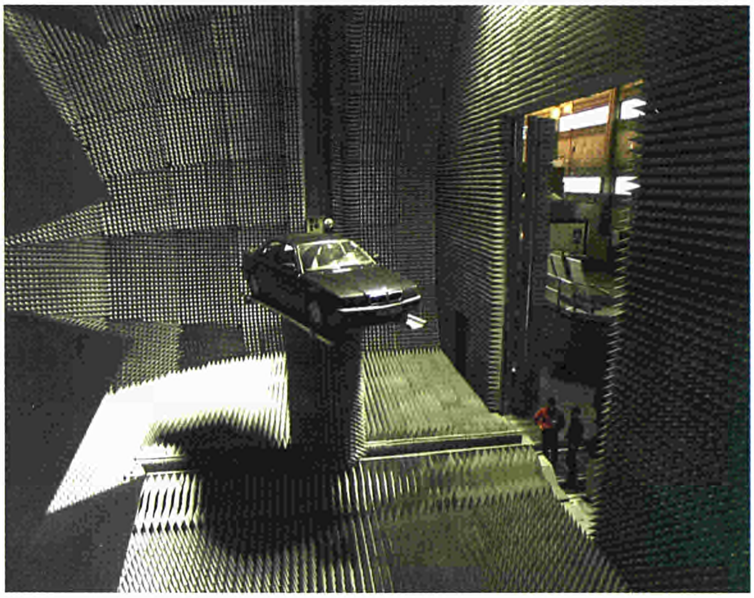


Figure 12.2: A BMW car is transported inside the measurement chamber. The radiation patterns of different types of telecommunication antennas located inside the car are measured by performing a full rotation of the target positioner about the vertical axis

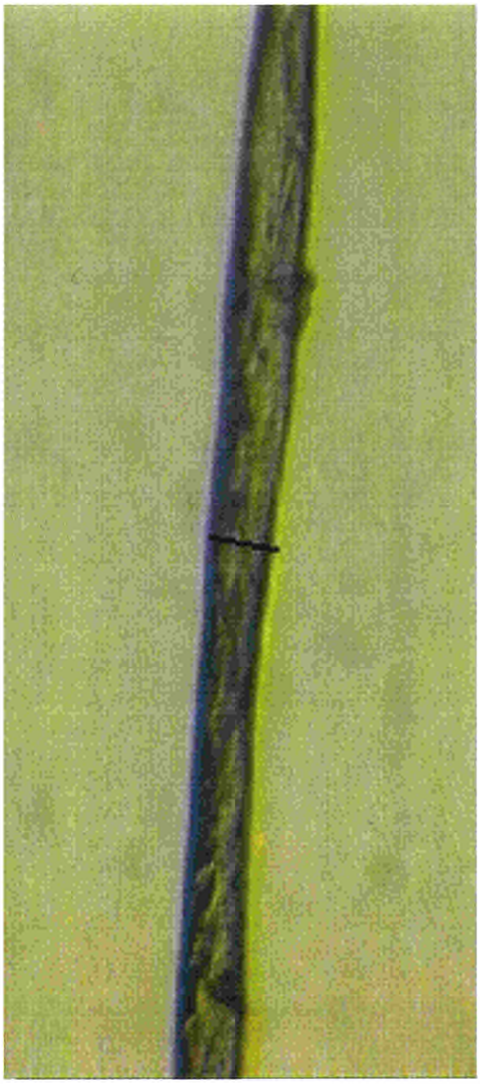


Figure 12.3: Paper fibres (provided by ABB Corporation Research Centre, Vaasa, Finland)

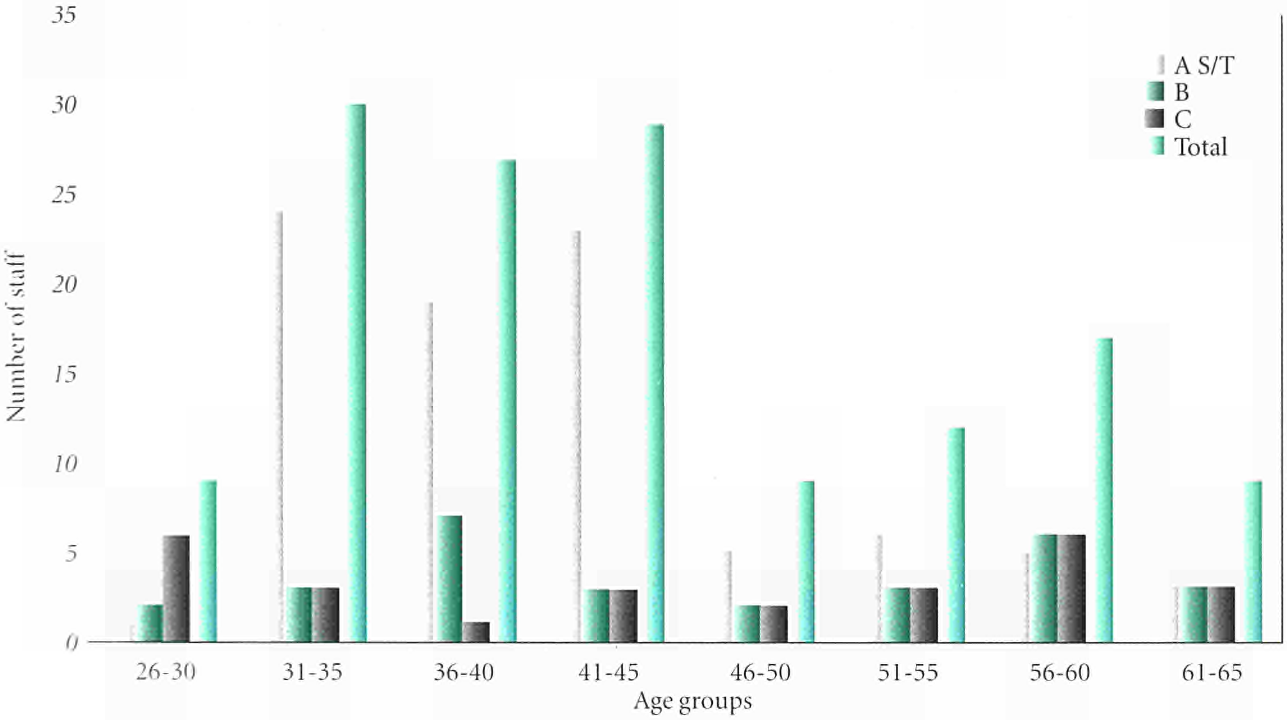
Staff

Unit	Stat. Staff	VS	PhD	Pdoc	Stag.	Total
AT	22	2	1	1	2	28
AIS	36	2	5	2	2	47
ME	18	2	4	2	6	32
MTV	17	1	2	1	9	30
EMAP	16	0	4	1	4	25
CEO	21	3	1	4	0	29
Dir	12	1	0	0	1	14
Totals	142	11	17	11	24	205

SAI staff distribution by unit and staff category, December 1997

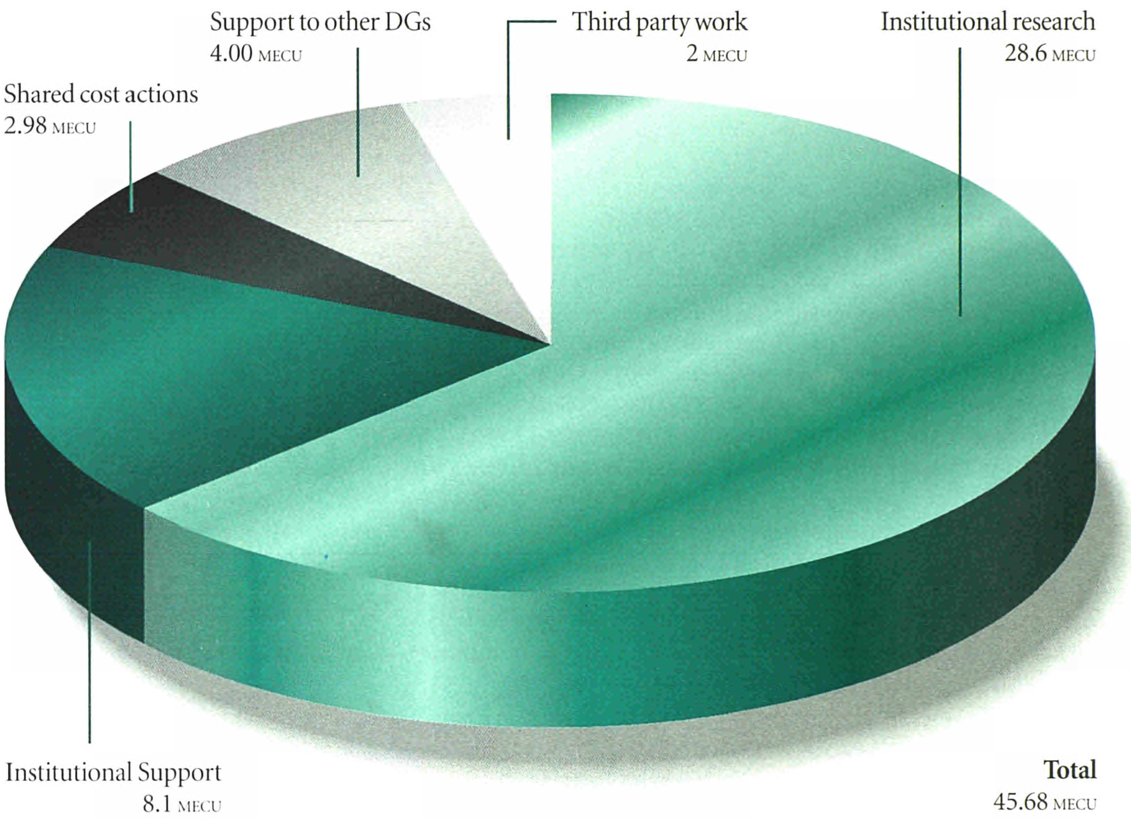
AT: Advanced Techniques
AIS: Agricultural Information Systems
ME: Marine Environment
MTV: Monitoring Tropical Vegetation
EMAP: Environmental Mapping and Modelling
CEO: Centre for Earth Observation
Dir: Directorate

Stat. Staff: Statutory staff
VS: Visiting scientist
PhD: PhD students
Pdoc: Post-doctorate research fellows
Stag.: Trainees



Statutory staff distribution by age and category, December 1997

Finances


Support to other DGs
4.00 MECU
Third party work
2 MECU
Institutional research
28.6 MECU
Shared cost actions
2.98 MECU
Institutional Support
8.1 MECU
Total
45.68 MECU

F

EWSE

In 1995, the CEO team developed an information exchange system dedicated to Earth observation data, named the European Wide Service Exchange (EWSE) which became operational in September of that year. The EWSE is based on the Internet and can be found at:

http://ewse.ceo.org/.

The EWSE is a dynamic on-line database of EO information (Figure 13.1). It provides tools such as:

- free text searching
- key word enquiries
- geographic searches
- search by category
- remote, on-line information submission and updating

The EWSE includes on-line user forums on remote sensing topics, such as remote sensing news groups and mailing lists, and an interactive Q & A section. Registered users can also subscribe to a regular, automatic e-mail broadcast of "What's new" on the EWSE.

Since its release, the EWSE has continually been improved and updated. During 1997, a new integrated search facility was made available. This "Super Search" is a Java applet which brings together all query possibilities into a single interface. Users can combine geographic, temporal, category and free text search into a single query. In September, a new section containing information about satellite data was added which offers "quicklooks" and limited access to catalogues of satellite images.

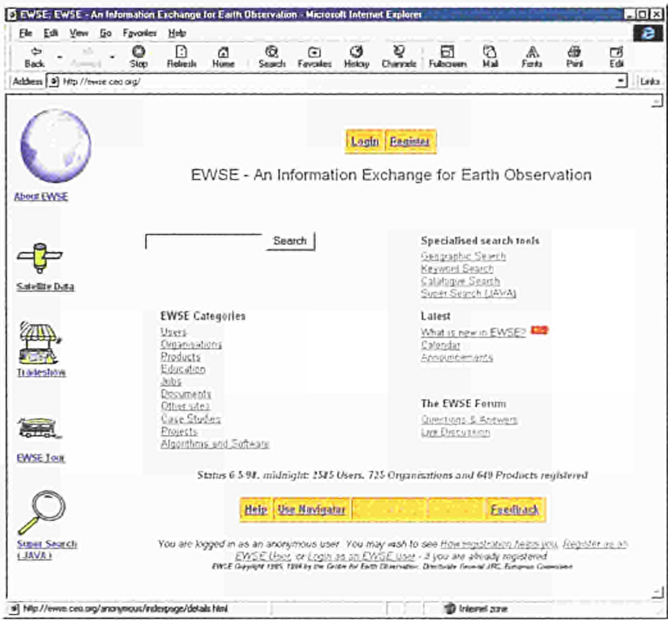


Figure 13.1: The European Wide Service Exchange (EWSE) home page

Since its launch in September 1995, over 2000 users and over 500 companies have registered on the EWSE. These users are based in 47 different countries worldwide. Most are from Europe, but a significant number of participants are from the USA, Canada and Australia. Currently, the EWSE web site is visited over 10,000 times per week.

EMSL

The European Microwave Signature Laboratory (EMSL) of the SAI is designed for experiments in the field of radar signature research. It is a unique European facility, which complements ground, air- and space-borne radar measurements by providing stable and reproducible environmental conditions, and operational modes for well-controlled experiments of microwave scattering.

The EMSL consists of a large anechoic chamber, providing the environment and the facilities to perform radar measurements. The measurements essentially can provide the spatial scattering pattern of the object under test in a three-dimensional characterization. The radar scattering matrix is measured, which represents the Microwave Signature of the target, the most comprehensive information from active microwave measurements. Other widely used parameters such as the Radar Cross Section (RCS) can be directly derived from the scattering matrix. The variety of measurement options can be used in two basic ways: scatterometric and imaging modes.

The facility, in addition to the monostatic configuration of usual radar systems, offers polarimetric measurement features in bistatic and multistatic configurations. This gives additional dimensions in the measured data for characterizing a target, validating a model, or testing of new sensors.

All collected data (microwave data, system parameters, environmental conditions, optical images) are transferred to the EMSL Information Management System. This data archiving and handling system was especially developed to cope with the complex information management for all data generated by the EMSL activities and related research.

In 1996, the first EMSL Reference Data CD-ROM on Radar Imaging Techniques was created with the financial support of DG XIII in the frame of the VALUE (VALorization and Utilization for Europe) Project. A new contract was awarded in 1997 for the implementation of a more efficient approach aimed at the dissemination of EMSL results and remote use of proprietary processing tools based on Internet technology. The Web Server "EMSL on Line" will be operative in 1998. It will allow, access to selected data packages, an overview of the general contents, down load facilities for specific data files and, most important of all, capabilities to run the EMSL proprietary processing tools to obtain new results according to the users' selection of parameters

European Goniometric Facility (EGO)

A fully automated European Goniometric Facility (EGO) is in operation at the SAI. It can perform bidirectional reflectance measurements of natural and artificial targets which may be of interest to various remote sensing applications. In particular, such measurements increase our understanding of the reflectance properties of both man made and environmental objects as seen from air- or space-borne instrumentation.

The structure of the EGO consists of two independent rotating arcs, one for the light source and the other for the detector, which allow variable geometrical configurations.

A variety of radiometers, spectrometers, precise light power meters and CCD cameras can be mounted as detectors in the EGO. Collimated halogen lamps or laser sources are currently used to provide the illumination, though the use of natural light is a future option, which would, of course, enhance the potential of the goniometer. To complement the EGO facility, a radiometric calibration laboratory permits precise calibration of the EGO detectors.

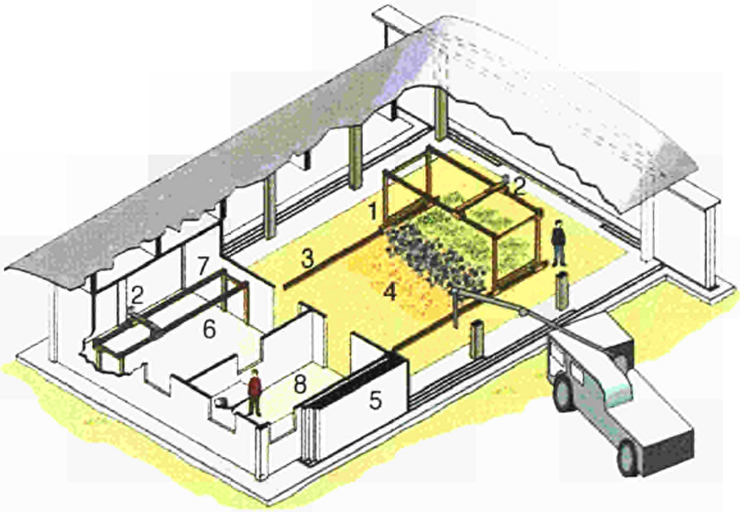


Figure 13.2: Layout of the non-metallic electromagnetics laboratory

European Electromagnetics Test Facilities

The Electromagnetics Test Facilities located at the SAI allow high sensitivity electromagnetic assessments using metal detectors, radars and IR sensors. The facilities consist of:

- A Non-Metallic Electromagnetics Laboratory, positioned in an electrically quiet area and constructed with minimal metal content, rendering it especially suitable for the evaluation of metal detectors,
- An Outdoor Test Facility which includes an aluminium test frame for complementary measurements in outdoor environments.

The Non-Metallic Electromagnetics Laboratory comprises an outer area and an enclosed area, both under a common non-metallic roof (Figure 13.2). With the facility closed there is the possibility of controlling the local environment. The facility enables the evaluation of the interactions of anti-personnel mines and soil or other environmental components on different types of sensors. Reference targets are used for the comparative testing of different sensors.

The establishment of a basic signature database of anti-personnel mines is planned for 1998.

Acronyms

ACSAD	Arab Centre for the Studies of Arid zones and Dry lands
ADEOS	ADvanced Earth Observation Satellite
APM	Anti-Personnel Mine
ARSENAL	Advanced Remote SENsing AppLications
AVHRR	Advanced Very High Resolution Radiometer
AVHRR-GAC	Advanced Very High Resolution Radiometer-Global Area Coverage
BRDF	Bidirectional Reflectance Distribution Function
CADMOS	Committee of Advisors: Detection of Mines based on Operational Standards
CAP	Common Agricultural Policy
CASOTS	Combined Action to Study the Ocean Thermal Skin
CCD	Charge-Coupled Devices
CEMAGREF	Centre d'Etudes de Machinisme Agricole du GREF (Genie Rural des Eaux et Forêts)
CEO	Centre for Earth Observation
CEOS	Committee on Earth Observation Satellites
CEVex	Concentration on European Validation experiments for Coastal/Shelf Water Remote Sensing
CGMS	Crop Growth Monitoring System
CILS	CEOS Information Locator System
CIP	Catalogue Interoperability Protocol
CLC	CORINE Land Cover
CLUSTERS	Classification for Land Use Statistics: EUROSTAT Remote Sensing Programme
CMO	Common Market Organization
CNASEA	Centre Nationale pour l'Amenagement des Structure des Exploitations Agricoles
CNRS	Centre National de la Recherche Scientifique
CoASTS	Coastal Atmosphere and Sea Time Series
COLORS	Coastal Region Long-Term Measurements for Colour Remote Sensing Development and Calibration and Validation
COMPARES	COnnectionist Methods for Preprocessing and Analysis of Remote Sensing Data
COP-3	Third Conference of the Parties
CORINE	Co-ordination of Information on the Environment
CORSA	Cloud and Ocean Remote Sensing around Africa
CZCS	Coastal Zone Color Scanner
DAIS	Digital Airborne Imaging Spectrometer
DEMON-2	DEsertification MONitoring – An Integrated Approach to Assess and Monitor Desertification Processes in the Mediterranean Basin
DESIMA	DEcision Support for Integrated coastal zone MAnagement
DG	Directorate General
DLR	Deutsches Zentrum für Luft- und Raumfahrt
DTM	Digital Terrain Model
E.E.A.	European Environment Agency
EARSeL	European Association of Remote Sensing Laboratories
EC	European Commission
ECMWF	European Centre for Medium-Range Weather Forecasting
ECOFAC	Conservation et utilization rationnelle des ECOsystèmes Forestiers en Afrique Centrale
ECU	European Currency Unit
EFICS	European Forest Information and Communication System
EFTA	European Free Trade Association
EGO	European GOniometer
ELSA	European Laboratory for Structural Assessment
EMSL	European Microwave Signature Laboratory
ENAMORS	European Network for the development of Advanced Models for the interpretation of Remote Sensing data
ENRM	Environment and Natural Resources Management
ENV	Environment and Climate
Envisat	Environmental Satellite
EO	Earth Observation
EOS	Earth Observing System
ERS	European Remote Sensing Satellite
ESA	European Space Agency
ESB	European Soil Bureau
EU	European Union
EUMETSAT	EUropean Organization for the Exploitation of METeorological SATellites
EUROSTAT	Statistical Office of the European Communities
EWSE	European Wide Service Exchange
FACOSI	Facility for the Automated Construction of Optimized Spectral Indices
FAO	Food and Agricultural Organization
FARSITE	Fire Area Simulator
FIRE	Fire In global Resources and Environment monitoring

FLIERS	Fuzzy Land information from Environmental Remote Sensing
FOFEM	First Order Fire Effect Model
GELOS	Global Environmental Locator Service
GHz	GigaHertz
GIS	Geographic Information System
GIST	Generic Information Server Toolkit
GLI	GLobal Imager (sensor on-board NASDA's ADEOS-II platform, to be launched in 1999 or 2000)
GPR	Ground Penetrating Radar
GPS	Geographical Positioning System
GVI	Global Vegetation Index
HYPRES	HYdraulic PRoperties of European Soils
IACS	Integrated Administration and Control Systems
IGBP	International Geosphere-Biosphere Programme
IGN	Institute Geographique National
IKSO	International Kommission zum Schutz der Oder
INPE	Instituto Nacional de Pesquisas Espacial (Brazil)
IRS	Indian Remote Sensing Satellite
ISIS	Institute for Systems, Informatics and Safety
JERS	Japanese Earth Remote Sensing Satellite
JRC	Joint Research Centre
LAI	Leaf Area Index
Landsat-MSS	LAND remote sensing SATellite – Multi-Spectral Scanner
Landsat-TM	LAND remote sensing SATellite- Thematic Mapper
LISA	LInear SAR
MARS	Monitoring Agriculture with Remote Sensing
MARS-PAC	Monitoring Agriculture with Remote Sensing – Common Agricultural Policy Sector
MARS-STAT	Monitoring Agriculture with Remote Sensing – Statistical Sector
MAST	Marine Science and Technology
MAUVE	MApping UltraViolet by Europe
MAVIRIC	MAchine Vision In Remotely sensed Image Comprehension
MEDA	Mediterranean Actions
MEDALUS	MEditerranean Desertification And Land USe
MERA	MARS and Environmental Related Activities
MERIS	Medium Resolution Imaging Spectrometer (on-board ESA's ENVISAT platform, to be launched in 2000)
METEOSAT	METEOrological SATellite
MISR	Multi-angle Imaging SpectroRadiometer (on-board NASA's EOS-AM/1 platform, to be launched in 1999)
MMR	Modular Multi-band Radiometer
MURBANDY	Monitoring URBAN DYnamics
NASDA	National Space Development Agency of Japan
NGO	Non-Government Organization
NIR	Near infra-red (range of the electro-magnetic spectrum)
NNW	Neural NetWork
NOAA	National Oceanographic and Atmospheric Administration
OCEAN	Ocean Colour European Archive Network
OSS	Observatoire du Sahara et du Sahel
PAAGE	Project on Agriculture and AGri-Environment
PC	Personal Computer
PSU	Primary Sampling Unit
RADARSAT	RAdio Detection And Ranging Satellite
RESURS MSU-E	Russian Satellite – narrow swath instrument
RTD	Research and Technological Development
SAI	Space Applications Institute
SAR	Synthetic Aperture Radar
SCA	Share Cost Action
SILVICS	Satellite Image Land Vegetation Integrated Classification System
SMA	Spectral Mixture Analysis
SME	Small or Medium size Enterprise
SOS	Satellite Observing Systems
SPACE	Software for Processing AVHRR data for the Communities of Europe
SPOT	Système pour l'Observation de la Terre
SST	Sea Surface Temperature
SSU	Secondary Sampling Unit
TBFRA-2000	Temperate and Boreal Forest Resource Assesment-2000
TFIS	Tropical Forest Information System
TIR	Thermal infra-red (range of the electro-magnetic spectrum)
TMR-LSF	Training and Mobility of Researchers – Large Scale Facility
TREES	Tropical Ecosystem Environment observation by Satellite
UN-CCD	United Nations-Convention to Combat Desertification
UN-ECE	United Nations Economic Commission for Europe
UN-FCCC	United Nations Framework Convention on Climate Change
VALUE	VALorization and Utilization for Europe
VEGETATION	VEGETATION instrument on-board SPOT-4
VIGIS	VEGETATION Interest Group In SAI
VIS	Visible (range of the electro-magnetic spectrum)
WCMC	World Conservation Monitoring Centre
WRI	World Resources Institute

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