nereus

network of european regions
using space technologies

25 Uses of GMES in the NEREUS Regions

Prepared by the NEREUS Earth Observation / GMES Working Group

June 2010

NEREUS Member Regions

- **Abruzzo** - Italy
- **Andalusia** - Spain
- **Apulia** - Italy
- **Aquitaine** - France
- **Azores** - Portugal
- **Baden-Württemberg** - Germany
- **Basilicata** - Italy
- **Bavaria** - Germany
- **Brandenburg** - Germany
- **Brittany** - France
- **Brussels Capital** - Belgium
- **Castilla y Leon** - Spain
- **City of Vienna** - Austria
- **Madrid** - Spain
- **East Midlands** - United Kingdom
- **Free Hanseatic City of Bremen** - Germany
- **Guyana** - France
- **Hesse** - Germany
- **Lombardy** - Italy
- **Mazovia** - Poland
- **Mecklenberg-Vorpommern** - Germany
- **Midi-Pyrenees** - France
- **Molise** - Italy
- **Piedmont** - Italy
- **Veneto** - Italy
- **Wallonia** - Belgium

Associate Members

- **Aratos Technologies SA** (Western Greece)
- **Assoknowledge Confindustria Servizi Innovativie tecnologici** (Lazio)
- **Capital High Tech SARL** (Aquitaine)
- **Centre d'Etudes Techniques de l'Equipement Sud-Ouest,CETE** (Midi-Pyrénées)
- **Centre National d'Etudes Spatiales, CNES** (Midi-Pyrenees)
- **Centro de Conservação e Protecção do Ambiente, CCPA** (Azores)
- **Centro de Vulcanologia e Avaliaçao de Riscos Geologicos, CVARG** (Azores)
- **Centro Interdipartimentale Studi e Attività Spaziali, CISAS, «G.Colombo»** (Veneto)
- **Chambre de Commerce et d'Industrie du Gers, CCI Gers** (Midi-Pyrenees)
- **Cité de l'Espace** (Midi-Pyrenees)
- **Consorzio per la Gestione di Coordinamento delle Attività di Ricerca Inerenti il Sistema Lagunare di Venezia, CORILA** (Veneto)
- **Consorzio per le Technologie per le Osservazioni della Terra e dei Rischi Naturali, TeRN** (Basilicata)
- **CYBERMAP Lda** (Azores)
- **EADS Astrium** (Midi-Pyrenees)
- **EDISOFT SA** (Azores)
- **Escola de novas tecnologias dos Açores, ENTA** (Azores)
- **EURAC Research European Academy** (South Tyrol)
- **France Développement Conseil, FDC SARL** (Ile de France)
- **FFG, Austrian Research Promotion Agency** (City of Vienna)
- **GLOBESTAR SYSTEMS Lda** (Azores)
- **Observatoire Midi-Pyrénées** (Midi-Pyrenees)
- **SICOVAL, Communauté d'Agglomération Sud-Est toulousain** (Midi-Pyrenees)
- **STAE Foundation** (Midi-Pyrenees)
- **TELESPAZIO FRANCE** (Midi-Pyrenees)
- **TéSA Laboratory** (Midi-Pyrenees)
- **Thales Alenia Space** (Midi-Pyrenees)
- **World Academy of BioMedical Technologies, WABT** (Ile de France)

nereus
network of european regions using space technologies

CONTENTS

CONTENTS

PREFACE

M. Alain Bénéteau - NEREUS President

I am delighted to present you with the outcome of an intense inter-regional collaboration and wish to thank all, especially the GMES-editorial team under the lead of Professor Alan Wells from the University of Leicester, UK, sincerely for their efforts and enthusiastic support in compiling this unique publication.

“The 25 Uses of GMES in the NEREUS Regions” is a vivid example of the immeasurable value of bringing different regions together, who have joined forces and pooled expertise to identify illustrative GMES-applications that are already being used at regional level.

Following the Graz Dialogue we have pursued with persistence our idea of a pan-European association that unites regions in order to exploit the benefits of space and now it is good to see the fruits of our cooperation. GMES is one of the key areas of collaboration on our platform.

The regional diversity by which our network is characterized has helped to gather an array of different GMES-examples which demonstrate that GMES, the second flagship project of the European Union, is an indispensible tool for life in our regions and offers manifold benefits to our citizens and enterprises. Moreover, GMES provides a vast field for regional exploitation in different areas. Regions are in fact a major end-user group and an important market.

By reading the articles you will see how wide-spread GMES already is in Europe and that it not only passed the mere research phase to an operational stage but is urgently needed at regional level. With respect to current environmental EU-legislation, the principles of the Aarhus Convention, the INSPIRE Directive and the Shared Environmental Information System (SEIS), regions need highly precise satellite based imagery and effective monitory systems for generating the necessary environmental information to comply with their duties. Monitoring of seas, oceans and atmosphere provides us with important data that we need to manage our territory. Rapid and precise mapping of different locations is essential to respond effectively to emergencies and natural disasters. The earthquake in the Abruzzo region, which is amongst our members, is a graphic example. The emergence of downstream markets offers many business opportunities and is a significant engine for growth and innovation in our regions.

This promotional GMES-brochure is a rich selection, 17 of our 26 member regions have contributed examples, and a very important step to understand the current situation of GMES in our regions. However I wish to highlight that GMES needs to be taken much farther and I wish to encourage all players in our regions to commit themselves to push the up-take of GMES forward. NEREUS has the potential to act as a catalyst for promoting activities to identify and utilise GMES. Especially with regard to the up-coming operational EU program for GMES, from 2014 onwards, we must work to define our needs and priorities.

To bring the benefits of GMES closer to the citizens in our regions we invite all our members to make efforts to translate the publication or parts of it in their native language.

I wish everyone a pleasant read and look forward to welcoming you to our GMES-Event under Belgian Presidency in December 2010.

Alain Bénéteau

INTRODUCTION

Professor Alan Wells. Co Chair
East Midlands Region, UK

Mrs Sonia Nicolau, Co-Chair
Azores Region, Portugal

NEREUS Earth Observation/GMES Working Group

"*25 Uses of GMES in the NEREUS Regions*" is a NEREUS publication containing 25 short descriptive articles that illustrate the widespread and growing application of Earth Observation and GMES in the NEREUS regions. The publication has been prepared through a collaborative effort by the NEREUS Earth Observation/GMES Working Group which already has over 50 participating contributors from NEREUS Regions and Associate Members, with representation from 17 out of the 26 current NEREUS member regions.

The target audiences for this publication are mainly non-specialists, such as decision makers in regional administrations, programme policy makers in the European Commission, elected representatives in the European Parliament and national bodies of the countries of the NEREUS member regions. Through “25 Uses” we wish to show the wide diversity of exploitation of GMES and Earth Observation in regional applications and to demonstrate the energy with which these applications are being developed in the NEREUS regions.

In this publication you will find exciting applications of the space technologies coming from EO/GMES; for mapping coastlines, regional areas and urban conurbations, for managing water resources and agricultural land use, for safety and exploitation of the oceans and coastal waters, for monitoring air quality for the benefits of citizens' health, for energy conservation in urban zones, for understanding the impact of climate change at regional levels and for civil protection from the hazards of forest fires, floods, landslips and ocean storms.

Already we can see clustering of common interests in GMES applications between different regions -risks of forest fire are high priority for many southern European regions, marine security concerns regions where shipping has high economic priority, air quality is an emerging issue in urban conurbations, and regional issues that can impact climate change take many forms. These different case studies, seen side-by-side, offer scope for exchange of knowledge, information and best practice between like-minded regional groups for whom collaboration in future projects might grow as a natural consequence of information sharing.

The publication is organised under the four main headings; of Land, Maritime, Atmosphere and Civil Emergency following the classifications used for FP7 GMES Core Services, thereby illustrating how operational downstream services will draw on Core Service products. However, you will also see pointers of future directions where operational downstream services for regional applications will require more in the way of data sources or services than can be provided from Core Service or other current EO products. Regionally focussed adaptation of Core Services or access to additional data sources from in-situ or space research assets will continue to be needed, as some of these papers clearly state.

Several of the papers in “25 Uses” describe how regional consortia are developing prototype or pre-operational services and products from existing EO/GMES data sources. Take-up of such services by regional or local authority end users or industry providers requires a high level of information exchange. Regional administrations may not fully appreciate how adoption of space based EO/GMES technologies could satisfy some of their regulatory needs, especially in areas such as some of those described in these papers. Conversely off-the-shelf products from service providers, driven by national or global prerogatives, may often not meet the operational requirements of these same regional end users.

Where regionally based consortia have been set up, and there are several referred to in this publication, close links to regional end users are easier to create. At policy level, consortia members may be advising on the capabilities of GMES space technologies as a means of delivery of regional development plans. Regional consortia, comprising of vibrant partnerships between regionally based academic centres, research institutes and SME-based industries, are well placed to deliver pre-operational projects. Demonstration of the applicability of the technology directly with a regional end user is a powerful first step to exploitation the new capability to wider markets.

Here, “25 Uses” is indicating a delivery mechanism for enhancing exploitation of EO/GMES across Europe, through the regional connection as GMES moves forward into its Operational Implementation Phase. NEREUS is ready to play its part.

BRANDENBURG (GERMANY)

www.brandenburg.de

Assessment and Monitoring of Natura-2000-Habitat Types Using Semi-Automatic Processing of EO-Satellite Data

A. Frick, H. Kenneweg
LUP GmbH Potsdam/Germany

The Brandenburg State Office of Environment (Landesumweltamt Brandenburg) has implemented a method for assessment and monitoring of several Natura-2000-habitat types which is based on satellite remote sensing and semi-automated data processing. This method is described exemplarily for the habitat types of European heath (4030 and 2310). It is being extended to more habitat types and to new sensor types which at present are still pre-operational.

Regional Objectives for Application of GMES

The cooperative professional cluster for application of geo-information "GEOkomm networks" is acting as an organisation representing the European region "Brandenburg/Germany" in the NEREUS-network on European level, although not all of the existing professional institutions, companies etc. in the region have become members of this cluster yet. Remote sensing, particularly satellite remote sensing, is one of the four core areas of GEOkomm activities. There is strong interest in the GMES-program and in the FP7 of the EU.
A main task of GEOkomm networks is to foster the development of innovative methods by intensive cooperation between different network partners-generally scientific institutes and SMEs.
The methods developed as a result of the project "SARA'04" (Satellitengestütztes Raummonitoring 2004, satellite-based monitoring of spatial information) are typical of results obtained by the GEOkomm networks, but are not the latest. The development started in 2003 as an interdisciplinary research project between several partners and, after a first cycle, ended up by 2006 with mature services which are successfully sold on the market for regional downstream services. In the second cycle a new research project has started. Its intention is to include imaging spectrometers as a new technology in the already approved assessment- and monitoring procedures.

Among the Natura-2000-habitat-types in Brandenburg European dry heath is widely distributed and is of special interest in the EU's Natura 2000 programme. Without management measures, this habitat-type can develop towards an unfavorable dry pine forest.

Results and Performance Using GMES in this Regional Application

The methods described here were not a result of a project within the framework of GMES; however, their application are transferable to GMES-initiatives and to other NEREUS-regions as a typical prototype for a "downstream services".

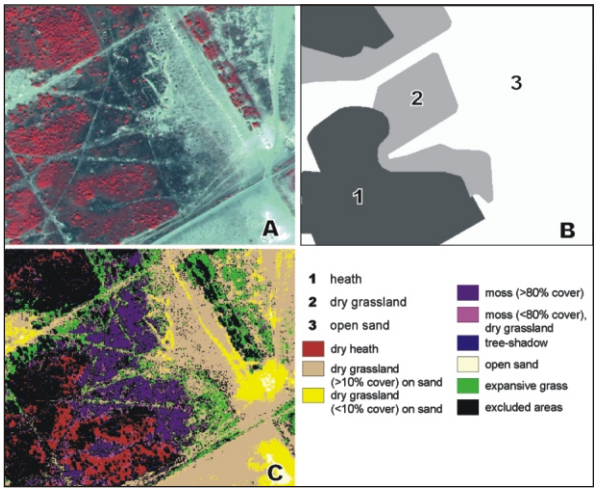


Figure 1: A: QuickBird subset, pan-sharpened, RGB=4,3,2; B: biotope type map from 1992; C: generated training areas for signature extraction

Figure 1 shows an example of automated generation of signatures from old biotope type data obtained from a knowledge base with comparison with high resolution satellite from QuickBird.

Operational Status of the Activity

Automated procedures to gain environmental information out of VHR-satellite-data, as shown in the preceding example, have proven to be operational and advantageous in terms of cost for certain NATURA-2000-habitat-types. Some details concerning the method are listed below:

- For an automated analysis the satellite images first need to be structured into semantic meaningful masks. This is done by using ratios and texture-measures, thus the valuable pixel-based information will be kept throughout the whole process. The classification is achieved by extracting training signatures from the "old" habitat maps with the aid of a static (and transferable) knowledge base which is actually filled with dynamic values via several image analysis algorithms. The process of segmenting the images into masks, extracting training data and classification is fully automated. The pixel-based indicators, so produced, can then be used for the evaluation of habitat types.

- As an example, the indicator set for European dry heath consists of area size, wood cover, percentage of open sandy spots, percentage of moss covered area, percentage of grass covered area and percentage of heath covered area. The produced indicator maps and the satellite images are published via internet, so that experts have access to the information and are able to validate results.

Added Value to the Activity Provided Through GMES

In comparison to other methods the suggested EO-supported procedures are objective, cheaper and more reliable. Moreover, remote sensing methods are in favour because in Brandenburg a high percentage of the respective habitat types is inaccessible due to previous military use and dangerous contamination with old munitions.

Figure 2 shows three habitat sites. Their respective composition of the different indicator-land-cover-types can be used for the assessment. The evaluation results for the three sites indicate a favourable situation in terms of wood cover for site No. 9, an unfavourable-bad situation for site No. 10 and an unfavourable-inadequate situation for site No. 11 according to the German NATURA 2000 evaluation scheme.

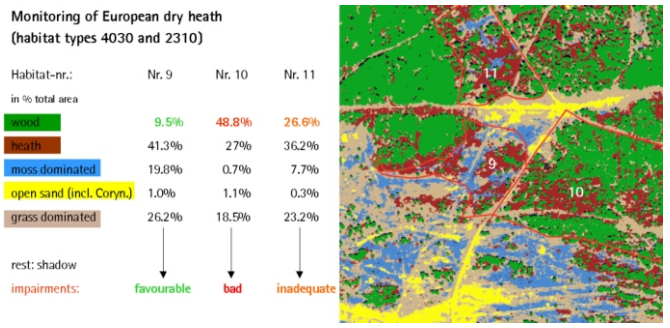


Figure 2: Three habitat sites (no. 9, 10 and 11) and their evaluation results.

Future Developments and Needs

The extension and further development of the suggested knowledge-based methods towards more Natura-2000-habitat types, towards other NEREUS-regions and to new sensor-types will improve already existing downstream-services. It is necessary to improve interregional cooperation, research and development in order to reach this goal.

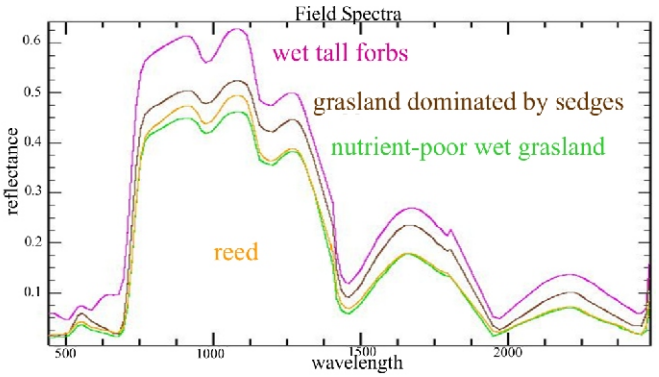


Figure 3: Many vegetation types (habitat types) are difficult to identify by analysis of present EO-satellite data. Some of them show differences in their spectral behaviour which could be exploited by future satellite sensors. Imaging spectrometers, and particularly the ENMAP satellite mission which is scheduled for 2013, offers a promising approach.

Participants:
LUP GmbH, Dr. A. Frick, G. Weyer, Prof. Dr. H. Kenneweg; annett.frick@lup-umwelt.de, www.lup-umwelt.de
LUA Landesumweltamt Brandenburg, M. Düvel; www.mluv.brandenburg.de/info/lua
TU Berlin, Prof. Dr. B. Kleinschmit; www.geoinformation.tu-berlin.de
GFZ German Research Centre for Geosciences, www.gfz-potsdam.de
The project was supported by the Ministry of Economics of the State of Brandenburg and co-financed by the European Fund for Regional Development.

Regional Plan of Ecological Coherence: Green and Blue Belt Networks

Laurence Hubert-Moy[1]; Simon Dufour[1]; Fabienne Gazo[2]; Eric Pottier[3]; Agnès Salvatori[4], Gérard Dedieu[5]

COSTEL UMR 6554 LETG/OSU Rennes[1], CETE Sud-Ouest[2], UMR CNRS 6164 IETR / SAPHIR[3], Pôle Aerospace Valley[4], CESBIO[5]

Abstract

The distribution of ecosystem sites, their connectivity and their evolution are key links between ecology and society, as these landscape patterns determine the regional sustainability for biodiversity and are subject to human interventions. A green and blue belt network is to be developed in all French regions to facilitate the free movement of natural species, and to provide recreation areas in suburban areas. To achieve this goal, as far as ecological reservoirs are now well known, it appears necessary to identify and characterize ecological corridors including wetlands, and corridor barriers including urban areas. Value will be added on the high resolution products made available by GMES from remotely sensed data in order to produce maps of green and blue belt networks on two scales, the regional and local scales.

The Brittany and Midi-Pyrénées regions have developed several activities directly related to GMES. They are divided between upstream, research oriented applications and downstream quasi operational ones. The Aquitaine region is both an end-user and a R&D contributor as it supports similar projects.

Regional Objectives for Application of GMES

Within the framework of its national strategy for biodiversity, the French Government has set the improvement of knowledge on the spatial distribution of landscape elements as a prerequisite. The Regional departments for environment, territory development and housing (DREAL), State representative, in partnership with the Regions Brittany, Midi Pyrenees, and Aquitaine have to elaborate a Regional Plan of Ecological Coherence (RPEC). This plan includes tools for town and country planning that identify ecological reservoirs and corridors: green and blue belt networks. The corridors provide channels and permeability within obstacles to facilitate movement of species and their durable protection.

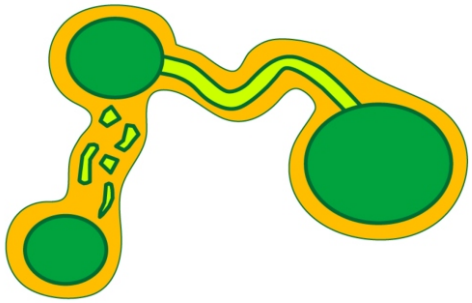


Figure 1: Corridors linking ecological reservoirs

The objective of this regional application is to provide high resolution layers for the mapping of green and blue belt networks at two scales (regional and local scales) using both multispectral satellite optical/infra-red data from MODIS, Landsat, SPOT 5 and Quickbird or Pléiades, and Synthetic Aperture Radar (SAR) data from RADARSAT2 and ALOS / PALSAR. This program will enable a better cooperation between the academic institutes and the SMEs on this topic as well as between the three regions involved in this GMES application.

Results or Performance using GMES in this regional application

Several projects are supported by the Regions and coordinated by several academic institutes and public and private actors in geo-information. So far, the projects are in a demonstration phase connected to this regional application:

- Programme DIVA- MEEDDM (The French Ministry of Ecology, Energy, Sustainable Development and Sea). Project :"Ecological continuities and public action" (DIVA-corridors)"
- Programme ANR « Villes Durables ». Project « Evaluation des trames vertes urbaines et élaboration de référentiels : une infrastructure entre esthétique et écologie pour une nouvelle urbanité ».
- Programme ESA-CSA SOAR. Project: "Evaluation of RADARSAT-2 quad-pol data for functional assessment of wetlands".

Figure 2: Photograph illustrating an ecological corridor

All these projects rely on downstream developments within academic and R&D company partnerships and data provided by different services and/or image providers. (See footnote).

Operational Status of the Activity and GMES added value

Green and blue belt networks cartography is a subject suited to test the contribution of the GMES services for regional observation applications, more particularly the identification of the natural areas, the main transport infrastructures and stream, the continuity of natural spaces. Value will be added on the high resolution products made available by GMES in order to produce maps of green and blue belt networks. Optical remotely sensed data are currently used to identify, delineate and characterize ecosystem sites including wetlands. The radar satellites are underexploited despite the fact that they can be used in the assessment of water surfaces, soil moisture, flood prone zones and land (agricultural) characterization, especially in regions where the cloud cover is high. Coupling radar and optical satellite data is promising. This sensor synergy will allow the mapping of the green and blue belt networks to be tackled at two scales, the regional and local scales. The Land service should propose the CORINE Land Cover's update and improvement. Preprocessed data, through GMES, will require atmospheric corrections, ortho-rectification etc.. Data classification in the CORINE scheme will use five thematic high resolution layers (wetlands, water resources, crops, meadows, forests). Outputs will include vegetation monitoring and an improved supply of reference data (topographic map, administrative borders, ground elevation models, etc).

If the high resolution layers are found suitable, GMES will thus be a major enabler for the use of satellite imagery as an answer to biodiversity monitoring. Some services are already operational and can answer immediately to part of the needs. However, resolution and frequency might in some cases not be sufficient.

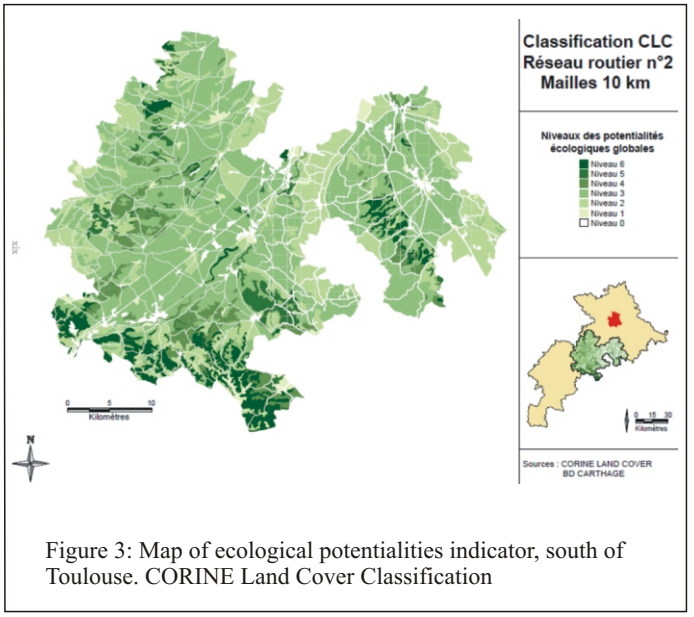


Figure 3: Map of ecological potentialities indicator, south of Toulouse. CORINE Land Cover Classification

Future developments and Needs

In all French regions, the RPEC will be developed on the basis of a national and local consultation, supervised by a national committee and regional monitoring committees, involving the players concerned. Plans to protect endangered species will be consolidated and the Water Agencies will be given the power to acquire wetlands, for the purposes of conservation.

To transfer this application into other regions, calibration and validation of the method used for the production of the fine high resolution products made available by GMES to map green and blue belt networks should be done not only by the French partners involved in this program, but with other European partners.

Participants:
The Scientific Group BreTel (Brittany Remote Sensing : COSTEL UMR 6554 LETG, UMR CNRS 6164 SAPHIR IETR), Université de Rennes 1 (UMR CNRS 6554 ECOBIO), INRA (UMR SAS), Centre d'Etudes Techniques de l'Equipement du Sud-ouest (Pôle satellitaire MEEDDM), Centre d'Etudes Spatiales de la Biosphère (UMR UPS-CNRS-CNES-IRD 5126, Britanny Region, Midi-Pyrénées Region, Aquitaine Region, DREAL Midi Pyrénées, Maison de la Télédétection de Montpellier (UMR CNRS 6590 TETIS), Pôle Aerospace Valley(DAS TVE)
Contact e-mail of lead author: laurence.moy@uhb.fr

CITY of VIENNA (AUSTRIA)

www.wien.gv.at

City of VIENNA: A "GMES-USER" and / or "GMES-PROVIDER"?

Christian Wurm
Department for EU-Strategy and Economic Development

Abstract

The project analysed to what degree individual municipal departments could take the role of a "GMES-USER" or a "GMES-PROVIDER" and how such a role could efficiently support them in fulfilling their tasks.

This was an explorative undertaking, focussing on the GMES Domain Land. It included information gathering, joint learning, technical analyses and a systematic screening of municipal tasks.

The project, which has been co-funded by the Austrian Research Promotion Agency, started in February 2009 and ended in May 2010.

As a result it can be noted that the project has boosted awareness for GMES. Expectations that the areas of possible applications of GMES are widespread were confirmed. Further activities will cover a broad range from "observing developments in the GMES-world" up to "preparations of potential pilot-projects".

The City of Vienna fosters innovation by following a systematic approach

The City of Vienna plays a significant role in the European process of becoming the world´s most competitive and innovative economy. Vienna has the advantage of being both, the national Capital as well as one of the nine federal provinces of Austria. As the country´s major business location Vienna always focuses on forward-looking activities.

Figure 1: Tina Vienna (copyright)

In order to foster innovation it is important to identify the potential of new technologies as early as possible and to follow a systematic approach. Therefore a systematic check of possible uses of GMES-products and also of costs and efforts of such applications has to be considered.

The objective of the project "GMES and Vienna" was to identify potential applications of GMES in all areas of the city administration.

The objectives of the project were:

- To raise the level of awareness for potential applications of GMES.
- To identify tasks where GMES-products could be of possible use and to deliver a differentiated evaluation concerning potential applications of GMES.
- To specify which next steps should be taken.

Figure 2: Klaus Vyhnalek (copyright)

Identifying potential applications

More than 10 different departments out of the following areas were integrated in this project:

- Emergency / Security
- Statistics ("socioeconomic data")
- Information Technology (Geographic Information System)
- City planning
- Environment (protected areas, waste deposit monitoring, green areas)
- Climate and Energy (Emissions, renewable energy, energy efficiency)
- EU-Strategy (EU-Commission: strategy for the Danube Region)
- Infrastructure (power plants, grid infrastructure, energy provision)
- Surveying and Mapping

Starting in February 2009 workshops with all participating departments were organised. In addition, expert discussions with every single department took place.

The degree of general information on GMES together with specific and detailed information about ongoing GMES-research projects was adapted to the needs of each single department.

By the end of 2009 the departments had finished their evaluations concerning potential applications of GMES.

Continuous reflexion on important aspects of successful innovation was an integral part of the project.

Results

Results of the project "GMES and Vienna" are the following:

- The expectation was confirmed that GMES products can be applied in a number of areas.
- At the same time the use of applications has still to be defined more explicit and clear. Once the use of an application is transparent, the necessary expenditure must be calculated.
- All involved departments are now well aware of the content and scope of GMES.
- Further activities cover a broad range from "observing developments in the GMES-world" up to "preparations of potential pilot-projects" for example in the area of forestry or air quality forecast.
- The project matched well with ongoing activities for expanding the Geographic Information System.

Figure 3: Tina Vienna (copyright)

Participants:
Wienstrom GmbH
EOX IT Services GbmH
Technopolis Forschungs- und BeratungsgesmbH

Co-funded by the Austrian Research Promotion Agency
Contact e-mail of lead author: Christian.Wurm@wien.gv.at

REGIONE LOMBARDIA (ITALY)

www.regione.lombardia.it

Cadastre of Glaciers in Lombardy for the year 2000

Andrea Piccin[1]; Anna Rampini[2]

Infrastruttura per l'Informazione Territoriale, Direzione Generale Territorio e Urbanistica, Regione Lombardia[1]; CNR IREA; Milan, Italy[2]

Abstract

About 1/3rd of the Italian glaciers are located in Lombardy including the widest Italian one, i.e. Adamello. Most of these glaciers have been observed and monitored by researchers and volunteers since the end of the 19th century, thus creating a valuable range of observations about climate in the last centuries. Data collected during field surveys are regularly published by the Italian Glaciological Committee and more recently also by the Servizio Glaciologico Lombardo.

By the end of 20th Century, Regione Lombardia supported a project with the aim to create an updated inventory of the Lombardy glaciers by exploiting the integrated use of remote sensing images and traditional field surveys.

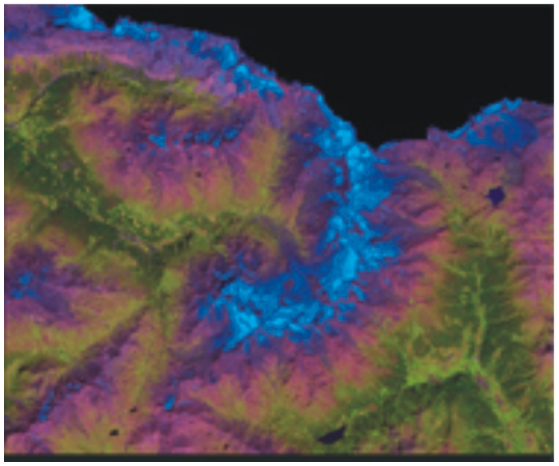


Figure 1: SPOT image acquired on July 30th, 2003

Regional Objectives for Application of GMES

In general monitoring of glaciers is considered of high interest to understand trends of climate change. This activity is critical in areas that are highly populated, such as Lombardia, and where glaciers represent a main resource for traditional activities (such as rice cultivation in Lombardy) and strategic ones (such as hydropower generation).

In this context, the main objective of the project was to create a new updated inventory of the Lombardy glaciers and to provide a quantitative estimate of the glacier variations through the use of remote sensing techniques. In particular, the project objective was to enrich current knowledge concerning glaciers by collecting new data, mainly based on a comprehensive monitoring of glaciers through satellite imagery.

Through the use of remote sensing images, integrated with traditional data, and suitable standardised procedures, the project aimed at providing results characterised by objectivity and reproducibility through time and spatial homogeneity. Moreover, it aimed at including glaciers where human observations could be difficult due to geomorphologic risks.

The project has been considered a case study to compare results obtained by different methodologies and assess reliability and costs of satellite imagery in Alpine zones.

Results or Performance using GMES in this regional application

The project tested the use of remote sensing images to derive morphometric and morphodynamic parameters of more than 300 glaciers.

Automatic classification of Landsat ETM+ (13.09.1999), and SPOT (30.07.2003) images have been performed and results have been integrated with in situ observations and compared with photo-interpretation of aerial imagery.

Two main problems have been identified in the classification of glaciers from remote sensing: the problem related to the non optimal spatial resolution of available images has been approached by applying unmixing classification paradigms, which allow the identification of classes at sub-pixel level. The problem of cloud cover that particularly affects mountainous areas of the Region still represents a limitation in the use of optical datasets; it can be solved by an increased schedule of image acquisition.

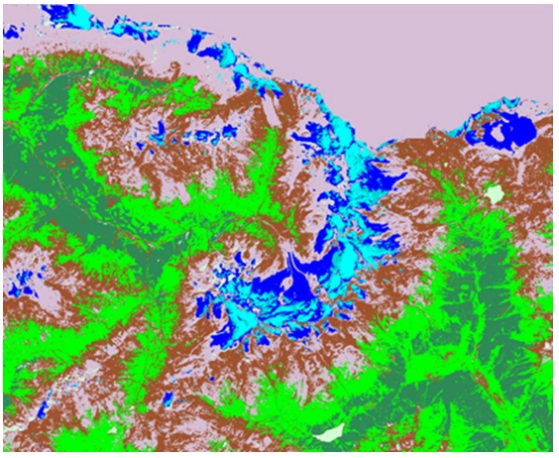


Figure 2: Classification of the SPOT image of Ortles-Cevedale Group

For each glacier body the following parameters have been produced:

- Min and max elevations; mean sea level (m)
- Equilibrium Line Altitude (ELA)
- Max width and length [m]
- Mean slope [%]
- Total area [km2]
- Accumulation basin area [km2]
- Ablation basin area [km2]
- Accumulation Area Ratio (AAR) [%]
- Perimeter [m]

Operational Status of the Activity

The project, concluded in 2003, is an example of integration of ground and remote sensing observations, following the philosophy of GMES oriented projects.

The database contains datasets related to 1991, 1999 and 2003; a general updating to 2007 is currently under development using aerial orthophoto images (both natural color and near infrared), while a multi-time analysis based on Ikonos satellite images (2003, 2004, 2006 and 2007) has been recently performed on some sample glaciers by ARPA (Regional Agency for Environmental Protection) for operative monitoring purposes.

The results obtained in the project are accessible through the Lombardia Geoportal at the following address: http://www.cartografia.regione.lombardia.it
(search in Catalogue for "Ghiacciai di Lombardia")

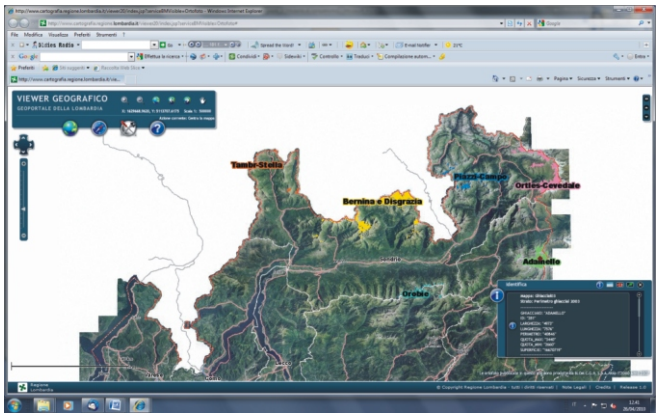


Figure 3: Glacier layer shown in the Lombardia Geoportal

Added Value to the activity provided through GMES

The project allowed assessing and validating a procedure to monitor glaciers from satellite imagery in Lombardia and, in general, in Alpine regions.

Exploitation of satellite techniques in this context is prevented by the small dimensions of Alpine glacier bodies and by frequent cloud coverage. However, this project shows their feasibility and reliability, by reducing costs of a necessary monitoring activity.
Though geometric resolutions of the used images are low with respect to Alpine glacier extensions, the results obtained are comparable with the traditional inventory approach based on aerial observations. However costs are dramatically cheaper, thus enabling an increased monitoring schedule.

Further advantages lie in both the objectivity of the procedure with respect to photo-interpretation (traditionally used in this application) and its reproducibility through time.

Glacier monitoring by satellite offers a synoptic view over a wide area, thus assuring uniform results with a well-known quantitative accuracy that does not vary depending on both the personal criteria of the observers/interpreters and the variability of traditional observation tools.

Future developments and Needs

The project is a demonstration of the effectiveness of the remote sensing approach; it could be implemented as a downstream service if suitable operational GMES core products are available, such as orthorectified images and/or CLC (Corine Land Cover) maps at due resolution. Considering that a multipurpose aerial orthophoto survey with regional coverage and ground resolution to 50x50 cm is currently realized in Lombardy every 3 years, GMES application should be particularly useful to obtain a one year frequency monitoring of glacier evolution, suitable to refine the highly climate sensitive water balance models.

The next goal is to define a consolidated procedure to integrate regularly (i.e. once a year) the different data sources and to extract a semi-automatic report from data containing information for the water balance modelling.

Participants: Regione Lombardia, Infrastruttura per l'Informazione Territoriale, Milano, Italy
Istituto di Ricerca per l'Ecologia e l'Economia Applicate alle Aree Alpine, Milano, Italy
Istituto per il Rilevamento Elettromagnetico dell'Ambiente (Consiglio Nazionale delle Ricerche), Milano, Italy
Dipartimento di Scienze della Terra "Ardito Desio", Università degli Studi di Milano, Milano, Italy
Servizio Glaciologico Lombardo, Milano, Italy
Agenzia Regionale per la Protezione dell'Ambiente Lombardia, Milano, Italy
Contact e-mail of lead author: andrea_piccin@regione.lombardia.it

REGIONE LOMBARDIA (ITALY)

www.regione.lombardia.it

Monitoring European Lakes by means of an Integrated Earth Observation System (MELINOS)

Giardino Claudia, Bresciani Mariano

Institute for Electromagnetic Sensing of the Environment (CNR), Milan, Italy

Abstract

MELINOS is a project aimed at monitoring water quality of lakes by means of an integrated Earth Observation (EO) system. It has been coordinated since 2002 by the Istituto per il Rilevamento Elettromagnetico dell'Ambiente (IREA) of Milan, part of the National Research Council, and is managed by the European Space Agency (ESA-AO ID553).

Regional Objectives for Application of GMES

Regione Lombardia has a valuable richness in freshwater resources and hosts in its area most of the major subalpine lakes in Italy. Its activity in monitoring water quality is an essential part of the regional implementation of the Water Framework Directive (WFD) of the European Commission (Directive 2000/60/EC). The main goals are to achieve sustainable management, to keep the ecosystem functioning and to reach a good ecological status.

MELINOS is aimed at assessing the potential of satellite data for mapping some macro descriptive water quality parameters in order to foster regional compliance of Lombardy with the above Directive. Tests areas cover the four major lakes of the Po basin (Garda, Maggiore, Como, Iseo) that are included in the Region.

Satellite imagery from ESA sensors, i.e. MERIS, PROBA, AVNIR-2, etc., are integrated with classic monitoring methods in order to detect lake water quality and thus provide complete and comprehensive spatial and temporal information with an excellent cost/benefit ratio for management and ecological characterization.

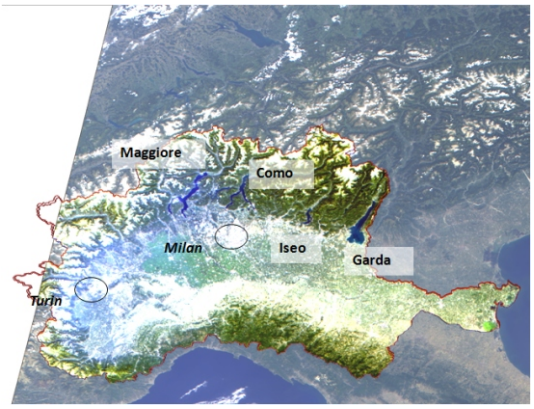


Figure 1: Test area in a MERIS image

Results obtained

The main sensor used is MERIS (Medium Resolution Imaging Spectrometer), dedicated to study water with a spatial resolution of 300 meters and monitoring frequency of 2-3 days (according to the latitude). By processing the MERIS images, MELINOS has been able to obtain good quality maps of Chorophyll-a, suspended solid and yellow substance concentrations, as well as water transparency and cyanobacterial blooms in subalpine lakes, on 239 different dates between 2003 and 2009. In situ observations at the IREA's Experimental Station in Sirmione (on Lake Garda) are used for implementing bio-optical algorithms and for validating the maps obtained.

Main end users are local agencies in charge of monitoring and assessing status of Lakes, in particular the Centro Rilevamento Ambientale of the Municipality of Sirmione (Garda Lake), that used them to monitor water quality and obtain the 'blue flag'. In general MELINOS results can provide local authorities with all the information necessary for management of the lake environment.

MELINOS results could be used not only for local/regional governance, but also for other users such as educational activities within the schools and local leisure associations (for example Lega Navale and Diving society).

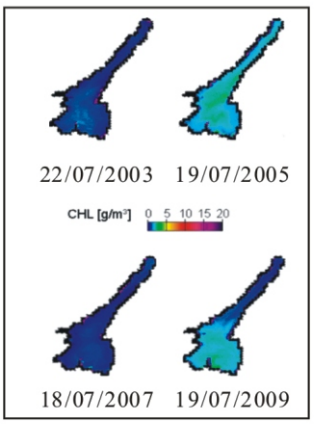


Figure 2: Maps of Chlorophyll in Garda lakes
Obtained by MERIS images

Project status

Satellite images have been continuously used to map water quality of lakes from 2003 till now and are going to be used in the context of the European inter-regional cooperation objective Central Europe programme EULAKES (2010-2012). Among the various lakes considered in this project, Lake Garda will be studied by integrating satellite, limnological and meteo climatic data.

Methods of MELINOS, following GMES philosophy of integration of EO with in situ data, were also applied to other lakes, outside Lombardy, such as Trasimeno (Italy), where the analysis of 115 MERIS images showed good correspondence between satellite and limnological data. Always in the framework of regional governance, MERIS images were used for a management feasibility study for Lake Chaohu in China and for Europe's largest lagoon (Curonian lagoon).

Added Value to the activity provided through GMES

The availability of satellite data, in particular MERIS imagery, allows large water bodies to be studied with satisfactory temporal frequency.

The main advantage in using EO techniques lies in building time series of datasets that improve monitoring activities of Lombardy lakes by exploiting the frequent and quasi real time acquisition by satellite sensors.

Satellite imagery is also useful for spatialisation of measurements acquired locally.

With respect to traditional monitoring methods, EO techniques are more standard at European level, faster to produce results and homogeneous over large sampling areas.

Future developments and Needs

Maps of water quality parameters are systematically produced from MERIS images by using a physical approach. Since lakes are optically complex bodies of water where the relations between optical properties and concentration of water components might have local-regional behaviour and can vary over time, continuous validation and calibration activities should be carried out.

The project is currently working at producing anomaly maps of the parameters describing water quality, which can provide synthetic information to water managers and users for a more sustainable use of water resources. Besides MERIS, the availability of high spatial resolution and/or hyperspectral sensors such as CHRIS and IKONOS (spatial resolution 18 and 1 meters respectively), recently acquired from ESA, will allow us to assess cyanobacterial bloom in Mantua lakes (Lombardy), and to map emerging macrophytes in the southern part of Lake Garda, respectively.

We look forward to the next generation of hyperspectral sensors with a spatial resolution around 20-30 m (e.g. EnMap, PRISMA). They will allow the study of also small lakes and improve the detection of toxic phytoplankton (cyanobacterial blooms).

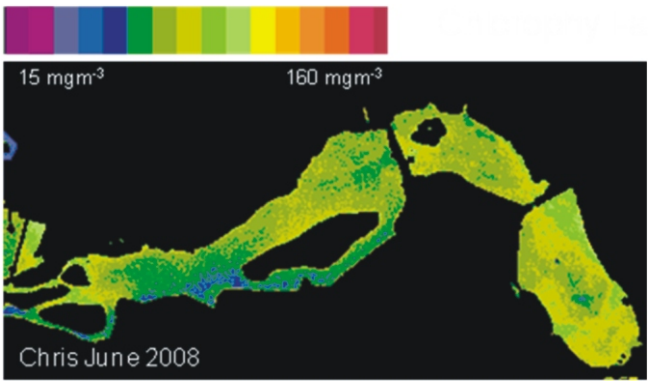


Figure 3: Maps of chlorophyll in Mantua Lakes

Participants:
Institute for Electromagnetic Sensing of the Environment (Consiglio Nazionale delle Ricerche), Unit of Milan, Italy
Centro Rilevamento Ambientale, Municipality of Sirmione, Italy
University of Parma, Italy
University of Zürich, Switzerland

Contact author: bresciani.m@irea.cnr.it

MAZOVIA (POLAND)

www.bgwm.pl

Changes in Warsaw built-up area in a period of 80 years

Marek Baranowski, Andrzej Ciolkosz
Institute of Geodesy and Cartography

Abstract

CORINE Land Cover database of 2006 of the Warsaw District in Mazovia Region (Poland) has been compared with an old map showing land use in the middle of the last century. The map presented five classes of land use only. To compare the old map with CLC 2006 data base it was necessary to generalize nomenclature of CLC 2006 to five similar classes. It turned out that in the last 80 years built up areas in the capital of Poland and in its surroundings has increased more than two times. The comparison of the map and the CORINE database shows also the direction of the city development and dynamics of the land transformation.

Regional Objectives for Application of GMES

Since the end of the World War II Warsaw the capital of Poland has been the fastest developing city in the country. This process has been observed not only in the time of the rebuilding of the city after the ravages of war but also in the present period after political and economic transformation of the country. Constantly increasing numbers of people have triggered development of housing construction that has resulted in occupation of a new surrounding area and conversion of arable area and forest into built up areas.

Development trends of built up areas are a subject of interest of several research institutes as well as regional management and planning authorities in Mazovia Region.

To check the speed and direction of the city development in Warsaw the land cover data bases elaborated in the frame of CORINE Land Cover (CLC) project of the European Environmental Agency has been investigated. These two databases cover a period between 1990 and 2006. Comparison of these databases allows land cover changes which occurred in this period to be determined. It turned out that the changes are pretty small. There are two important reasons of those findings low spatial resolution of the data stored in databases (the surface area of the smallest unit mapped in the project was 25 hectares) and the short period of time under consideration (only 16 years).

To determine spatial distribution, direction and dynamics of land use changes in Warsaw and in its vicinity over a much longer period, a new map of land use has been created from the topographical maps that were produced in 1930's at the scale 1:100 000,

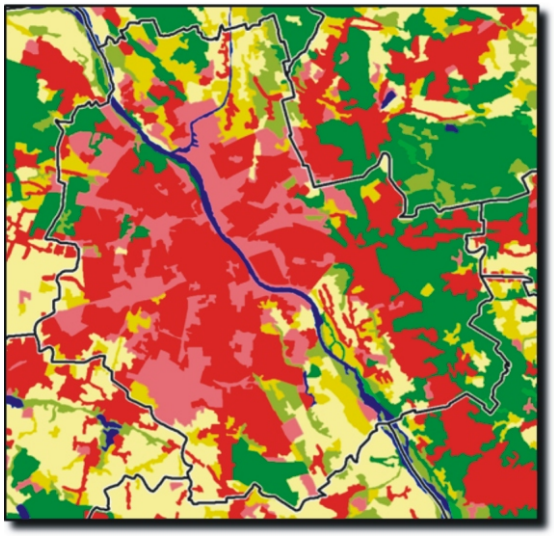


Figure 1: Artificial surfaces (red colour) in Warsaw and its vicinity in 2006

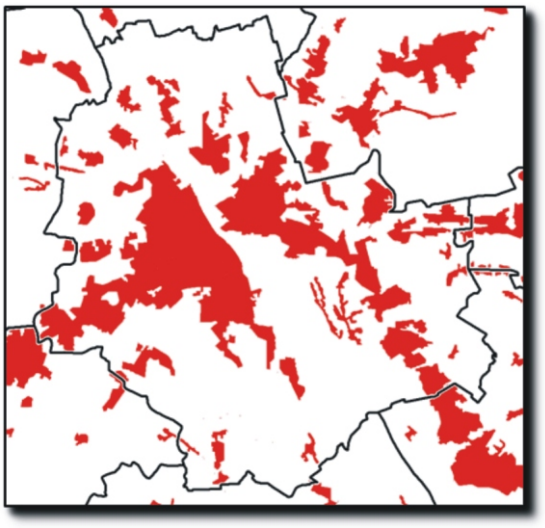


Figure 2: Artificial surfaces in Warsaw and its vicinity in 1930. (Red colour)

Having in mind that the map presents five land use classes only it was necessary to aggregate 31 classes of the CLC nomenclature distinguished in Poland into five classes in order to compare this old map with the CORINE Land Cover database.

Due to some differences between the first level of the CLC nomenclature (comprising five land cover classes) and five classes of land use presented on the old map it was impossible to use this level of CLC database for comparison with land use map based on topographical map. It was necessary to perform redistribution of the level 3 of CLC nomenclature to fit it with 5 land use classes distinguished on the map.

Figure 1 presents areas occupied by five land use classes in a Warsaw District in 2006. The image has been obtained after generalisation of the CLC 2006 database. The densely and scattered built-up residential, industrial and commercial areas (red colour) occupied 76 321 ha in Warsaw District.
Almost 80 years earlier, in the 1930's, the area occupied by the same land use classes was much smaller it covered 37 109 ha only. Figure 2 shows the artificial (built-up) surfaces in the Warsaw District in 1930.

The conversion of the old map of land use into digital form allows comparison with results of interpretation of present satellite images used for elaboration of CLC 2006 database. Figure 3 presents a result of the comparison. It shows the development of built up areas in Warsaw District during last 80 years.

It has turned out that in the last 80 years the artificial surface in the capital of Poland and its surroundings has increased more than two times. The city has developed concentrically, occupying mostly arable land. The results of the analysis will be taken into account in elaboration of the next plan of spatial development and management of the city.

The Project has been developed by the Institute of Geodesy and Cartography as a follow up application of the GMES Fast Track Land Monitoring Core Service to demonstrate the usefulness of Earth Observation product supported by auxiliary data for spatial planning purposes.

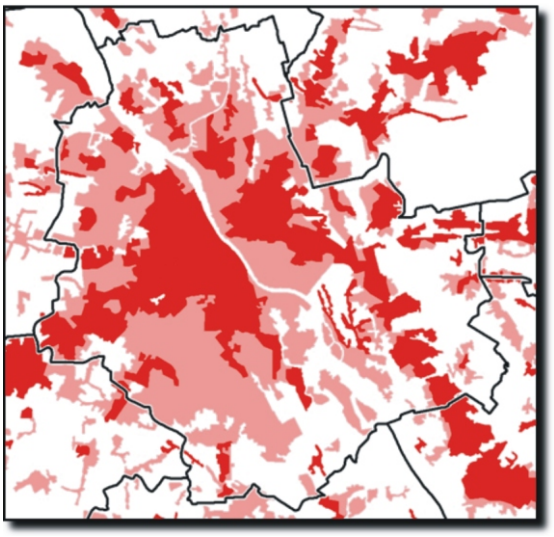


Figure 3: Development of built-up areas in Warsaw and in its vicinity during last 80 years

Operational status of the activity

The purpose of this activity was to demonstrate to the regional planning and development authorities a usefulness of information derived from Earth Observation satellites and to convince them to use this source of information in everyday practice in whole Mazovia Region.

Future developments and Needs

Due to the large size of the mapping unit used in elaboration of the CLC 2006 database (25 ha.) a number of new construction areas in Warsaw District have been omitted. That is why a new task will be undertaken. The high resolution satellite images available through the GMES Programme will be applied as a source material for mapping of land use in Warsaw District. Then the size of mapping unit can be decreased down up to 5 ha. and all construction areas seen on the satellite images can be mapped.

Participants:

Institute of Geodesy and Cartography, Warsaw;
Mazovia Voivodship Surveyor Office;
Mazovian Office of Regional Planning

Contact e-mail of lead author: Marek.Baranowski@igik.edu.pl

CAL/VAL Site DEMMIN for Remote Sensing

Erik Borg
Institute German Aerospace Centre
German Remote Sensing Data Centrey

Abstract

The observatory TERENO/DEMMIN is a durable Earth observation site for remote sensing to derive value added information products for forestry, agriculture and environment. Thematic processors such algorithms for assessing evapotranspiration can be tested in the Durable Environmental Multidisciplinary Monitoring Information Network-DEMMIN-Calibration/Validation site under practical conditions. Farmers of the DEMMIN Interest Group are cooperating with the German Aerospace Center (DLR) and other scientific centers to establish sustainable strategies for land use under changing climatic conditions.

Regional Objectives for Application of GMES

The DLR is integrated in the TERENO-Initiative (Terrestrial Environmental Observatories) of the German Research Centers within the Helmholtz Association (HGF). The objectives of this initiative are the implementation and instrumentation of long-term observatories to monitor the regional consequences of global climate change and to derive survival strategies to help communities to respond to expected regional impacts of climate change.

The expected climate change will trigger different environmental changes on regional scales, such as alterations in land use, water resources, and ecological systems.

The social changes driven by these effects are going to have an increasing impact on forestry and agriculture. However, both industries are extremely important, since they contribute to a large part of the export production of Mecklenburg-Vorpommern. Finding solutions to the impact of global change is one of the most important challenges of the 21st century, especially on a regional scale.

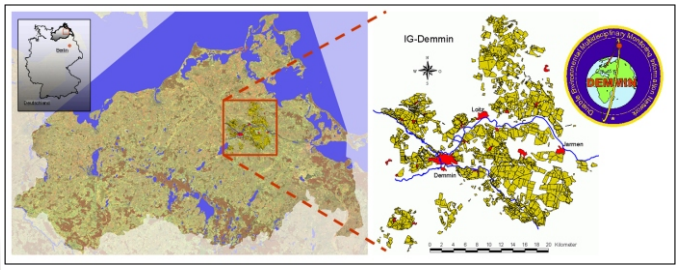


Figure 1: Geographical location of the CAL/VAL site DEMMIN (left) as well as the deviation of agricultural fields of the Interest Group Demmin (right)

In this context there is a common regional interest of Near Real-time GMES services for assessing hydrological parameters, such as soil moisture or evapotranspiration to manage sustainable land and water use for stable forestry and agriculture. In order to establish those GMES services for forestry, agriculture, and environment based on complementary remote sensing and in situ measurement technology, research sites are an essential for developing cost efficient, automated value added technology and products for Service Providers. DEMMIN as integrated part of TERENO-Initiative is such a research site for remote sensing. (Figure 1) The proposed approach of the TERENO-Initiative in DEMMIN is based on a cooperation of DLR with farmers.

Results

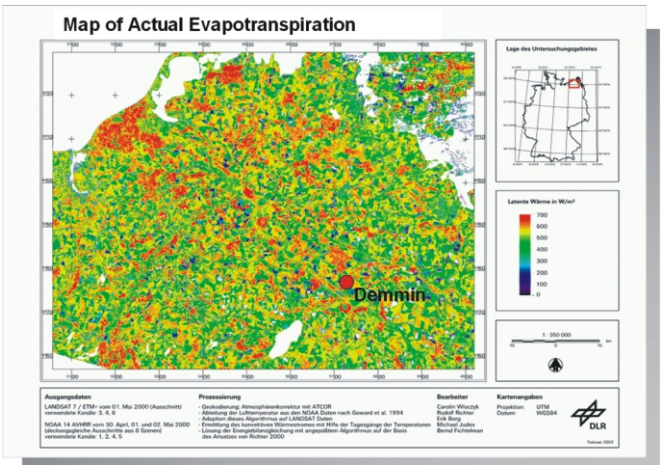


Figure 2: Regional derivation of actual evapotranspiration for Mecklenburg-Vorpommern extracted from LANDSAT 7/ETM+ - spatial resolution: 30m. (wloczyk, 2004)

Knowledge of the actual evapotranspiration is of vital importance for managing water resources in ecological sensitive areas such as Mecklenburg-Vorpommern. (See Figure 2)

Therefore, a processor for deriving evapotranspiration on the basis of remote sensing data was developed at the DLR. An operational processing chain for a monitoring evapotranspiration needs a CAL/VAL site which allows the in situ measurement of all influencing parameters together with remote sensing measurements and an automated agrarian meteorological weather station network.

GMES Domain LAND

The test site is enclosed to the GMES Land Management Core Service. One of the objectives of this service is to provide timely, continuous, and independent observations about the use of soil and other land resources and to estimate land use changes. To meet this requirement the interaction between terrestrial measurement networks and remote sensing is a pre-requisite. (Figure 3). In addition, the test site has relations to the GMES Atmospheric Service, for one of the important objectives is local weather estimation using an automated agrarian meteorological network in addition to remote sensing data.

The agrarian meteorological data provided by the automated agrarian meteorological network are stored at the Ground Station and merged with remote sensing data from LANDSAT.

Successful evapotranspiration experiments using different optical and thermal data are possible and necessary to assess the quality of the evapotranspiration processor.

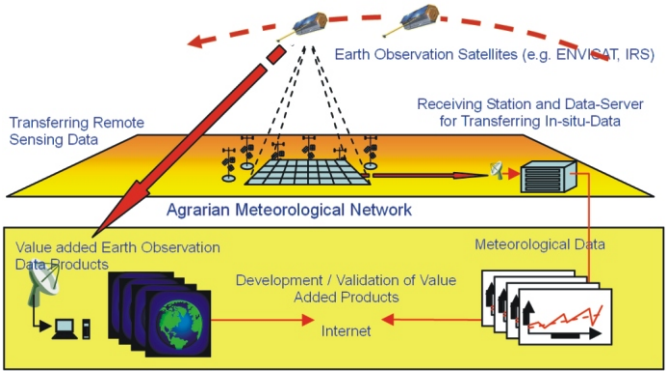


Figure 3: Combination of complementary remote sensing and in situ measurement technology for deriving value added products, such as evapotranspiration

Operational Status of the Activity

The development of the processor and service is ongoing.
According to a continuous sustainable water management, complementary remote sensing data and parallel measured agrarian meteorological data are mandatory for a GMES service for sylvicultural or agricultural applications.

The results of the operational processor will be integrated into a consulting service for sprinkling and irrigation.

Added Value to the activity provided through GMES

The network DEMMIN aims to develop automatic processors for deriving remote sensing-based information products (e.g. improvement of soil and yield maps), which can be used directly for a sustainable management of agricultural production processes. By direct inclusion of farmers in definition and specification of these information products the scientific development of these products can be designed according to market requirements.
The benefit for the science community consists in the possibility to compare different analysis procedures under known and defined measuring conditions as well as the possibility to certify interpretation algorithms under practical conditions.

Future developments and Needs

In order to overcome the limits of optical remote sensing (no information under cloud cover) a combination of both remote sensing and complementary in situ measurements are under development for monitoring evapotranspiration. To provide an operational service a CAL/VAL site for calibration and validation of value added products is necessary.

The main objectives of the TERENO/DEMMIN initiative are the delivery of value added products for forestry, agriculture, and environment to develop and establish sustainable strategies for land use, minimizing the application of agrochemicals and resources under altered climatic conditions.

Participants:
German Aerospace Center, Interest Group Demmin, German Research Centre for Geosciences, Forschungszentrum Jülich, Helmholtz Centre for Environmental Research , Forschungszentrum Karlsruhe, Helmholtz Zentrum München - German Center for Environmental Health, University of Applied Sciences Neubrandenburg, University Ernst-Moritz-Arndt-University Greifswald, and University Rostock

Contact e-mail of lead author: Erik.Borg@dlr.de.

Snow Cover Monitoring

Gérard Dedieu[1], Benoit Duchemin[1], Gilles Boulet, Philippe Maisongrande[2]

Centre d'Etudes Spatiales de la Biosphere[1], Laboratoire d'Etudes en Géophysique et Océanographie Spatiales[2]

Abstract

Seasonal information on the extent of mountain snow cover, the monitoring of its temporal variability and the estimation of the amount of water released by snow-melt are required by a number of applications such as regional water management and hydroelectric production. The methods develop in Midi-Pyrénées rely on the use of medium resolution (~1 km) data such as provided by SPOT-VEGETATION or MODIS. Higher space resolution data, provided by Formosat, Landsat, and SPOT are used to correct the results obtained with 1 km resolution images and to validate the results. Satellite data allow monitoring the extent of snow cover with a temporal sampling of about 10 days, depending on cloud coverage. A model, driven by meteorological and other data, uses satellite derived snow cover maps to estimate the contribution of snow melt to stream flow. The validity of the approach has been demonstrated for the Atlas Mountain.

Regional Objectives for Application of GMES

The regional objective is to use GMES for the operational monitoring of Pyrenees' snow cover, in order to contribute to the forecast of the amount of water in reservoirs, the management of water for crops irrigation, hydroelectric production management, river stream flow modeling and flood forecasting. In addition long term monitoring of snow cover is a valuable indicator of climate change and climate tele-connections.

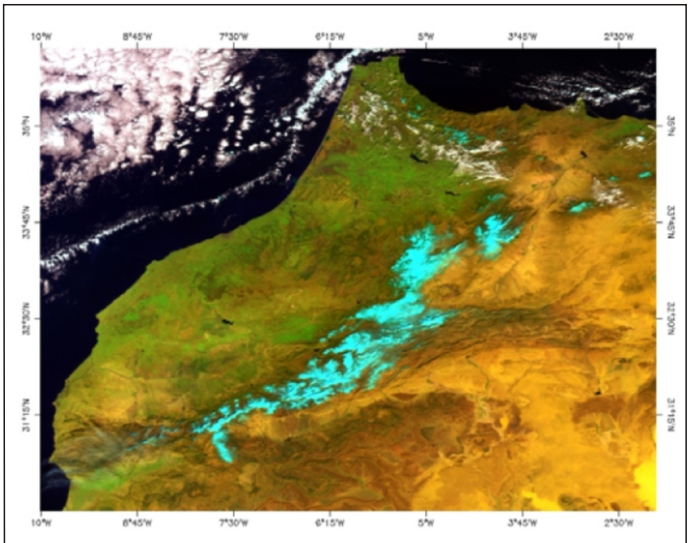


Figure 1: Image over Morocco acquired by the VEGETATION instrument onboard SPOT at 1 km

Snow cover monitoring currently relies on daily medium resolution satellite data, provided by SPOT-VEGETATION and Modis instruments at 500m or 1km resolution-see Figure 1. Decametric resolution data from SPOT, Landsat and Formosat are used when available in order to calibrate the relationship between snow cover fractions and remotely-sensed indices. Such high resolution data, together with in-situ observations, also allow validating the results.

Results or Performance using GMES in this regional application

The methodology for snow cover monitoring has been initially developed over the Atlas Mountain, in Morocco.

In Morocco, as well as in many other countries, snow cover plays a major role in the regional water balance. It stores water during winter and releases it to rivers and reservoirs during the snow melt which occurs in spring and summer. Then, this water is often used for crop irrigation or to maintain river flow during low water periods. Snow cover accounts for about 40% of the Mount Lebanon stream flow, and from 15% to 50% of the flow of the wadi Tensift tributaries. In most countries, in situ observations are sparsely distributed, and satellite imagery provides an efficient tool for estimating the surface of snow covered areas.

Medium resolution images acquired by the SPOT-VEGETATION instrument have been used for several years over the Atlas Mountain and the Pyrenees.

In Morocco, snow cover maps have been used together with weather data and snowmelt and hydrologic models in order to predict the amount of water supplied to the rivers. Results compare well to in situ observations as well as to high resolution satellite data. See Figure 2.

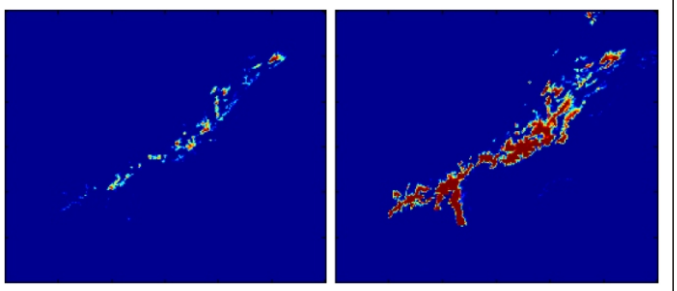


Figure 2: Snow cover over the Atlas Mountain at two dates: 06 February (left) and 23 February 2004 (right)

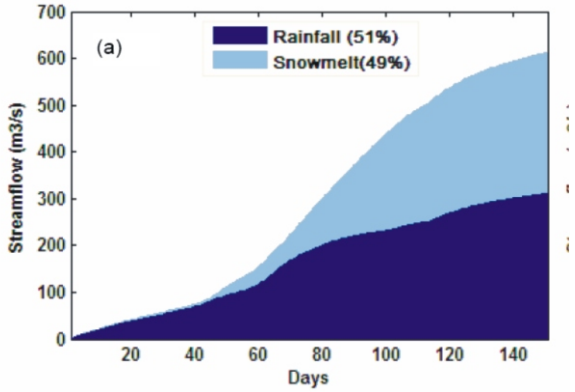


Figure 3. Snow melt and stream flow modelling: Respective contributions of rainfall and snow to the flow of the Ourika River, Morocco

Operational Status of the Activity

The feasibility of snow cover monitoring from satellite data has been demonstrated by CESBIO, a research laboratory. Several years of data have been processed over the Atlas Mountain and the Pyrenees. However, there is no operational and real time implementation of the application for now.

Two kinds of service could be delivered. The first service deals with the near real time monitoring of snow cover and snowmelt forecast. This information can then be tailored to several user needs, such as water management or flood risk forecast. The second service could address monitoring of snow cover over long time periods, taking into account current data and past observations archives as provided by NOAA/AVHRR. This information is useful as a witness of climate fluctuations and change.

Even if the method could be easily transferred for operational, R&D effort could be worthwhile to improve the results, for example to insure that snow cover is still detected under tree cover.

Added Value to the activity provided through GMES

The input data required for the snow cover monitoring application consists of geometrically and atmospherically corrected reflectances. Middle infrared channels (1.6µm) are particularly useful to distinguish snow from clouds. In the future, it is expected that the service will use Sentinel-2 and Sentinel-3 to routinely process and distribute such datasets. Possible contribution of the radar products from Sentinel 1 is still a research issue.

Future developments and Needs

Snow cover monitoring mainly requires frequent (daily ore more) remotely sensed data. A good multitemporal registration, of a fraction of a pixel, is of paramount importance in mountainous areas.

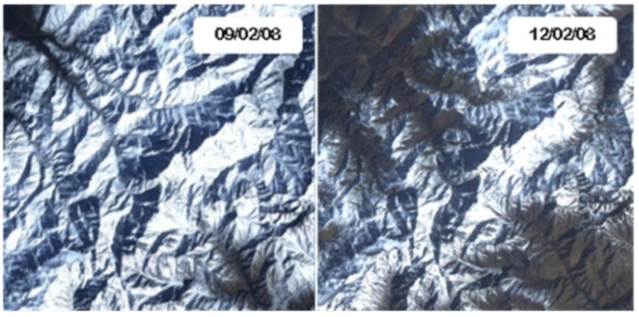


Figure 4: High resolution monitoring of the Atlas Mountain snow cover with Formosat-2

Participants:

Centre d'Etudes Spatiales de la Biosphère (CESBIO, Toulouse), Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS, Toulouse), Cadi Ayyad University, Marrakech. Agence de Bassin Hydraulique du Tensift (Maroc)

Contact: gerard.dedieu@cesbio.cnes.fr

MIDI-PYRENEES & AQUITAINE (FRANCE)
www.midipyrenees.fr & www.aquitaine.fr

Precision agriculture and agri-environment

Agnès Salvatori[1],Gérard Dedieu[2]
Spot Infoterra - Astrium Services[1] ;Centre d'Etudes Spatiales de la Biosphère[2]

Abstract

Developing an environment-friendly agriculture has become a priority in many European countries facing the consequence of abusive consumption of water and extensive use of chemicals.

Crop management services based on satellite imagery are already commercially available and used to ease crop monitoring at critical growth stages. Users, service providers and relevant research institutes can be found in the Midi-Pyrénées and Aquitaine regions. The same technologies, skills and products can be used to address the environmental aspects of agriculture and support environment-friendly agriculture. The satellite images necessary for such applications are optical multi-spectral data from which bio-physical parameters of the vegetation can be retrieved, and which need to be collected at strategic periods of crop growth and at times relevant for monitoring the impact of risky practices (such as wrong use of fertilizer).

Regional Objectives for Application of GMES

The specific downstream Agri-environment services that the Midi Pyrénées and the Aquitaine regions would like to highlight encompass: precision agriculture (crops and vineyards), water consumption management, diffuse pollution assessment and dynamical monitoring of land cover and land use.

The scope of the GMES Land Monitoring Service, as planned from 2011 onwards, should encompass a Global Component, a European Component and Local Component. The European component includes five high resolution layers that can serve the agri-environment applications, even if they will probably need to be complemented by additional data acquisition at relevant periods of the year. This is because the pan European coverage will not be updated frequently enough to allow for a timely monitoring of vegetation across the year.

Results or Performance using GMES in this regional application

Precision Agriculture is about “doing the right thing, in the right place and at the right time”. It strongly relates to sustainable practices. The ability of remote sensing to provide with both spatially and spectrally accurate data makes it a key tool for Precision Agriculture. It can be applied to field crops management and also inspires more novel applications in the area of viticulture. The services associated to Precision Agriculture are multiple: crop or vineyard plot identification and delineation, crops/vine species detection, crops/vine vigour mapping, fertilizer requirement estimation for precision fertilizer application, early detection of crop disease, weed or insect pest (early detection allows to take immediate and well quantified measures to be taken).

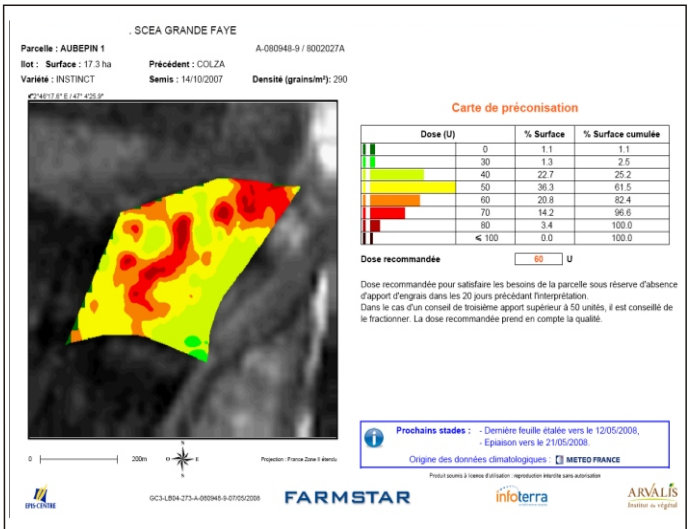


Figure 1: Fertilizer application recommendation over a wheat field (from no application - green- to maximum application (red))

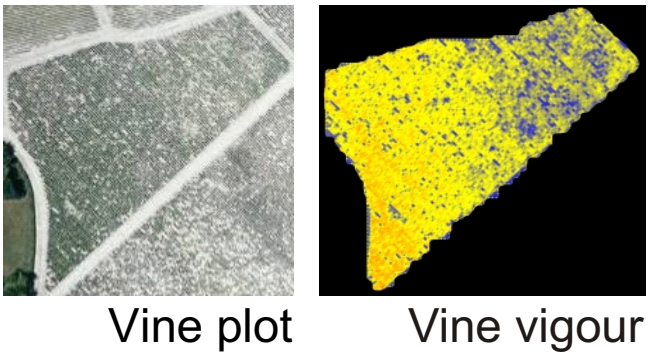


Figure 2: Vine vigour estimation (blue: low, red: high)

The diffuse pollution assessment addresses pollution carried into the soil by the combined effect of chemicals use, runoff or irrigation.

Water consumption management address irrigation control aspects.

Dynamical monitoring of land cover and land use is a prerequisite for most agri-environment applications. Experiences carried out in Midi-Pyrenees have shown that the capability to characterize land use, such as irrigation practices, intermediate crops or the type of ploughing is important for a number of applications. Such information is required on a monthly, yearly or decennial basis pending on the ultimate use.

Operational Status of the Activity

Precision agriculture and Land cover mapping techniques are operational. For example, the Farmstar service is used over 400 000 ha and Oenoview is used by several Bordeaux and Languedoc vineyards.

Agri-environment applications have been demonstrated in several regions (Midi Pyrénées, Seine-Normandie water basin,) and even outside Europe (Morocco) but have not found yet an operational implementation model.

Early warning applications and some areas of the Land Use characterisation still requires R&D effort.

Added Value to the activity provided through GMES

The GMES Land Monitoring Service (LMS) will provide a multi spectral coverage of Europe that will contribute to agriculture and agri-environment applications although the low sampling frequency is a limitation. LMS products may be fully sufficient to address the dynamical monitoring of land use, but will need to be complemented by additional data collected at specific periods of culture growth. Nevertheless even with the current limited sampling, the geo-information provided can be used by a commercial service provider either for R&D purposes (service improvement) or as an indicator of growth behavior at certain times in the growth cycle (at lower cost than the full seasonal cycle).

Future developments and Needs

Agri-environment is such a necessity for Europe that any performing and affordable service should find its customers rapidly and in a sustainable manner.

The challenge lies in the communication to the end-users (where NEREUS can greatly help) and the price of the service (where GMES can contribute while probably not being able to provide the complete set of information).

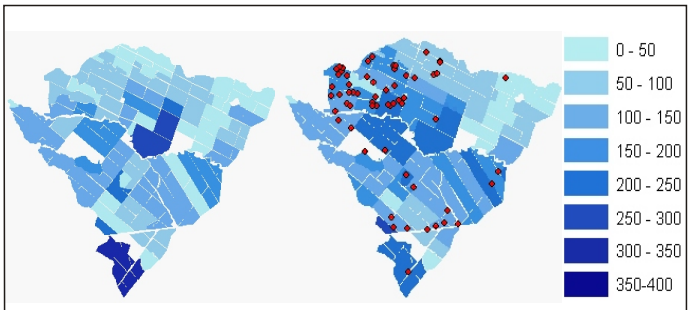


Figure 3: Estimation of irrigation water supply in Morocco.
Left: data from in situ survey, right: satellite based estimation.
Red dot are well locations. (Hadria et al., 2009)

Participants:

Arvalis, Spot Infoterra, GEOSYS, CETIOM
CESBIO (Centre d'Etudes Spatiales de la Biosphère), INRA (Institut National de la Recherche Agronomique)

Contacts: agnes.salvatori@astrium.eads.net ; gerard.dedieu@cesbio.cnes.fr

MOLISE REGION (ITALY)

www.regione.molise.it

Monitoring coppice clearances by multitemporal VHR satellite imagery in Molise (Italy)

Marchetti M.

Dipartimento di Scienze e Tecnologie per l'Ambiente e il Territorio, University of Molise, Contrada Fonte Lappone, I86090 Isernia, Pesche (Italy),

Abstract

In the Molise Region (with an area of about 4437 km^2) a multitemporal forest clear cutting monitoring has been carried out within the GMES (Global Monitoring and Security-Service Element Forest Monitoring) project. The clear-cuts were mapped and dated by photointerpretation and manual digitalization on screen, on the base of a set of SPOT5 satellite multispectral images, integrated with other geographical data under GIS (Geographical Information Systems) environment, for the years 2002-2006.

Context

The Molise Region has developed two geographic information systems that offer web-services to institutions, businesses and citizens: SVA - the system of environmental monitoring and SIIT - the information system for regional and urban planning. These two systems are becoming part of a much larger project called GEOSAT Molise, a National Project developed by a consortium, whose members are: ASI (Italian Space Agency), Molise Region, University of Molise, and Telespazio. It is one of the first initiatives in Italy of a public/private R&D "laboratory" developed in order to provide geospatial services and geo-spatial data to the Public Administrations and Citizens. In this context, the University has a very important role in the development of innovative geo-services. In particular, it is developing a service to produce forest clearance maps and forest spatial pattern maps.

Regional Objectives for Application of GMES

In Italy, wood harvesting is assessed yearly on the basis of authorizations requested by forest owners and collected by the local forest authority (National Forest Service). Some Authorities have criticized such methods as possibly underestimating forest harvesting statistics, especially in coppice forests.

The main aim of the study was to make a comparison between the clearance mapping based on multitemporal SPOT5 images of the Molise Region and official forest harvesting statistics.

The clearance date was determined by comparison between two satellite images taken one year apart, as showed in figure 1 below; on the left, the SPOT5 image dated 2004, on the right, the SPOT5 image dated 2005. In the left image the portion of forest (within the white circle) had not yet been cut in 2004

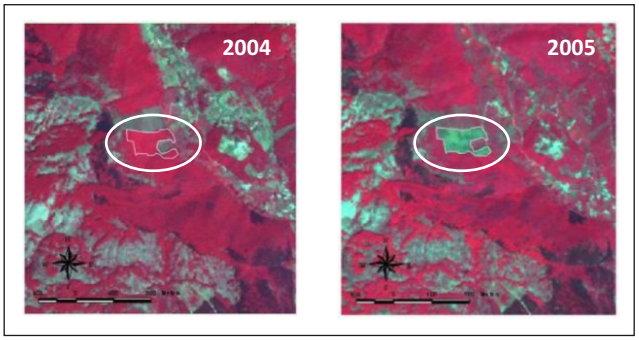


Figure 1: Comparison of SPOT5 images, 2004 and 2005

Classification of the clearance areas and their sizes were determined by photo-interpretation of the SPOT images supported by GPS-based surveying of clearance sites to calibrate the area determination.

Forest clearance from forest patches of at least 0.5 ha were mapped and classified according to the date of harvesting. An example of the clearance map (Western part of the Region) for the year 2006 is shown in Figure 2.

The accuracy of the resulting clearance map was estimated from 388 GPS based field surveys. The results showed that the accuracy of the clearance mapping was close to 100% since all observed clearances were confirmed in the field and no unmapped clearances were found in the images. Also the positional difference between GPS positions acquired on the perimeter of a clearance and the mapped boundaries from the images was accurate to within +/-6.8 m (rms error).

Data obtained by visual interpretation of SPOT5 images have been therefore considered suitable for: assessing possible discrepancies with administrative statistics.

Results or Performance using GMES in this regional application

For the Molise Region, a total area of 3041 ha was mapped for the years 2002-2006. An example of a clearance map (Western part of the Region) for the year 2006 is reported in Figure 2.

The comparison between official administrative statistics and mapped clearcuts by photointerpretation of SPOT5 imagery highlight a relevant underestimation of official statistics

For the examined years the clearance area reported by official administrative statistics was significantly lower than the mapped clearance area by manual photointerpretation of SPOT5 imagery: 1791 ha reported compared with 3041 ha measured from SPOT images.

This may be due to the method used for collecting administrative data and the simplified legal administrative process of authorization of clearance in coppice forests. Forest owners may declare smaller clearance areas than the real ones in order to be able not to require an official authorization.

Operational Status of the Activity

The monitoring of coppice clearcuts in Molise Region was carried out within a service to the MATTM (Ministero dell'Ambiente e della Tutela del Territorio e del Mare) Italy Department, for the clearcut monitoring and forest fragmentation in the Mediterranean Region in the GMES-Forest Monitoring Service Element. The project it was completed in 2008 and have involved several partners (see list below).

The results obtained by the clearance monitoring for the Molise Region showed that SPOT5 imagery can be operatively used in mapping forest clearances.

Added Value to the activity provided through GMES

The results highlighted the necessity to settle official forest logging statistics in order to provide more exact information for carbon sink assessment and for several international reporting processes (for example, the Ministerial Conference on the Protection of Forest in Europe or for the Forest Resource Assessment by FAO).

Future developments and Needs

The aim was to provide services on a European scale, while identifying and taking into account the needs, practices and regulations at local, regional and national levels. This federative approach proposes:

- Better harmonisation of services allowing an enlarged European applicability
- European deployment to enhance a cross-border interoperability

This project clearly fits within the Civil Emergencies domains of GMES.

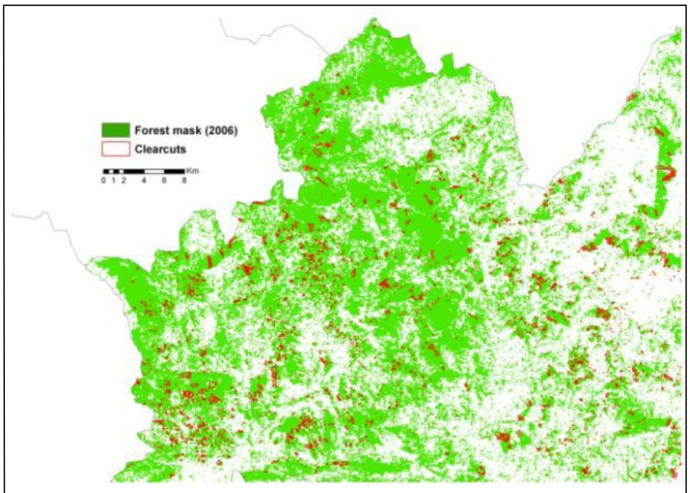


Figure 2: Forest clearance map for Western Molise in 2006

Participants:

MATTM Italian Department (Ministero dell'Ambiente e della Tutela del Territorio e del Mare); Telespazio S.p.a.; Università degli Studi della Tuscia (Viterbo-Italy); Università degli Studi del Molise (Pesche-Isernia, Italy).

Nereus contacts: ancora@nelidaancora.it; marchettimarco@unimol.it; g.biallo@geoforus.it

REGIONE DEL VENETO

VENETO REGION (ITALY)

www.regione.veneto.it

Land Use Map of Veneto Region

Maurizio De Gennaro, Silvano De Zorzi,
Massimo Foccardi, Aldo Marolla;
Veneto Region

Abstract

The Veneto Land Map is part of the GMES Urban Atlas project. The objective is to create a land cover database with high geometric and thematic accuracy with which to establish a baseline for spatial and environmental planning and land use monitoring. This database is upgradeable, to be able to measure the dynamics of land transformation, with the land cover map serving as a "snapshot" of the region at a fixed date.

Regional Objectives for Application of GMES

In the first stage of the GMES Urban Atlas for Veneto, mapping covered only the urban city area; it was then extended to cover the entire Veneto region including rural, agricultural areas, small towns and villages. Land use is divided into several classifications. For example, the classification of artificial land corresponds to Class 1 in the CORINE classification but in GMES the accuracy is much higher. (1:10,000 for GMES compared with 1:100,000 for CORINE). This mapping phase was completed in 2008.

It was decided to use GMES instead of CORINE for the size of representation scale. GMES, indeed, fits better with the dimension of local Authorities in the Veneto Region.
The next stage is to extend the classification to cover regions outside the urban zone. Following the GMES scheme, there are 5 classifications for the Urban Atlas (Class 1-urban, Class 2 - agricultural land , Class 3 - forests and semi-natural areas, Class 4 - wetlands, Class 5 - water)
In the second stage of the Veneto project the mapping covered all the remaining classes so as to better describe and represent the extra-territorial areas also deepening the thematic areas of non-urban land cover maps. This second stage has now been completed.

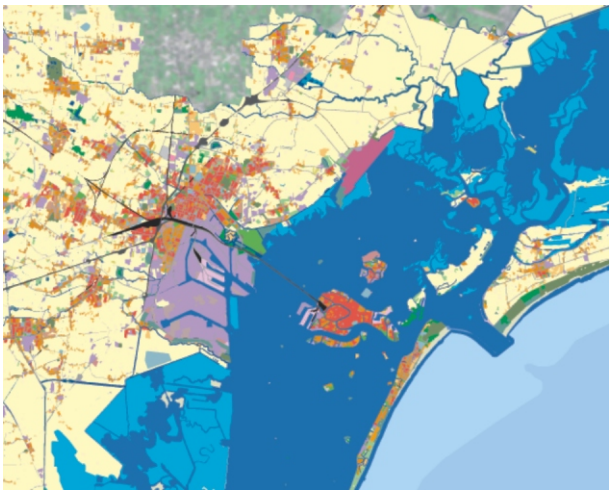


Figure 1: GSE-Land by Spot5 & Ikonos satellite

Results or Performance using GMES in this regional application.

The completed Land Cover Map of Veneto is now made available to all regional and local authorities throughout the Veneto region, as a standard for all Veneto, for planning, applications and studies that require high accuracy thematic data and ease of interpretation. Further upgrading of the Veneto map is required, using newly acquired satellite data, to enable land use change to be monitored whilst availability of higher spatial resolution satellite data permits improvements in the spatial resolution of the map.

Figure 2: Processing by Geoeye1 satellite

The Land Cover Map is a basic database for land use planning and control of land use (urban expansions, conversions and change of land use) and, especially, for applications and studies that are based on thematic data precision (agricultural soil, ecological corridors, drainage basin of the Venice lagoon.). It is used for Regional and local Authorities planning.

The approach is more widely applicable and can be adapted for use in other regions as a common tool to support local planning because standard user requirements are employed in an international context; the methodologies are accredited at European level. Regular upgrading is possible and the mapping results which can be integrated with other instruments to give users homogeneous material for the whole region.

Operational Status of the Activity

The development of the regional program for the creation of the land cover database occurred in two phases:

1) With the project G.S.E. Land - Urban Atlas, funded by the European Commission and ESA (European Space Agency), through which the definition of urban land soils was developed in more detail;

2) With the project for extending the thematic map of land use GSE Land - Urban Atlas, to land cover outside urban areas (agricultural land, territories, areas of semi-wooded, wetlands and water bodies). Satellite remote sensing data used in conjunction with other auxiliary sources significantly increased the level of accuracy of the land cover regional map.

Added Value to the activity provided through GMES

GMES services are structured around "Core" and "Downstream" levels. The former are at Pan-European level while the latter are more specialized services to meet the interests of different users (at national, regional, or local level). The downstream applications may arise from use of Core Services with an additional customised implementation that provides added value to the users.

For the Land Cover Map of Veneto project GMES was decisive for the production of a Land Cover Map permitting work on a detailed geographical scale at regional level that was not available from non-GMES sources i.e. the improved accuracy scales of GMES Urban Atlas compared with CORINE. The availability of satellite mapped images, at periodic intervals, has allowed a system of regular product updates to be established. Without GMES technology a unified European legend that allows the harmonization of geographic data among European countries would not be possible.

Future developments and Needs

Currently the project has completed the coverage of the entire Region. An upgrade using GEOLAND2 technology and data sources is already under construction. The next stage for continuation of the project is called Urban Atlas HR, and will use the integration of new generation satellite images from Worldview-2 which are characterized by a geometric resolution of the order of one meter. WorldView-2 technology will generate a land use map with higher geometric and thematic detail, allowing the delineation of the single building. One of the key aspects of the Urban Atlas IV consists of deepening the level of density classes of the urban fabric. The HR Urban Atlas will allow for a more detailed classification of densities using both the high spatial resolution and the spectral properties made available from the 8 spectral bands of WorldView-2. A second side project will evolve using historical data from satellite images and creating past Land Use Maps, which will be useful to compare with the present coverage

Figure 3: Image by WorldView 2 satellite

Participants:

Project Unit for the Geographical Information System and Cartography, Veneto Region.

Contact e-mail. maurizio.degennaro@regione.veneto.it, silvano.dezorzi@regione.veneto.it, massimo.foccardi@regione.veneto.it, aldo.marolla@regione.veneto.it

In Situ and Satellite Observations for Estuarine Water Quality Assessment

Eric Maneux[1] ; Jean Marie Froidefond[2] ; Virginie Lafon[3] ; Henri Etcheber[2]

Pôle Aerospace Valley[1], UMR CNRS EPOC[2], GEO Transfert[3]

Abstract

Estuaries are among the most productive ecosystems in the world, whose health is controlled by complex interconnections existing between the quality, quantity and timing of water inflows. In Aquitaine, increasing urbanization and industrialization, along with the impact of climate change, constitute severe pressures on water quality of the main estuaries going through the region, namely the Adour and the Gironde.
In order to promote a sustainable development of the territories surrounding these estuaries, the Aquitaine Regional Council, organized in partnership with regional structures and enterprises, have encouraged the implementation of research programs and operational monitoring services. This initiative has resulted in the creation of databases and tools useful for end-users and decision makers. In situ- and space-based experiments have been deployed, with relevant scales in time or space for water quality management.

The MAGEST automated network, that equips the Gironde estuary, has been operational since 2004. It aims to provide high frequency in situ monitoring of the water quality. Using MAREL buoys (© Ifremer, Brittany, France), measurements are transmitted in real-time, and then, processed and analyzed by the coastal and estuarine research group of the EPOC laboratory (Bordeaux University). In addition, R&D programs have been supported using remote sensing techniques and developing operational methods for the estimation of the turbidity in the Adour and Gironde estuaries and their coastal plumes.

These experiments constitute regional demonstrators of the GMES project. In the next years, by coupling complementary observation means with modeling tools, it is expected to achieve full GMES services for coastal and estuarine environments.

Regional Objectives for Application of GMES

The main concerns in the Gironde estuary are encountered in most NEREUS regions. The metallic and organic contaminations, together with urban wastewater discharge, degrade the water quality. Natural processes may interfere with many practices. Salinity gradients and strong tidal currents favour the development of a maximum turbidity zone (MTZ) that is a key indicator for water quality assessment. Sometimes associated to MTZ, de-oxygenation periods are regularly observed

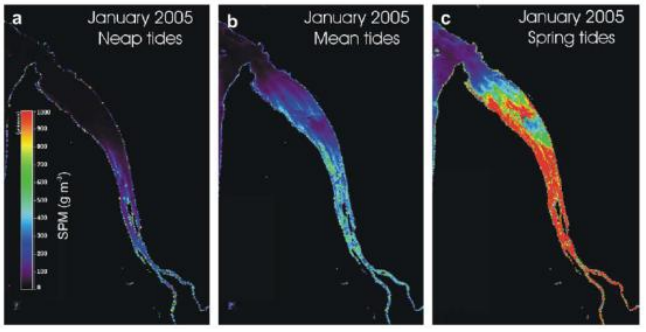
In Aquitaine, these parameters need to be closely monitored with specific objectives: The protection of the ecological environment (ex: preservation of stocks of migrating fishes and of emblematic species such as Sturgeon); the conservation of good water quality (Water Framework Directive); prediction of the hydrological consequences of climate change; development of sustainable water resources. These issues are considered for the implementation of river and estuary management plans.

To meet these objective, the implementation of observation networks and measurement facilities have been coordinated by all the relevant stakeholders (the managers, planners, administrators and users) with consulting scientists. Since now, they have been maintaining an in situ monitoring network able to describe high frequency water quality variability as well as spatial variability along the main salinity and turbidity gradients. Simultaneously, the capabilities of remote sensing sensors have been exploited to map the stretch and position of the MTZ and of coastal turbid plumes associated to the estuaries.

This regional project may be used as an example for the implementation of services of water quality and pollution monitoring in other NEREUS regions and the applications may constitute value added services for the Marine Core Service MyOcean.

Results or Performance using GMES in this regional application

Since 2004, the MAGEST network allows real-time and high frequency monitoring for water temperature, salinity, turbidity and dissolved oxygen (http://www.magest.Epoc.u-bordeaux1.fr).



Variations of surface SPM concentrations in the Gironde estuary observed in January 2005 using MODIS Terra and Aqua full resolution data during neap, mean and spring tides (a, b, and c, respectively).

Figure 1: Maximum Turbidity Maps - Gironde Estuary (Doxaran et al. 2009)

The MAGEST network's technical features have been successfully adapted to the macro tidal environment and to high salinity and turbidity gradients. Tidal cycles and seasonal cycles are now fully documented.

SPOT, MODIS and ENVISAT sensors are being used for the definition and validation of characteristics specific to each estuary. The concentrations of suspended particulate matters (SPM) are derived from water colour within the ranges of 0 up to 1000 mg/L in the turbid plume and of 0 up to 10 g/L in the MTZ. SPM are determined with an accuracy of about 5% on average. In the Gironde estuary, remotely sensed SPM values are validated using MAGEST continuous measurements.

Operational Status of the Activity

From 2004 up to 2006 the Gironde estuary was a R&D and demonstration site. The MAREL technology (©Ifremer) was tested and qualified for high turbid coastal environment. The MAGEST network is now an operational service. In 2007 the implementation of a network similar to MAGEST (the SYVEL network) was achieved in the Loire Estuary.

The pre-operational phase of the turbidity map service is now achieved. A demonstrator is currently under development. The EPOC Laboratory of Bordeaux University and GEO Transfert provide up to 60 two-dimensional turbidity maps per year. Up to now, this technology was mainly applied for research or R&D purposes: GIS ECOBAG and ANR program (assessment of the SPM exportation in the Gironde plume); INTEREG program LOREA "Littoral Ocean River Euskadi-Aquitaine".

Added Value to the activity provided through GMES

Coastal area monitoring services implementation requires the availability of adapted observation tools. In this scope, the mapping of geophysical variables will be supported by the GMES Sentinel satellites. Medium to high resolution sensors with high revisit capability will be adapted to the extraction of turbidity maps. High resolution will be required for most European estuaries that show narrow riverbeds. Also, metric resolution of Pleiades images will provide information at the right scale to evaluate the impact of dredging operations, to assess urban wastewater discharges and to monitor industrial spills.
Moreover, hydrodynamic models provided through GMES will be used to force local models which are under development.

Future developments and Needs

The growing intensity of human activity in coastal regions (in Aquitaine, the population will increase by 15% until 2010) combined with the impact of climate change involve an increasing needs in environmental monitoring and security. Thus, innovative GMES services will be developed in most NEREUS regions, in order to achieve relevant and sustainable

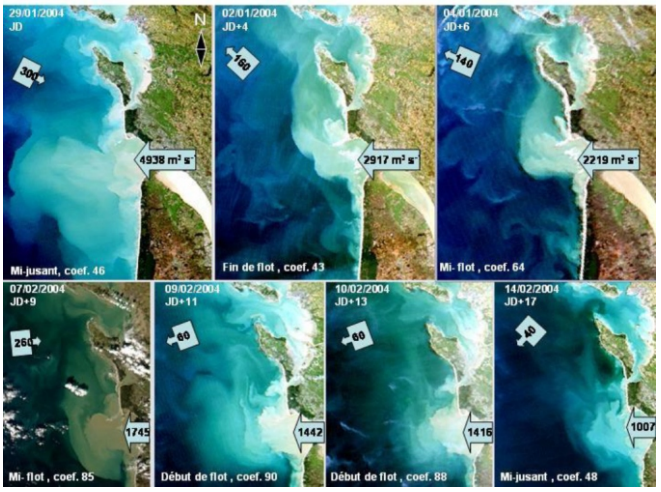


Figure 2: Gironde plume as a function of water discharge (© GEOtransfert)

Participants:
Agence de l'Eau Adour Garonne, CNES, Conseil Régional d'Aquitaine, EDF CNPE du Blayais., Etablissement Public d'aménagement de la DORdogne, GEOTransfert, GIP Loire Estuaire, Grand Port Maritime de Bordeaux, IFREMER, NKE, Observatoire Aquitain des Sciences de l'Univers, Syndicat Mixte d'Aménagement de la Garonne, Université de Bordeaux-UMR CNRS EPOC, Syndicat Mixte Développement Durable de l'ESTuaire

Contact e-mail of lead author: e.maneux@epoc.u-bordeaux1.fr

AQUITAINE & MIDI-PYRENEES (FRANCE)
www.aquitaine.fr & www.midipyrenees.fr

Coastline Monitoring

Virginie Lafon[1] ; Eric Maneux[2] ; Jean Marie Froidefond[3] ; Cyril Mallet[4]
GEO Transfert[1], Pôle Aerospace Valley[2], UMR CNRS EPOC[3], BRGM Aquitaine / Observatoire de la Côte Aquitaine[4]

Abstract

The Aquitaine coast undergoes chronic erosions. In order to anticipate and avoid the potentially dramatic human and socio-economic implications of the coastline retreat, the marine erosion hazard must be integrated in the land planning policy.

With this aim, the Regional Council of Aquitaine has been creating a resource center (the Aquitaine Coast Observatory) that provides relevant information for coastal planners. Amongst its activities, the Aquitaine Coast Observatory (ACO) continuously monitors the coastline (dune foot) position. Along the coast (240 km long), field differential GPS records of 40 geographically fixed transects are acquired once a year. High resolution spatial imagery is used to derive the coastline location between the transects.

Since 2007, comprehensive maps of the coastline have been delivered yearly by a technology transfer team in Aquitaine (GEO Transfert) that has progressively implemented a service of space observation on the scale of the Aquitaine coast.

A service demonstrator has been developed and tested within the framework and the objectives of the ACO. Along sandy beaches, the coastline location is derived with a precision of the order of the image pixel size. Spatial beach/dune/forest cartography is also generated and provided, upon request.

Regional Objectives for Application of GMES

The Aquitaine Regional Council (leader of the ANCORIM project "Prevention of environmental risks and adapting to climate change") designed a regional management scheme in Aquitaine which is based on a partnership of the state, regional administrations and scientists. Its operational management tool involves the monitoring of the coastline with three main objectives: to improve the knowledge, to quantify the movement and to anticipate the risks by defining a Coastal Risk Prevention Plan on the ocean front.

The survey of the coastal area at a regional scale is a mission focused on the environmental assessment and on civil security. Thus, the scopes of GMES fit perfectly the objectives of coastal regions that experience erosion and develop Integrated Coastal Zone Management at a regional scale.

Figure 1: Definition of the coastline (© GEO Transfert)

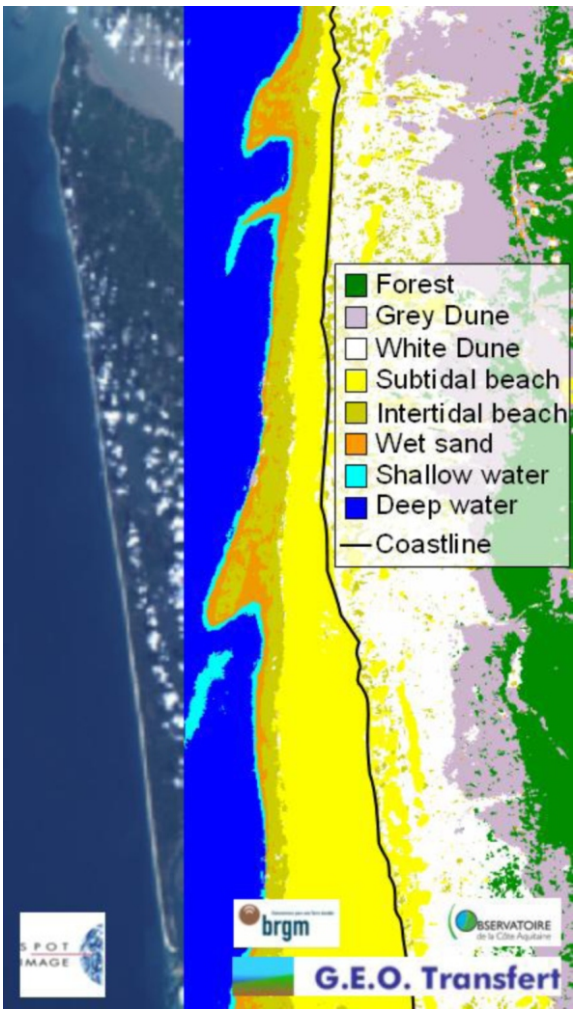


Figure 2: Formosat-2 imagery and derived map of coastal indicators (@ GEO Transfert / OCA)

Results or Performance using GMES in this regional application

Coastline change analysis must be based on regular and accurate surveys of key indicators. In the case of the Aquitaine coast, Formosat-2 high resolution imagery acquisition has been programmed during the spring to obtain space and field coincidental datasets.

As a first step, a mapping approach has been defined. Based on classification and filtering procedures, it is possible to map five classes (forest, grey and white dunes, back shore, intertidal beach). The forest/dune limit and the coastline (the foot dune) are also derived. Then, the results of the cartography have been validated by an exhaustive in situ DGPS data set. The accuracy of the coastline positioning, and hence the performance of the change analysis that can be achieved, is only limited by the resolution of the space sensors. Lastly, the remotely-sensed coastlines have been compared with past datasets to derive the current trend of the shoreline all along the sandy coast of Aquitaine.

These results are used to project the future evolution of the coastline and assess the erosion risks as a function of human and economic issues. This latter project is led by the Aquitaine Regional Council.

Operational Status of the Activity

A semi-operational methodology has been jointly developed by BORDEAUX 1 university researchers and local end-users (BRGM, Aquitaine Coast Observatory).

A service demonstrator has been achieved and maps of the coastline and major geo-morphological indicators are provided once a year. It is expected to achieve a fully-operational service with the support of INFOLITTORAL-1, an Aerospace Valley Program that involves an Aquitaine / Midi-Pyrénées partnership.

Added Value to the activity provided through GMES

The implementation in European coastal regions of coastal monitoring tools and services implies satellite-based observation capacities to offer cost-effective tools. Thus, the sustainability of GMES information infrastructures will favour such initiatives. For instance, the Sentinel and Orfeo programmes will enable us to obtain synoptic views with space and time resolutions adapted to coastline monitoring. The improvement of the image resolution and hence of map accuracy will enable coastal operators to better analyse the changes in response to short (storm) to long (global climate change) term variations and to apply the results of these analysis to public policy requirements.

This project could be an implementation of FP7 Geoland 2. Also, the monitoring of the coastline is related to the marine project since the development of coastal activities may involve drawing up of coastal erosion risk mitigation strategies. The impact of climate change must be integrated in future management plans.

Future developments and Needs

It is intended to extend progressively this innovative observation service to the 27 regions of the Atlantic Arc Commission and to the Mediterranean Sea. The development of the service will follow the strategy developed in Aquitaine to ensure that the developed service will fit the needs expressed by the end-users.

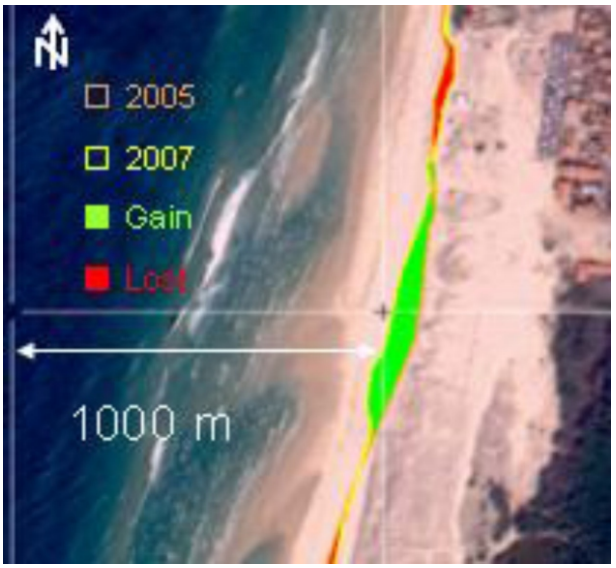


Figure 3: Evolution at Biscarrosse city
(Lafon and Sénéchal, 2008)

Participants:

BRGM Aquitaine, CNES, Aquitaine Regional Council (Conseil Régional d'Aquitaine), Aquitaine Coast Observatory (Observatoire de la Côte Aquitaine), GEO Transfert, SPOT Image, University Bordeaux 1 / UMR CNRS EPOC

Contact e-mail of lead author: v.lafon@epoc.u-bordeaux1.fr

AZORES (PORTUGAL)

www.azores.gov.pt

Azores Ocean Monitoring and Environmental Management (REMORA)

Ana Martins; Ana Mendonça; Miguel Figueiredo; Sandra Sequeira, Ana Filipa Silva; Paolo Lambardi; Sérgio Gomes, and Alexandre Medeiros

Department of Oceanography and Fisheries, University of the Azores, Portugal

Abstract

The Azores archipelago is located in the NE Atlantic and as such, it is very exposed to a harsh environment (ocean/atmosphere) where natural catastrophes are frequent. These in turn, largely affect day-to-day local population activities and life. The Azores also provide a key area in the NE Atlantic for continuous oceanic monitoring of many diverse habitats and ecosystems (Figure 1). From an oceanographic and climatic standpoint, the Azores oceanic region provides an excellent opportunity for remote observation of basin scale ocean circulation and its effect on long-term climate changes.

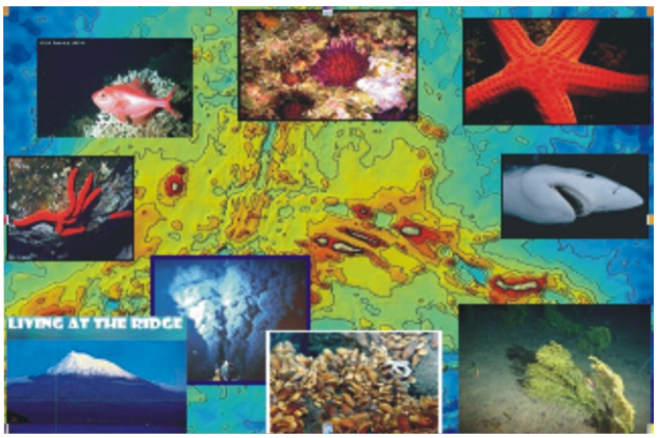


Figure 1: The Portuguese Exclusive Economic Zone (EEZ) is one of the largest in Europe and the most diverse in terms of habitats and ecosystems. Azores in particular, include: seamounts; hydrothermal vents; cold coral reefs, canyons etc., constituting new frontiers for oceanographic research and for economic exploitation (mining, pharmacological, fisheries, cinema, tourism, etc)

Recognising this importance, and through the integration of different regional to international projects, the Dept. of Oceanography and Fisheries at the University of the Azores (DOP/UAz) has initiated a larger effort to develop and enhance scientific and technological competences for a better understanding of the coastal/oceanic Azores ecosystem structure and functioning. These activities comprise extensive decadal in situ cruise surveying and most recently, the introduction of satellite technology. All these incorporate an outreach component, to promote public awareness on marine conservation and to provide relevant data to help support decision making by relevant authorities.

Medium to long term objectives comprise the full installation of an operational network/platform for an efficient "Azores Ocean Monitoring and Environmental Management" (REMORA platform).

Regional Objectives for Application of GMES

Main ocean socio-economic activities in the Azores involve commercial fisheries and tourism. DOP/UAz has supported for decades decision makers at the level of fisheries advice and legislation, creation of marine biotope habitat directives, and natural environment management. Main efforts are also being made to provide: short and long-term ocean monitoring and forecasting; improved topographic mapping; and support for emergency management of natural hazards and civil protection (Figure 2). These applications can be incorporated as part of GMES Core Services: Marine; Security; and Emergency. Application of GMES for Azores downstream services include: maritime surveillance; maritime safety; monitoring of water quality; environmental protection and management; maritime forecasts; and ocean production.

Figure 2: Disaster with CP Valour ship in Faial Island (Azores) during winter 2005. DOP/UAz provided local authorities and TV with daily estimations of probable occurrence of surface oil slicks around the islands (http://www.horta.uac.pt/projectos/cp_valour/index.html)

Results or Performance using GMES in this regional application.

The application of space technologies to ocean studies in the Azores was initiated in 2001 by DOP/UAz with the installation of an Azores HRPT station (Faial island) and the development of an "HAZO" semi-automated satellite processing system which acquires and processes real and near real time satellite imagery (http://oceano.horta.uac.pt/detra/) for the region (Figure 3). Other satellite data products are being added to the HAZO system but are not yet daily available on the site. DETRA site provides statistical data for NE Atlantic regions (e.g. Azores, Madeira, mainland Portugal and Canaries).

GMES Domain MARITIME

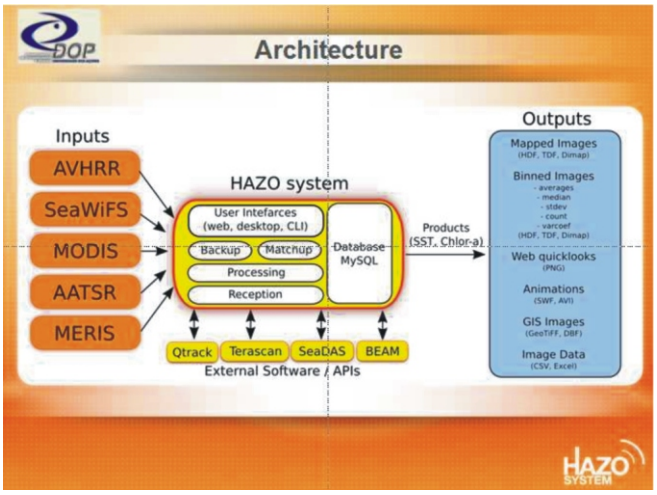


Figure 3: HAZO system developed at DOP/UAz. Satellite images are automatically processed by integrating standard source programs. A database containing image meta-info is formed and statistical products are generated. GIS integration and backup tools are also provided

Real-time tidegauges, installed around Azores islands provide data to the Global Tsunami Warning and Mitigation System (coordinated by UNESCO-IOC and a component of GMES). An "Oceanographic Atlas" has been developed, which provides ocean information for the NE Atlantic region. The "Azores Oceanographic Data Centre" (AZODC) (Figure 4) provides an integration of all these sites and the REMORA platform shall assemble in, an operational mode, all the existing infrastructures.

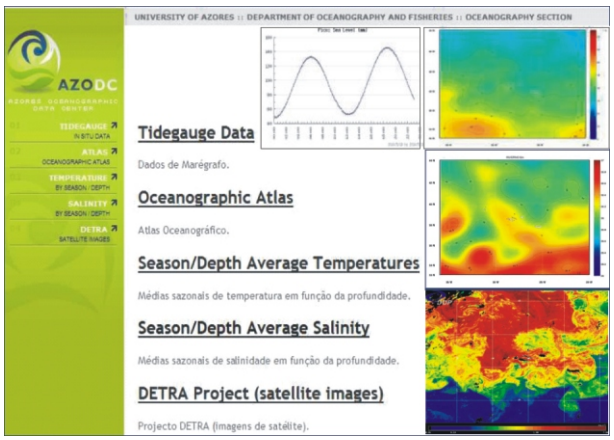


Figure 4: The Azores Oceanographic Data Centre (AZODC) provides oceanographic data information for the Azores region (http://oceano.horta.uac.pt/azodc)

Operational Status of the Activity

The Azores region, and in particular DOP/UAz, is making its first steps towards providing civil protection authorities, port- or local authorities, and other institutions with regular oceanographic scientific support. Presently, the status of the activity is still on a research/demonstrator phase. There remains a number of local data receiving stations or structures which cannot be maintained or supported on a fully operational basis because of funding limitations, and hence, cannot yet be relied upon to provide efficient and continuous response to local or regional crisis incidents. A larger regional/national effort has to be made in order to integrate new, and maintain existing, networks so that proper response and advice can be efficiently transmitted to end-users on an operational basis (Figure 5).

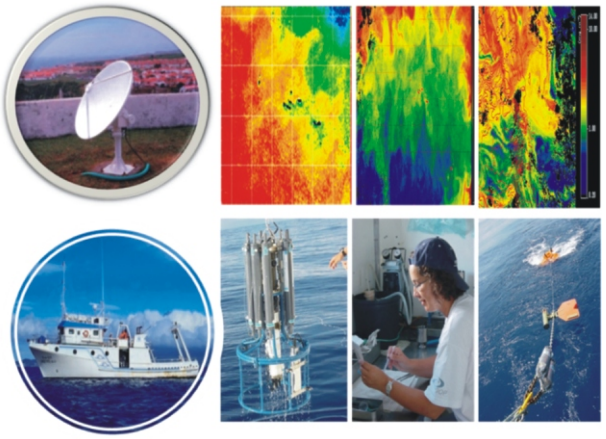


Figure 5: Continuous oceanographic data collection in the Azores is being made through satellite and in situ data acquisition and processing. A fully operational service is not yet available although, many recognize its vital importance for the region

Future developments and Needs

The processes of interest for marine emergency response and environmental support actions are multi-scaled in space and time, requiring both fine and broad scale spatial sampling (cm to km), frequent temporal sampling, and sustained observation (inter-annual to decadal). In the Azores region it is vital to have localized high resolution oceanographic information (with the best possible accuracy) in order to be able to generate and provide end-users with both near real time automatic products as well as, on-demand ad-hoc products. Besides other applications, this oceanographic information can effectively save Azorean lives and holdings.

Participants:

DOP/UAz and IMAR-Instituto do Mar.
Other partners or collaborating research groups/institutions: National Hydrographic, Meteorology, and Oceanographic Institutes, NASA/GSFC, ESA, Joint Research Centre (ISPRA, Italy) and IFREMER (France).

Main author: anamartins@uac.pt

BREMEN (GERMANY)

www.bremen.de/haefen_und_logistik

Contributions to Safety of Maritime Transport

V. Schumacher
CEON- Centre for Communication, Earth Observation and Navigation Services

Abstract

The safety of maritime transport is of highest interest to Bremen because of the importance of its maritime economic activities in shipping and logistics.

In addition, Bremen has a strong competency in polar and climate research. Therefore, the development of applications and services combining GMES services and other satellite-based technologies (e.g. sea ice maps, ship detection) and in-situ data (e.g. Automatic Identification System, (AIS), sea state and ship voyage data as well as SATCOM and SATNAV) can provide valuable support to the safety of shipping. A specific case of an integrated application concerning the shipping in arctic sea routes is presented.

Regional Objectives for Application of GMES

While Bremen as a two-city state covers only a relatively small geographic area, traditionally it has connections worldwide which are further driven by its vibrant maritime and space sectors. Bremen's ports and maritime/ marine sector is one of its most important economic drivers. Shipping, harbour, transport and logistics secure every fourth job in Bremen. In total, about 86.000 jobs in Bremen and Bremerhaven are directly or indirectly connected to the port and the container trade.

In this respect, maritime GMES applications are of highest interest to Bremen as a "GMES pilot region".

Figure 1: Container Terminal in Bremerhaven (© WfB)

Results or Performance using GMES in this regional application.

Services based on space technologies can contribute to enhancing the safety of maritime transport. Although shipping in Northern waters can bring significant economic advantages (through fuel savings due to shorter routes and thus fewer emissions), it remains a hazardous endeavour. An integrated ship routing support service potentially consists of several components:

- Ice services (sea ice maps operationally derived from Earth observation data)
- Tracking of ships by terrestrial, as well as future satellite based, Automatic Identification System (AIS)
- Ship detection by Earth observation data (all weather radar images)
- In-situ component: analysis of voyage data (speed, course etc) for route optimization
- Weather forecast data derived from Earth observation systems (wind, waves etc).

Each of these components represents an area of regional competency applied to the specific application "Safety of Maritime transport". The intention is to transfer scientific innovations via demonstrated user driven applications towards an operational service in selected core areas of competency.

Figure 2: The "Beluga Foresight" navigates the icy waters, following an ice breaker (© Beluga Shipping)

GMES Domain MARITIME

Operational Status of the Activity

Several aspects are covered contributing to this application at all levels:

I. Operational-level:
Merchant ships belonging to the Bremen based Beluga Shipping Company used the Northern Sea Route for the first time in the summer of 2009. Sea ice maps derived on an operational level from Earth observation data were used to support the routing.

II. Demonstrator-level:
The research vessel "Polarstern" belonging to the Bremerhaven based research institute AWI was tracked by satellite AIS during a voyage to the Antarctic. The voyage was also supported by real time transmission of in-situ weather data via satellite communication to a processing centre in Bremen (German DeMarine project).

III. Research-level:

a. On-going research by AWI (i.e. measurement of ice thickness, modeling of ice pressure), contributes to ship routing in Polar Regions.
b. The development of detection services covering ships and man-made objects using Earth observation data contributes to maritime safety (German DeMarine project).

Added Value to the activity provided through GMES

Bremen's competencies in GMES provide the following regional benefits:

1. Cost avoidance of shipping accidents and efficiency gains in route planning
2. Environmental benefits in the North and Baltic seas as well as coastal zones
3. Technological benefits through a high level of innovative activity finding solutions for the maritime sector
4. Economic benefits through the growth of local industry providing GMES services.

Future developments and Needs

All these components shall be combined in an integrated approach to contribute to the enhancement of safety in shipping, here with strong focus on polar environments. In a further step, ship routing support as a contribution to the safety of maritime transport can be extended to cover global shipping routes. The applications and services developed have strong links to GMES and can potentially become a GMES Downstream services.

Figure 3: **CRYOSAT-2**, measuring ice thickness for climate change analysis (© ESA - AOES Medialab)

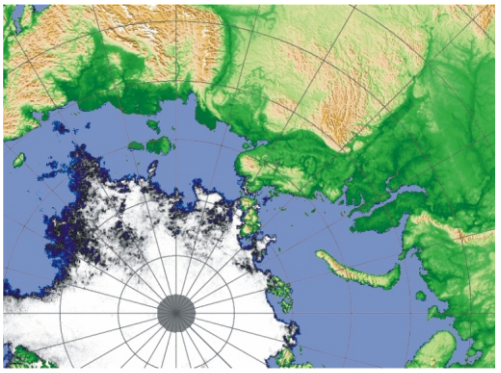


Figure 4: Operational daily Sea Ice Map (© IUP, University Bremen)

Participants:
Alfred Wegener Institute for Polar Research (AWI), Astrium GmbH, Beluga Shipping, CEON - Centre for Communication, Earth Observation and Navigation Services, DLR Institute for Space Systems, Gauss mbH Environmental Protection and Safety in Shipping, Institute of Applied Physics (IUP) of the University of Bremen, OHB System AG, University of Applied Sciences (Hochschule Bremen).

Contact e-mail: schumacher@ceon-bremen.de

Coastal Zones Remote Sensing and Management

René Garello[1] ; Bertrand Chapron[2] ; Marie-Marguerite Bourbigot[3] ; Jean-Yves Eouzan[3] ; Eric Maneux[4]

Telecom Bretagne[1], Ifremer[2], Pôle Mer Bretagne[3], Pôle Aerospace Valley[4]

Abstract

The Brittany region has developed several activities directly related to GMES. They are divided between research oriented applications and quasi operational ones. The Aquitaine region is both an end-user and a R&D contributor as it supports similar projects. One might notice that the Operational Oceanography was born from GMES through major projects such as MERSEA or MyOCEAN. In this context, the PREVIMER project is set up as the Operational Coastal Oceanographic Centre with the aim of providing observation data, modeling tools and real time forecasts as required by a fast growing number of users working along the French coastlines bordering the English Channel, the Atlantic Ocean, and the Mediterranean Sea. From the PREVIMER service, a set of specialized products and services tailored for specific user needs are derived: GIRAC, PREVICOT, APOSTROPHE, LOREA and several other applications are underway, bringing together political, scientific and industrial players. These applications are developed in support of European policies for the marine environment and security as well as in response to the needs of specific users such as maritime civil engineering firms, coastal waste water treatment plant managers, ferry operators, fishermen and fish farmers for characterizing, modeling and forecasting coastal ocean conditions, pollution detection and monitoring, water quality monitoring, etc. They all are fed by data coming from satellites (VIGISAT receiving station, Met data from MeteoFrance), in situ acquisitions (HF radars, bathymetric soundings), archived data (CERSAT) or data of opportunity (sensors on board ferries or fishing boats).

Regional Objectives for Application of GMES

This programme enables a better cooperation between the academic institutes and the SMEs on several thematic topics. The academic research is more upstream oriented, but the range of possible downstream applications is quite large. The Brittany region has funded the development of PREVIMER and supports a formal Scientific Group BreTel (standing for Bretagne Télédétection or Brittany Remote Sensing) on the subject of Remote Sensing for oceans, lands and coastal zones.

One of the aims is to become a center of excellence in the research and academic domains linked to the knowledge of the environment and for an increase in security. The research projects linked to oceans and coastal zones, and developed by this group, are connected to operational themes and are largely based on the data acquired by the VIGISAT operational ground receiving station operated by the SME CLS (through its Radar division in Brest).

Concerning oceans and coastal zones security, the support of the Cluster (Pôle de Compétitivité) Mer Bretagne, is fundamental for coordinating all the actions developed around the main theme of oceans and coastal zones security. Indeed, Brittany with 2730 km of coasts is the first maritime region of France.

Indeed, the large spatial coverage of the observations, coupled with a quite good temporal revisit time, allows us to reach a spatial structure in the framework of the monitoring of oceans and land for climate change purposes. Scientists will therefore be able to help in societal development and spatial planning at the regional scale, for a better warning for natural or man-made hazards, such as oil pollution, flood, etc. and in the spirit of territorial cohesion. We believe that this action will support the European spatial development perspective as elaborated in the Territorial State and Perspectives of the European Union.

Results or Performance using GMES in this regional application

In this section, we will focus on the description of the main applications linked through GMES, through projects supported by the Regions and coordinated by several companies and academic institutes. In terms of classification of actions, the natural approach consists of identifying the project belonging to GMES services, the semi operational applications and the means of achieving the overall needs. PREVIMER is a center for operational coastal oceanography (http://www.previmer.org/en). Several projects, so far in a demonstration phase, are connected to it:

- **PREVICOT:** Four-day forecasts for all sea and coastal parameters concerning sea conditions, for all coastal users, professional or recreational (http://www.previcot.com).
- **GIRAC:** modelling tools and real time forecasts for the bathing water quality management system (http://www.pole-mer-bretagne.com/girac.php).
- **LOREA:** this project is supported by the Aquitaine region in the framework of the Interreg programs. It concerns several main applications ranging from water quality to pollution monitoring and security monitoring. (http://www.azti.es/lorea/).
- **APOSTROPHE:** Operational system of forecast of the nuisances related to the bloom for shellfish applications.

All of these projects share some common points: they are related to the very sensitive problem of pollution, water qualities and coastal zones monitoring. They are a complement to the French state privilege and are connected to several projects aimed to provide operational services on pollution watch and coastal navigation within the European Maritime Safety Agency .

Finally, all these projects rely on upstream developments within academic and R&D company partnerships. They also need the data provided by several means of acquisition. The list below shows both types of activities:

- **POLHSAR:** improve the actual spaceborne and airborne sensor performances for the detection of oil pollution at the sea surface.
- **MODENA:** simulation platform for the modeling of the electromagnetic interactions (radar) and the marine environment.
- **VIGISAT:** receiving ground station for radar satellites (ENVISAT, ERS-2, RADARSAT 1&2)
- **METEOSATMER:** this platform receives data from many orbital and geostationary satellites in the visible and infrared range.
- **CERSAT:** acquisition, algorithmic processing, quality control, archiving and distribution of the satellite data to the oceanographic community.
- **HF radars:** operated by ACTIMAR and SHOM, provides a high temporal resolution of the sea surface parameters (wind, currents) on a local scale.
- **Litto3D:** SHOM and IGN produce a geographic reference for the littoral, aimed to littoral protection, risks prevention and regional development.

Operational Status of the Activity and GMES added value

As described in the previous sections, the activities are at several levels from operational use to demonstration, with R&D heavily involved. The aims of GMES and of the program here are in synchronization: systematic monitoring and forecasting of the state of the Earth's subsystems, emergency response (e.g. floods, fires, technological accidents, humanitarian aid) and security-related aspects (e.g. maritime surveillance, border control).

The Brittany and partner regions have made a strong commitment to these activities and support fully the projects and the teams working on them. The figure beside presents the connection between the services, the projects and the R&D means.

All the projects and the means of achieving them are developed in order to fulfil these goals: collect data from multiple sources (earth observation satellites and in situ sensors such as ground stations, airborne and sea-borne sensors), process these data and provide users with reliable and up-to-date information through the services.

Future developments and Needs

The Brittany and partner regions (Aquitaine, Midi-Pyrénées) are part of the DORIS (Downstream Observatory organised by Regions active In Space). The aim consists of establishing a network among European regional and local authorities being potential users of GMES services and to build a prototype of a "European GMES Downstream Platform". This prototype shall be tested in a first pilot run in a nucleus consisting of European pilot regions already active in using GMES services.

Several projects aimed at improving the detection and monitoring of the ocean surface and floating objects near the coast will be developed in this framework.

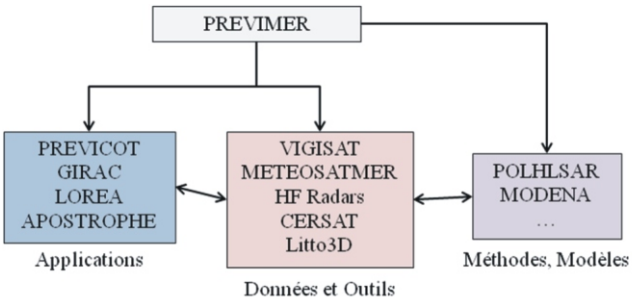


Figure1: Connection between services, projects and R&D means. The central themes are: pollution, water qualities and coastal zones monitoring

Participants:
IFREMER, TELECOM Bretagne (UMR LabSTICC), UBO-IUEM (GEOMER), Université de Pau et des Pays de l'Adour (LASAGEC), Université de Bordeaux (EPOC), SHOM, METEOFRANCE (CMS Lannion).
CLS, NKE, HOCER, IDHESA, ACTIMAR, GEIE Littoralis, NKE electronics, Neotek Ponsel, Veolia, ALTRAN, Thales, Satimo.

Contact e-mail of lead author: rene.garello@telecom-bretagne.eu

MECKLENBURG-VORPOMMERN (GERMANY)

www.geomv.de/gmes-mv

Ship Detection Service

Egbert Schwarz; Holger Maass; Susanne Lehner; Stephan Brusch
German Aerospace Centre (DLR)
German Remote Sensing Data Centre; Institute of Remote Sensing Technology

Abstract

The European Maritime Security Service, MARISS is the first phase of a pan-European activity of ESA (European Space Agency) under GMES (Global Monitoring for Environment and Security). The objective of MARISS is the development of integrated maritime and costal services to support European regions.At the DLR site in Neustrelitz (Mecklenburg-Western Pomerania), an application for ship detection based on satellite image data of synthetic aperture radar (SAR) from ERS2, ENVISAT and TerraSAR-X has been developed and implemented.

Regional Objectives for Application of GMES

The priorities for the EU Integrated Maritime Policy are the improvement of maritime safety and security, reduce pollution and to fight against illegal activities. A special objective of MARISS is to characterize the added value from combination of satellite based Earth Observation data with conventional data streams such as AIS (Automatic Identification System).

In this context there are common regional and national interests for developing and extending Near Real Time (NRT) Services for maritime applications. The location of the Neustrelitz Ground Station provides excellent real-time facilities for regional, national and international users.

The approach for the MARISS Service Network is based on a cooperative network, composed of a set of NRT Ground Receiving Stations covering specific areas with specific sets of sensors. Service Providers may then use the network to improve products and provide cost efficient services compliant with customer requirements.

As Figure 1 shows, the acquisition circle of Neustrelitz (appr. by elevation of five degree) allows coverage from the North Altlantic to the Mediterranean Sea. The primary regional focus is to provide ship detection services covering the German Bight and the Baltic Sea. Neustrelitz is the exclusive Ground Station in Europe for the German Radar Satellite TerraSAR-X.

Results

Satellite data are processed in real time. Data reception and real-time processing are carried out at Neustrelitz using an applied algorithm, developed by DLR's Institute of Remote Sensing Technology. Dependent upon the data resolution of satellite images, image and other products can be delivered within 12 minutes. See Figure 2.

Terrestrial AIS data for the Baltic Sea are acquired via the network and stored at the Ground Station and merged to the SAR images during processing.

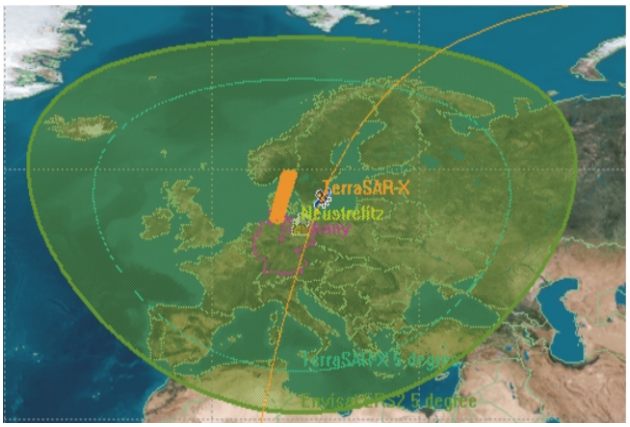


Figure 1: Ground Station Neustrelitz, acquisition circle for ERS2 and TerraSAR-X; 5 degree elevation

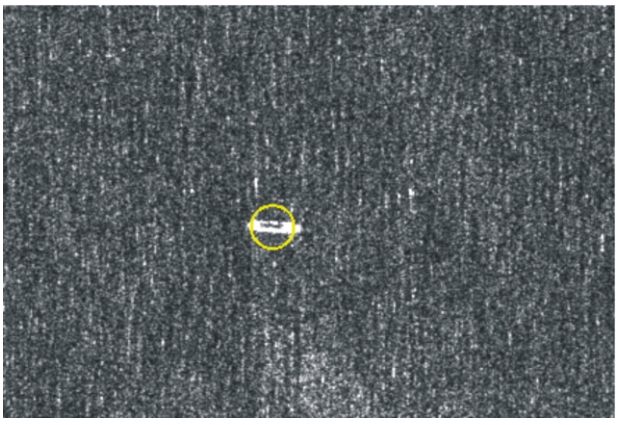


Figure 2: Detected ship on TerraSAR-X image data sub scene; Image Mode StripMap, resolution 3 meter

GMES Domain MARITIME

The detection service provides information such as the position, length, and direction of the ship. The fusion with AIS data from terrestrial and satellite sources creates a more significant picture with additional information e.g. ship name, ship class and destination. AIS messages are broadcast and regulated for all vessels larger than 300 GRT.

The product delivery to the user is established in the following way.

Products such as quicklook images, text files with ship position and kml file for loading in Google Earth are delivered via auto generated e-mail. (See Figure 3) The full resolution product is available for download on the delivery server user account.

Successful AIS experiments using ERS2 and TerraSAR-X data were conducted in different areas, including the Baltic Sea and German Bight.

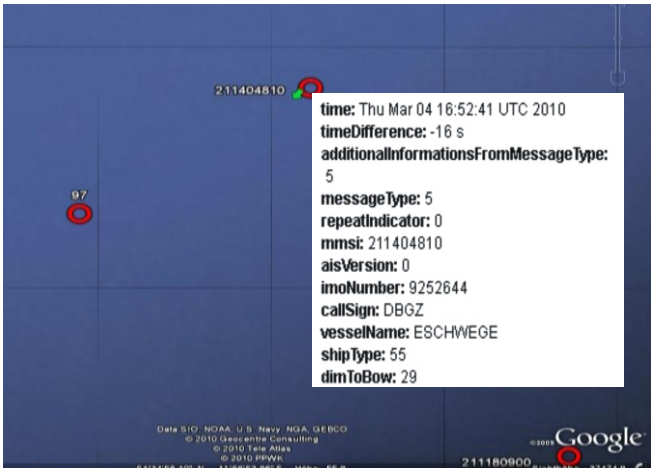


Figure 3: kml output product extract; image data product merged with AIS data; Google Earth used for product

Operational Status of the Activity

The development of the application and service is ongoing.
According to an effective maritime surveillance and tracking the integration of different, complementary data streams are mandatory. Satellite SAR and AIS are only two of the data streams of possible interest. Vessel Monitoring System (VMS) and Long Range Identification and Tracking System (LRIT) are further options.

The integration of other satellite data like ENVISAT will increase the reliability of the service.

Added Value to the activity provided through GMES

Coastal-based surveillance systems are widely used, but are limited in their coverage. SAR Satellites provides the possibility for ship surveillance over wide areas independent of weather conditions, cloud cover and daylight. Different SAR modes with different area coverage can be selected to obtain images over larger areas or with higher resolution according to the size of target ship.

With TerraSAR-X, very high resolution SAR images (up to 1meter) are available.

Future developments and Needs

In order to overcome the limits of terrestrial AIS, a Satellite-based AIS is under development and will be integrated if available. To provide users with easy and fast data access further harmonization of services with existing the exchange formats is necessary.

The main objectives of the MARISS project to create a Coordinated Service Network to provide all the European Users Organizations with integrated ship detection. Services will take this into account.

One of the project aims is the standardization and best practices adopting within the maritime sector.

This needs further development to conform to existing regional and national user interfaces.

Participants:

QinetiQ, FFI, ELMAN, DLR, SPACE HELLAS, LUXSPACE, gmv, CLS, e-geos, ASSYSTEM, EDISOFT,KONGSBERG, ITD

Contact e-mail of lead author: Egbert.Schwarz@dlr.de.

BREMEN (GERMANY)

www.bremen.de

Determination of Particulate Matter Concentration Across Germany and Europe

M. Vountas, W. v. Hoyningen Huene, H. Bovensmann and J.P. Burrows
Aerosol/Cloud research group of the Institute of Environmental Physics (IUP/IFE) Bremen

Abstract

Environmental control of air pollution uses concentrations of particulate matter (PM) for evaluation of the pollution load. A method for PM determination from spectral aerosol optical thickness measurements obtained from satellite observations is described. Retrievals of PM from satellite observations are supplementary information to ground-based national observation networks. A combination of satellite and in-situ measurements is being used in a research demonstrator for environmental control of air pollution.

Regional Objectives for Application of GMES

It is an urgent obligation of every country and worldwide authorities like the World Health Organization or the European Union, to ensure the surveillance of air quality parameters like ozone, nitrogenoxide, sulfur dioxide and natural or anthropogenic particulate matter(PM) with sizes in the range from nanometers to micrometers.

The approach taken by IUP/IFE Bremen uses satellite measurements of high spatial resolution to improve the availability of high qualitative, complementary and cost-efficient information on PM concentrations. IUP/IFE Bremen has developed a scientific prototype retrieval model (a research demonstrator) which can provide a near-real-time operational processing chain for particulate matter PM10using satellite data, principally data from the MERIS instrument on Envisat. So far the software uses novel modules which provide particulate matter mass concentrations of PM10 and also PM2.5(particle size smaller than 10 ìm and 2.5 ìm resp.), in high quality and a high spatial resolution of 1 km, optionally 300 meters. The projects builds on recent validation results taken over Germany and is potentially suitable for larger areas in Europe (see Figure 1). The retrieved particulate matter maps can be used for assimilation to improve and complement the current particulate matter measurements made by ground based gauging stations. Especially in the context of GMES-Atmosphere (and to a certain extent GMES-Maritime air quality in ports and on shipping routes), this project demonstrates the benefits of monitoring particulate matter mass concentrations because particulate matter is one of the most hazardous air pollution, not only in urban areas.

Results or Performance using GMES in this regional application

So far a proof of concept, involving a first validation of satellite-based data retrieval with in-situ measurements, has been performed.

Cloud-screened PM10 retrievals have been compared with ground-based PM10 measurements taken during over-flight times of Envisat. Ground-based PM10 measurements are obtained within the measurement networks of the 16 German federal states, provided by the Federal Environmental Agency(Umweltbundesamt, UBA) of Germany. The results of the comparison are presented in Figure 2.

At first sight it seems that the retrievals from satellite observations do not correlate with PM10 from ground-based measurements. (See all points [crosses + open circles] in Figure 2). A deeper analysis of the character of the ground stations is needed.

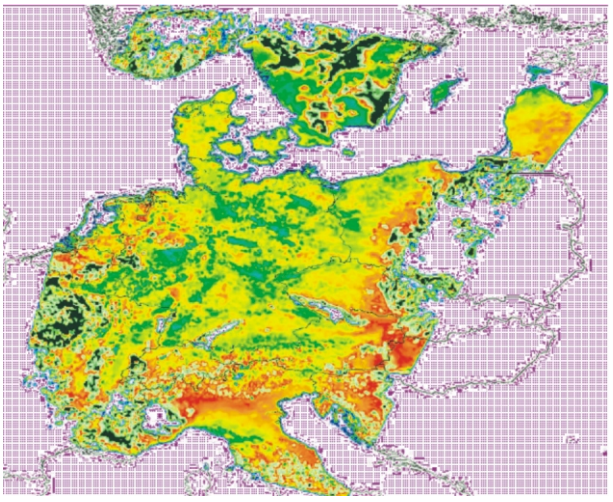


Fig. 1: PM10 concentration over Europe

A large number of data points, mainly with high PM10 concentrations relate to urban areas and include the pollution from traffic along main road connections in the measurement. MERIS (reduced resolution) data, however, gives an average estimation for this parameter on a scale of 1.2 km . 1.2 km, mostly above the urban canopy layer. Comparisons with stations, affected strongly by urban traffic are indicated in Figure 2 with red open circles. These data show no correlation with the PM10 concentrations derived from satellite observations. The latter are clearly underestimating the ground-based measurements.

Taking into account that local aerosol concentrations are expected to be high near traffic roads and decrease rapidly off-roads and that the spatial resolution of the co-located satellite pixel is relatively poor, a dilution of the MERIS measurement towards lower concentrations is to be expected. Better spatial resolution of the satellite data is needed to resolve near such traffic hot spots and in urban street canyons.

By removing all data points from stations affected strongly by urban traffic, one obtains a scatter plot, which correlates well with ground data (crosses in Figure 2). We performed a linear fit of PM10 derived using satellite measurements with those on the ground: PM (satellite) = 0.725 PM10 (ground) + 7.98 with a correlation coefficient of 0.71. The average standard deviation is 11 ìg/m3. Considering the fact, that the regional variability of the meteorological conditions is treated as constant for the whole scene, the scattering of the data is within an acceptable range.

Operational Status of the Activity

The project aims to support and enhance the current ground based measurement network and to establish connections to users (authorities). Improvements with respect to broader applicability, large-scale validation and the establishment of an operational demonstrator with users are envisaged. In the long term this service could serve as part of an air-quality health warning system. However, the present results show that current satellite retrievals underestimate PM concentrations in traffic-heavy urban environments but give representative indications of average pollution levels on regional scales.

Alongside this PM retrieval work, IUP/IFE has built up significant expertise in the field of nitrogen dioxide retrievals- which is another important air quality parameter. However, this seems already well covered within the framework of GMES Atmospheric Services.

Future developments and Needs

The data indicate that the retrieved PM10 concentrations give the average pollution by particulate matter on the larger scale of the MERIS satellite pixel and not local peaks. On a scientific basis, further improvements can be expected, if real regional meteorological conditions can take into account. On a technical basis, the method would need to be developed as an operational system.

For routine PM10 retrievals input data from MERIS is needed. For the future, especially to resolve localized traffic-induced pollution, satellite data with better spatial resolution are necessary. In the short- to mid-term this gap could be closed using MERIS full resolution data (300 m x 300 m) while in the long-term data of the multispectral instrument (MSI) on GMES-satellite Sentinel 2 (prospected max. resolution: 10 m x 10 m) could be used.

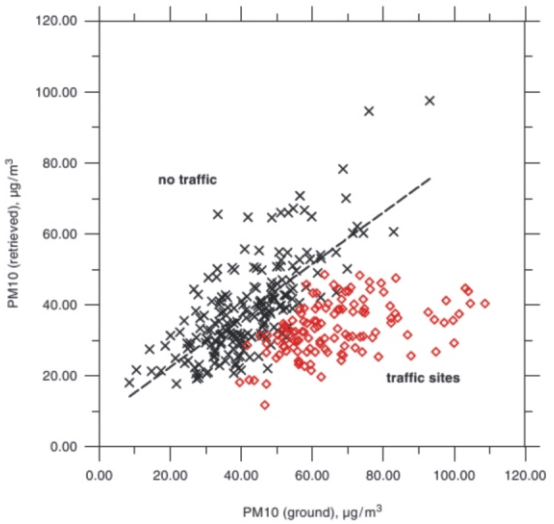


Figure 2: Comparison of cloud-screened retrievals of PM10 from MERIS scene of October 13, 2005 and ground-based measurements of PM10 concentrations for the MERIS over flight time, provided by the German Federal Environmental Agency (Umweltbundesamt). For the traffic sites no correlation is found between satellite-derived and ground data.

Participants:

Aerosol/Cloud research group of the Institute of Environmental Physics (IUP/IFE), Bremen

Contact e-mail of lead author: vountas@iup.physik.uni-bremen.de

How Clean is Our Air? Local Air Quality Monitoring and a Role for GMES

K. P. Wyche[1], A. G. Edwards[1], P. S. Monks[1], R. Leigh[1] and E. Davies[2]

G-STEP, University of Leicester, Leicester[1], Pollution Environmental Services, Leicester City Council[2]

Abstract

"Clean air is considered to be a basic requirement of human health and well-being. However, air pollution continues to pose a significant threat to health worldwide" (World Health Organisation, 2005).

This paper describes current efforts made in the City of Leicester (UK) for the monitoring of air pollutants using ground based instrumentation and modeling tools. It also highlights that our understanding of local and regional air quality can be advanced, and the local environment better characterized, through the addition of integrated measurements from satellite borne instruments and GMES products. The combination of local measurements and satellite data can advance the capability to monitor, predict and manage the magnitude and evolution of air pollution.

Regional Objectives for Application of GMES

It is well known that airborne pollutants cause detrimental impacts upon human health, the environment, buildings and heritage, and ultimately upon the economy (e.g. Monks et al., Atmos. Env., 2009). Despite attempts made by EU legislation to reduce emissions of key anthropogenic air pollutants (e.g. NECD, 2001), levels in many areas of Europe still remain unacceptably high and further action must be taken to bring about air quality improvement.

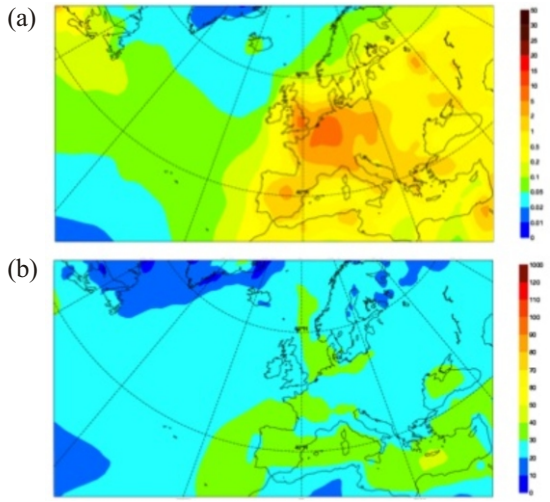


Figure 1: GEMS reanalysis for (a) NO2 and (b) ozone concentrations over Europe during August 2007 (http://www.gmes-atmosphere.eu/d/services/gac/reanalysis/ gems/)

By its very nature, air pollution is an international, transboundary issue (e.g. Figure 1); as such it needs to be addressed by coordinated actions across a range of temporal and spatial scales from national to regional and local.

Local authorities within the UK are obliged by the Environment Act (1995) to ensure certain air quality standards are adhered to. In order to do this, and hence assess the state of air quality and impacts made by air pollution abatement and reduction measures (and thus to drive policy forward), coordinated observations of the evolving state of our air are made by in-situ monitors at many sites across the UK. Ultimately, these data are submitted to DEFRA and the European Environment Agency for analysis, storage and dissemination (e.g. http://www.eea.europa.eu/).

Results using GMES in this regional application

In the East Midlands, Leicester City Council and the University of Leicester undertake detailed measurements of the city's air quality using both standard instrumentation and novel research tools. Many air quality parameters are measured in-situ, including EU legislated pollutants such as nitrogen dioxide (NO2) and particulate matter (PM) as well as volatile organic compounds (VOCs) and ozone (e.g. Figure 2).

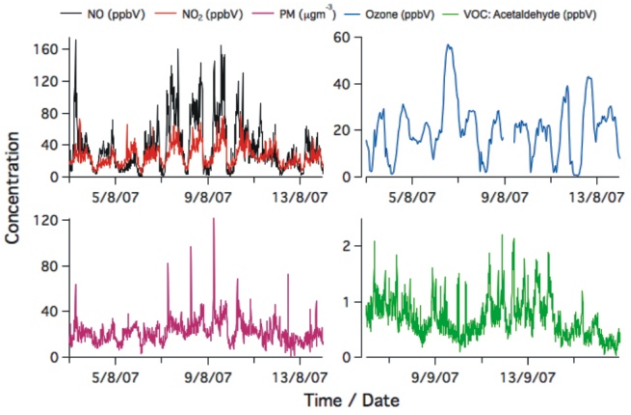


Figure 2: Evolution of common pollutants measured in Leicester city centre during August 2007.

To complement these observational data and to improve our understanding of how the chemical composition of the local atmosphere evolves, the partners also employ local scale modeling tools such as the Airviro dispersion model (SMHI) and in-house bespoke chemical models utilizing data from the Master Chemical Mechanism (http://mcm.leeds.ac.uk/MCM/).

As shown in Figure 3, such models can provide a wealth of additional air quality information, effectively plugging the large data gaps that exist between monitoring stations (which constitute fixed validation points for the model). Figure 3 also demonstrates how such models can be employed to track local pollution hotspots throughout the day and provide source-receptor information. Such tools can also be used for planning and policy enforcement, for example in establishing/monitoring Air Quality Management Areas.

GMES Domain ATMOSPHERE

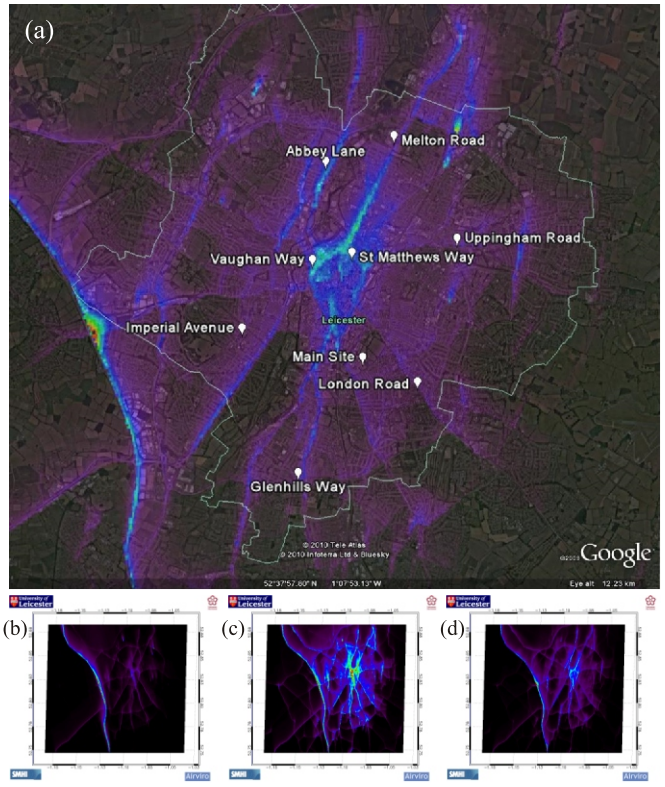


Figure 3: (a) Simulated NO2 distribution over Leicester city at (b) 06:00, (c) 09:00 and (d) 12:00 hrs using the Airviro model. Monitoring sites are shown.

Owing to the transboundary nature of air pollution, it is critical that such local observations be integrated with detailed holistic scale (compositional and meteorological) GMES earth observation (e.g. satellite and model) data in order to:

(i) Determine regional influences on local air quality (e.g. local air quality standards may be being breached by air pollution imported from another region, Figure 1),
(ii) Provide measurement site and model cross validation to ensure data quality (e.g. via the correlation of local in-situ measurements with satellite data),
(iii) Provide a detailed picture of European air quality (e.g. via the integration of local scale data with European scale satellite data),
(iv) Help formulate best practice and policy.

Operational Status of the Activity

Leicester City Council makes routine measurements of NOx and PM at seven different urban sites across the city (Figure 3(a)). This activity is periodically complemented by intensive in-situ research campaigns conducted by the University to measure VOCs, ozone, PM composition and remotely sensed NO2 and aerosol optical depth.

Further research is ongoing to construction ensemble tools that integrate ground, space and model data, to add value to, and improve the monitoring and management of local air quality.

Added Value to the activity provided through GMES

Using space based data in concert with in-situ data allows a transboundary problem such as air pollution to be observed and addressed. Air pollution is, by its very nature, geographical and therefore the detailed level of data available via GMES for both urban and rural locations (where little monitoring takes place) will undoubtedly benefit the population at large. Via the use of such data, tools can be produced that will for example, allow: individuals with respiratory illnesses, (who are seriously affected by air pollution) to avoid polluted areas; city planners to have a better understanding of issues pertaining to environmental protection and highways agencies to plan effective traffic management strategies that take account of air quality regulations.

Future developments and Needs

With local partners, the University of Leicester are currently working on the design and construction of a new technology, based on Differential Optical Absorption Spectroscopy (DOAS), for the measurement of NO2 in boundary layer air. Known as CityScan, this novel instrument will be used to build up a detailed picture of evolving pollution tomography in a city's atmospheric environment in near real-time (www.pollutionradar.co.uk).

The University of Leicester is also working to utilise the GMES "atmospheres" core service, MACC, to assist in the production of other local air quality tools and products. Current efforts include investigations, with the City and other partners, into the impact of traffic congestion on local air quality and potential mitigation measures. More specifically, by combining real-time monitoring of both traffic density and air quality with local scale modelling, satellite data and pollution forecast information, new approaches to intelligent traffic management and alternative travel route planning are being developed in order to improve both inner city travel flow and local air quality.

The use of pollution forecast data for the implementation of a local alert service, such as the highly successful airTEXT and airALERT projects (e.g. http://www.airtext.info/), is also currently under investigation.

To ensure that such projects are successfully realised, specific requirements/support from GMES and MACC are need, these include: good, easy to use local air quality products (e.g. NOx and PM); speciated PM data; local scale air quality forecasting and data quality and heritage information. Any such local air quality monitoring data should have high spatial and temporal resolution.

Although current efforts are focussed primarily on regional applications in Leicestershire, wider applications of these developments are applicable and transferable to other cities and regions throughout Europe.

Participants:

GMES-Space Technology Exchange Partnership (G-STEP), University of Leicester, UK.
Leicester City Council, Pollution Environmental Services.

Contact e-mail of lead author: kpw5@le.ac.uk

MADRID REGION (SPAIN)

www.madrid.org

GMES Advanced Urban Applications in Madrid

Félix Bellido[1]; Antonio Garzón[2]; Marino Palacios[2]
[1]IMADE Madrid Aerospace Cluster; [2]INDRA Espacio

Abstract

The Madrid Region, through the Strategic Plan for Aerospace, is promoting the development of advanced GMES products and services related to regional interests. In this context, products have been developed relating to brown fields, air quality, light pollution and urban climate, all of which use different Earth Observation technologies. The final goal of this research is to provide GMES products and services to the regional administration in charge of these topics as the final user and more widely to users across Europe and worldwide.

Regional Objectives for Application of GMES

Madrid, as an urban region, demands geo-spatial information related to advanced and updated cartography: territorial information (as land use/land cover maps, change maps, related indicators, etc.); natural resources management information (forests, water, agriculture and biodiversity); environmental quality information (soil degradation, water quality and sustainable consumption, air quality, light pollution and urban heat islands analysis); emergencies information and future scenarios forecast including regional climatic change models.
Within the framework defined by the Region's Strategic Plan for Aerospace (2010-2014) Madrid is promoting specific support for activities covering the use of space technologies for the purpose of improving sustainable competitiveness. The operational programme, which is being implemented, and coordinated through the Madrid Aerospace Cluster EO/GMES Working Group, includes supporting R&D activities in cooperation with other countries and regions, both for the provision of new services and the creation and development of new technology based firms.

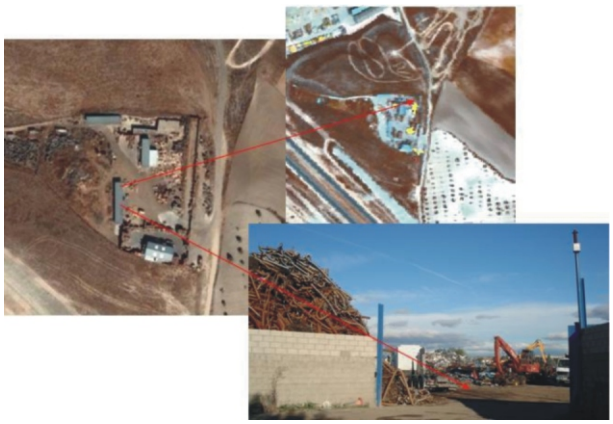


Figure 1: Junkyard detected using hyperespectral data

Land use maps, derived products and indicators are being developed around the experiences of Madrid and other European Cities with the methodology of the GMES Urban Atlas programme. Other Earth Observation-based environmental products are being developed through the Madrid Region Strategic Plan on Aerospace, including brownfield site and degraded land maps, (used for land use analysis); light pollution maps; improvement of air quality models using EO data and services related with urban climate such as urban heat islands and climate change impacts.

Results using EO data in urban environmental quality analysis

The presence in contaminated land of pollutant materials that compromise future land use is being analyzed using hyperspectral imaging. The use of airborne and space images has the capability to obtain much more spectral information than is obtainable by other classical approaches.

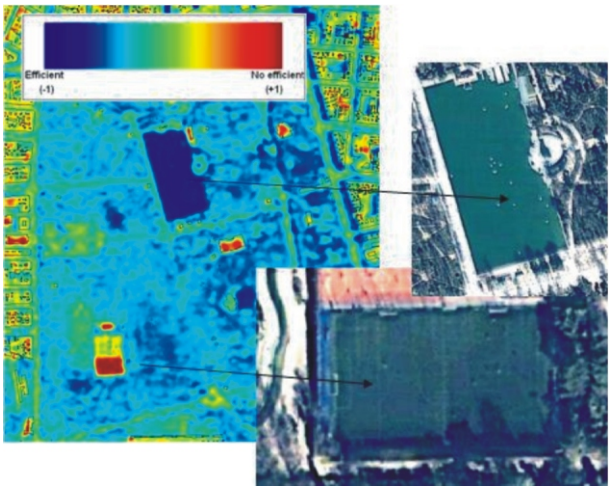


Figure 2: Temperature map of Retiro Park in Madrid City

Using these images a methodology has been generated that allows regional authorities to improve the detection of pollutants materials such as asbestos used in roofs in earlier times; areas treated with fertilizer from pig farms; junkyards.

The pollution of European skies from city lights is considered to be a major environmental problem. Using thermal imaging from satellites and night flights over Madrid with thermal airborne cameras energy efficiency maps are being developed that not only monitor light pollution of the region but also assist with evaluating the energy efficiency of the electrical network of the city of Madrid.

Many cities and regions operate networks of air quality sensors and air quality forecast models. Earth Observation is being used to improve these measures and forecasts. Data from ENVISAT is used to improve air quality forecasting for Madrid.

The energy efficiency of cities and the impact of urban heat islands on citizens' health are now being considered in the portfolios of urban managers. Current status and forecasting of heat island effects is also being followed using EO-derived thermal imaging data to derive indexes related to citizen health and data for urban planning in order to mitigate these effects.

Also, the scientific community and decision makers understand the particular impact of cities in global climate change. Models of urban climate change are being improved using EO and aerial data and other geo-spatial information.

Status of EO advanced urban applications

Based on research supported by the Madrid Region Strategic Plan on Aerospace, the feasibility studies reported above have resulted in a range of developed products and service prototypes. Additional actions needs to be taken to introduce theses products and services in the daily practice of the Madrid administration.

Added Value provided through EO

There are several advantages revealed in the Earth Observation studies carried out in Madrid:

- The clear advantage of using hyper-spectral data in the detection of degraded land and the opportunities of these types of techniques in the future.
- The data provided by EO sensors is practically the only source of information to produce regional maps of light pollution. Data from thermal night-time imaging from satellites and their application are of clear area of interest to the sector.
- The data provided by satellites devoted to atmospheric analysis could contribute to improve the current air quality models.
- Thermal imaging has a clear role in the future of the provision of cities data: analysis of urban heat island and energy efficiency of the cities and understanding of the effect of the climate change within cities.

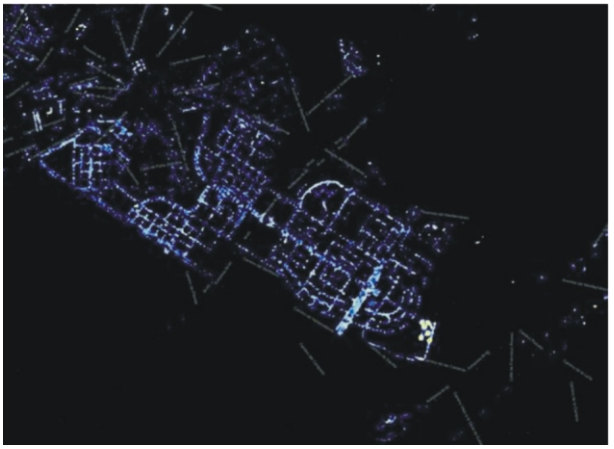


Figure 3: Light map of new urban development

Future developments and Needs

The main GMES products and services, in the form of land use-cover maps and urban change maps, are already being introduced in the Madrid Region administration and more EO advanced products and services are required. The current initiatives that are related to urban environmental quality could be improved in Madrid and in other regions by promoting the EO urban based products between the European regional administration and developing European scale services. Pollution maps of European cities and services related to urban efficiency and urban heat islands are typical examples.

A further regional strategy focus for future actions will be to exploit common approaches of EO/GMES and Galileo/GNSS applications and services, and develop a regional portfolio of new and advanced services completing a “regional portfolio”. In its capacity as an international centre of excellence in regional civil protection, Madrid will expect to be a driving force for further developments.

Participants:

IMADE. Madrid Aerospace Cluster. Consejería de Economía y Hacienda
INDRA Espacio/Instituto Nacional de Técnica Aeroespacial (INTA)/Instituto Geológico y Minero de España (IGME)/Universidad Politécnica de Madrid (UPM)

Contact e-mail of lead author: fbellido@imade.es ; mpalacios@indra.es ; felix.bellido@madridnetwork.org

REGIONE BASILICATA

REGIONE BASILICATA (ITALY)

www.basilicatanet.it

Pre-operational test and real time validation of advanced satellite techniques for Forest Fires early detection and monitoring.

Giuseppe Basile[1], Nicola Pergola[2], Valerio Tramutoli[3]

Dep. of Infrastructure Pub. Works and Mobility, Civil Protection Off. - Basilicata Region[1]

Institute of Methodologies for Environmental Analysis - National Research Council[2]

Department of Engineering and Physics of the Environment - University of Basilicata[3]

Abstract

The Basilicata Region has an experimental program to test and validate the potential of advanced satellite techniques for early detection and continuous monitoring of forest fires in the Basilicata territory.

An original fire detection scheme, RST-FIRE, based on the general RST (Robust Satellite Techniques) approach (figure 1), is under evaluation in close collaboration with end-users, namely the Regional Civil Protection Office. A multi-sensor, integrated surveillance system, based on the use of data coming from both polar (e.g. NOAA-AVHRR, EOS-MODIS) and geostationary (e.g. MSG-SEVIRI) satellite sensors, is under test to evaluate its possible impact on fire fighting standard procedures and regional protocols.

Its performance in detecting fires promptly and efficiently is being evaluated by comparing with other current operational satellite-based techniques.

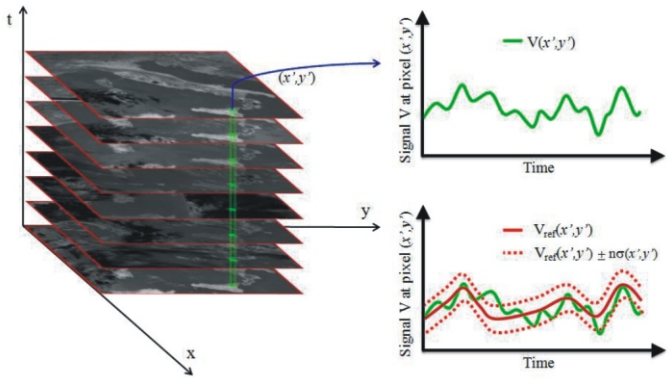


Figure 1: Robust Satellite Technique (RST) approach rationale. A time series of satellite images, analysed to generate reference fields (expected signal and natural variability) and to automatically detect hot spots.

Regional Objectives for Applications of GMES

An efficient and effective fire fighting activity must foresee a timely detection and intervention. A rapid detection minimizing the time interval between the fire start and the first alarm would allow local authorities to prevent fires becoming too widespread, so reducing the hazards for population and environmental damage. Thus, the regional interest in such a project is because satellite observations, continuously updated (up to 15 minutes for geostationary systems) and properly analyzed in automatic processing chains, represent an additional and powerful tool for a quasi-continuous monitoring the regional territory and providing environment protection and hazard mitigation.

Results or Performance using GMES in this regional application

The 2009 experimental campaign of fire monitoring, made in strict collaboration with the Civil Protection and local institutions of Basilicata Region, has been performed by a Total Validation Approach (TVA) allowing the direct control of each possible fire automatically detected by RST (through airplane surveys and personnel on the ground)

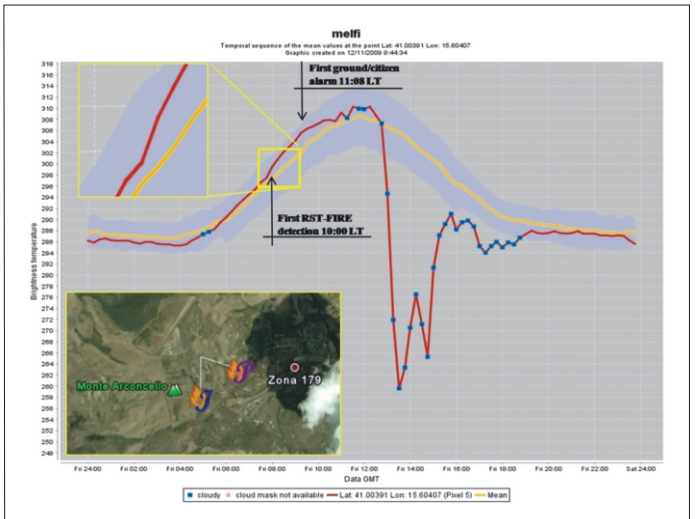


Figure 2: Example of RST timely detection during the 2009 real-time validation campaign: the Melfi (Potenza) event. In the plot, the daily MSG-SEVIRI MIR signal compared to its expected value. In the inset, the two thermal anomalies detected at 08:00GMT, one hour before the first alarm.

The TVA approach then allows RST-FIRE robustness (low false alarm rate) and sensitivity (capability to detect small fires) and response time (early detection of fires) to be evaluated.

During the 2009 real-time campaign, several cases of rapid detections were demonstrated. For example, a small fire occurred in Basilicata region near Monte Arconcello (Melfi-Pz), on 28 August 2009, at 10.00 LT (8.00 GMT) which was promptly detected by RST-FIRE using MSG-SEVIRI data (Figure 2), about one hour before the first alarm was provided by private citizens and traditional ground fire surveillance systems. Preliminary analysis has also shown that RST-based products perform better than standard fire detection methods, like the MOD14 contextual algorithm, which is considered to be one of the most reliable techniques for fire detection.

A first validation campaign was carried out in summer 2009 with encouraging results. A second real-time test is planned for July-August 2010. Similar pre-operational studies were carried out, jointly by IMAA-CNR and DIFA-UNIBAS, on different Italian territories (Lombardia Region, Palermo Provence in Sicily), confirming the actual portability of such an application in other regions.

Operational Status of the Activity

This is an on-going research which is already providing pre-operational and operational products, also through the involvement of a young spin-off company (www.unibas.it/geospazioitalia/index.html). RST products and alerts are, in fact, directly sent to civil protection operational room for a prompt check. The forthcoming assessment campaign (July-August 2010) will probably see the involvement of international institutions, both scientific (e.g. University of Wisconsin, from US) and from the end-user community (e.g. the Unitad Militar de Emergencies in Spain, as an observer), interested to implement and test similar experiments in their territories.

Added Value to the activity provided through GMES

Only GMES facilities, like EO data at very high temporal resolution, can guarantee continuity, synoptic view and timely response at relatively low costs. This represents an added value for regions which have to manage risk often with limited resources (both human and economical).

Future developments and Needs

The proposed service has already been experimented in different Italian territories (Lombardia and Sicily regions), with different fire regimes and characteristics, confirming its applicability at larger scales, up to a European level. Through these tests, the RST approach has been shown to be intrinsically exportable both being independent of the satellite systems used and useable in different geographical areas. Moreover, through the wide spatial coverage of the satellite systems and low costs of direct readout data, the service is both applicable to, and can be shared with, the wider user community. In addition, satellite products may be imported in GIS environments and immediately usable and integrated with other relevant information. So, starting from this experience specific actions devoted to improve the interoperability of products, like metadata generation and standard formats, are also easily achievable and will surely enhance a cross-border applicability. As an example, a specific plug-in for GoogleEarth® environment has been developed (figure 3), which automatically updates (with 15 minutes of refreshing time) and displays detected fires over the GE interface with relevant information about geographic position, intensity, time and date of detection, etc. With different colours related to fire occurrence intensity/probability providing to end-users and regional staff, often non-expert in remote sensing technology, a simple and common tool.

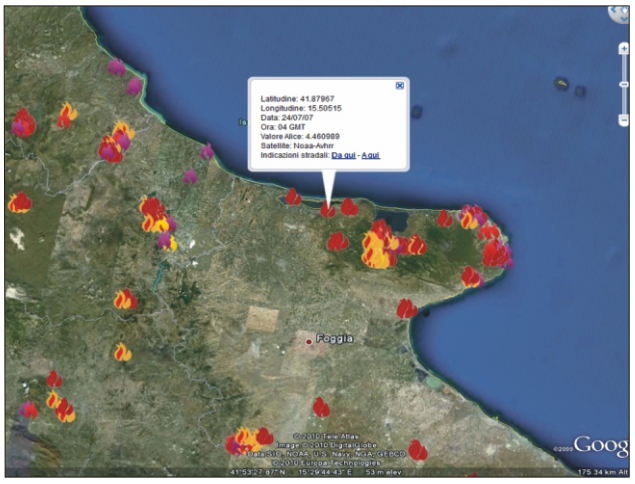


Figure 3: The GoogleEarth® plug-in of RST-based fire early detection service

Participants:

Department of Infrastructure Public Works and Mobility, Civil Protection Office- Basilicata Region. Institute of Methodologies for Environmental Analysis - National Research Council. Department of Engineering and Physics of the Environment - University of Basilicata

Contact e-mail of lead author: valerio.tramutoli@unibas.it

BAVARIA (GERMANY)

www.stmwivt.bayern.de

Support for Management of Natural Disasters

Manfred Schroeder, bavAIRia e. V
Gunter Schreier, DLR-DFD

Abstract

Bavaria does not have much to fear from volcanic eruptions, earthquakes and tsunamis. However in central Europe forest fires and vast masses of snow and water can cause extensive damage and loss of life. Geostationary weather satellites are already giving us in advance warning of extreme weather situations. But precise analysis of the extent of a natural disaster is based on data from earth orbiting satellites which can provide images at much higher spatial resolution

Regional Objectives for Application of GMES

In Bavaria more than 30 GMES stakeholders from industry, research institutes and regional administration meet regularly in a GMES working group with the aim to exchange experience and to join competencies. These activities are coordinated by the Bavarian GMES office at bavAIRia e. V.
Many of the involved companies have been participating for many years in GMES projects of the ESA and the EU with the aim to generate geo-information products. The experience gained in these projects is used on a regional level, e.g. for land use mapping and for mapping of floods and other natural disasters. Also support of forest fire monitoring for other European areas is regarded as a regional application and as a good example for cooperation between regions across borders.

Besides regional applications GMES products from satellite images are presently mainly used for international cooperation and to support supranational organizations. This involvement of Bavarian earth observation companies in international projects makes an essential contribution to their economic benefit and is sustaining a high added value capability in the region.

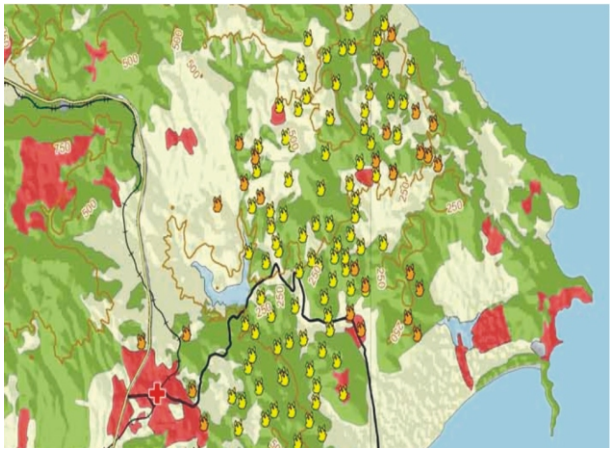


Figure 1: Forest fire map from satellite images

Results or Performance using GMES in regional applications

Provision of "Rapid Mapping" products from satellite images to support the management of natural disasters is a good example of cooperation on a regional and international level.

High resolution satellite images can be used to map floods, with radar systems like the German radar satellite TerraSAR-X even through cloud cover. Questions about the extent of wind and fire damage in forests, the destruction of infrastructure after earthquakes, the accessibility of streets, and the location of refugee camps can be answered with the help of satellite images.

Because of its practical use for European support and management in the case of natural disasters (Example Forest Fire in Greece) and as a European contribution for other locations (Example: Flood in Namibia-Angola), rapid mapping during emergencies using satellite imagery is a core GMES service.

Figure 2: Hot spots of forest fire transferred to a land cover classification map

Example: Greece-Attica, Northern Part- Forest Fire, August 25, 2009

Several forest fires occurred since August 21, 2009, in the prefecture Attica, north-eastern of Athens. Many residents had to be evacuated from their homes. The map (Fig.1) shows the burnt areas (reddish colour) derived by the analysis of SPOT- 5 satellite data acquired on August 25, 2009 and the location of active fire spots on different days (yellow, orange and red spots). Only cloudless areas could have been considered for calculating the

statistics for the burnt areas. Streets have been digitised on the basis of World Street Map and may only show an extract of the entire road network. All information is superimposed on natural colour image of the SPOT-5 scene of August 25, 2009 (Fig.1). Additionally these hot spots were transferred to a land cover classification map with contour lines derived from a SRTM terrain elevation model (Fig.2).

Example: Namibia-Angola Flood Extent, March 25, 2009 (Fig.3) Heavy rains in Angola and parts of Zambia's Western Province led to flooding in Namibia's north and north-eastern parts. On March 18, 2009 emergency was declared in the concerned areas, where floods have caused large-scale destructions to homes, schools, health facilities, mahangu and maize fields and infrastructure. The water mask was generated by analysis of TerraSAR-X radar satellite data and is superimposed on a SPOT 5 satellite image of February 14, 2007.

Data as well as services for these applications are being provided by institutions and companies in Bavaria. One of the most important actors at both European and international levels is the Center for Satellite Based Crisis Information at DLR-DFD in Oberpfaffenhofen (ZKI, www.dlr.zki.de). As part of a network of international partners as well as EU and UN services, ZKI is a major contributor to an operational GMES service for rapid mapping during and after natural disasters.

Added Value to the activity provided through GMES

Besides damage analyses and mission planning for widespread areas in Europe, satellites also make it possible to obtain information about natural disasters and humanitarian emergency situations from less accessible parts of the globe. Satellite data have, for example, contributed to recording the disastrous destruction caused by the 2004 tsunami in the Indian Ocean and to mapping the flooding in Myanmar in 2008 and the Haiti earthquake in 2010, making it possible to inform the public about the extent of these catastrophes.

This information from satellite images is not only important for rendering humanitarian and logistic assistance and for reconstruction activities, but also for insurance and reinsurance companies, who use analyses of satellite data to obtain a clearer picture of the damages to be claimed by their customers.

Future developments and Needs

The spectrum of applications and competencies in Bavaria covers the areas of land, aquatic systems, atmosphere, climate change in alpine regions, management of natural disasters and civil security. The medium term focus is on services for land applications and for natural disasters.

Already now, satellite data is being shared internationally during disastrous events and humanitarian crises (www.disasterscharter.org). Coordination of the information yield from these satellite data was initiated in Europe with the GMES pilot projects Risk-EOS and RESPOND, and is currently being continued by the preoperational Emergency Response Core Service project SAFER. These preparatory activities should lead to an operational European Service for providing geo-information products to support rapid mapping services and emergency response actions

Figure 3: Mapping of flood extent from satellite images

Participants:
Center for Satellite Based Crisis Information (DLR-DFD), Oberpfaffenhofen; Definiens AG, Munich; EADS Astrium, Ottobrunn; ESG Elektroniksystem-and Logistik-GmbH, Fürstenfeldbruck; European Space Imaging GmbH, Munich; ESRI Geoinformatik GmbH, Kranzberg; EOMAP GmbH&Co.KG, Gilching; GAF AG, Munich; IABG mbH, Ottobrunn; GEOSYSTEMS GmbH, Germering; Remote Sensing Solutions GmbH,

Contact e-mail: schroeder@bavAIRia.net

CASTILLA Y LEÓN (SPAIN)

www.jcyl.es

Development of Fire Propagation Simulator

J. Ramirez
Tecnosylva S.L.

Abstract

Wildfire Analyst is the operational propagation tool that incorporates the fuel data bases developed from VHR satellite imagery. It has been developed as part of the FP6 PREVIEW project with focus on fire risk. It is now integrated in the fire response module of the OASIS project. Two modules make up the Wildfire Analyst- the fuel data base (Fuel Parameter product) and the Fire Propagation simulator tool. Wildfire Analyst has been validated in Portugal and Spain.

Regional Objectives for Application of GMES

Accurate and high resolution fuel data are needed for fire prevention and use in operational decision support systems in fire fighting tasks. For this purpose, the project has acquired fuel data from object oriented analysis on Very High Resolution (VHR) satellite imagery. These data are assembled as a Fuel Parameter product and presented in GIS format, ready for use as an operational propagator tool.

Wildfire Analyst is the operational propagation tool that incorporates the fuel data bases developed from the VHR satellite imagery. Wildfire Analyst is designed for supporting decision making in Forest Fire Command Centres. It can be used to localize areas with risk to operations or for fire prevention training. Another direct application is its use for supporting critical decisions that need to be made quickly during forest fire emergencies. These capabilities are reinforced with real time simulations and updating with real-time VHR imagery superimposed on the 3D visualization.

At the present time, the high resolution fuel model methodology is being used in the development of some Spanish regional territorial fire prevention plans to estimate the risk of forest fire.

Results or Performance using GMES in this regional application

The Fuel Parameter product consists in a detailed vector GIS layer with information on fuel type, fuel load and canopy cover. The geographic definition of the layer is based on INSPIRE project standards to make possible real time projection on to compatible mapping systems. Additional advantages are the potential for automation and applicability

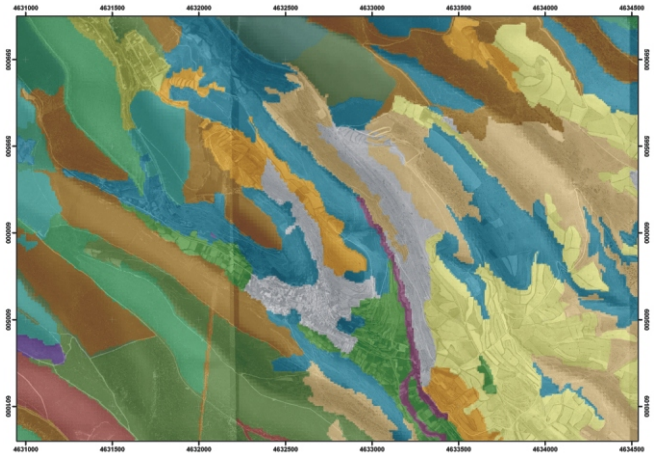


Figure 1: Example of fuel parameter mapping in GIS

The second component of Wildfire Analyst is the Fire Propagator Service. It consists of a real time simulator of fire events based on fuel, meteorological and topographic data. The fire propagator provides outputs as a GIS tool showing advancement of the fire on a step by step basis, depending on the data inputs. Burnt area per pixel in a predefined area and time period are further outputs from the simulation.

After performing individual unit testing on the Fuel Parameter and Fire Propagator tools, integrated tests of the Wildfire Analyst system were carried out over validation period of 6 months in Portugal and Spain.

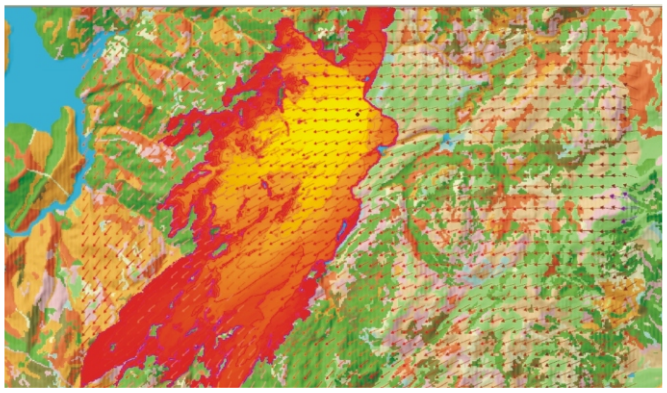


Figure 2: Example of Fire Propagator outputs

Operational Status of the Activity

The fire propagator simulator software, Wildfire Analyst, is nowadays totally functional and operational. The results have been integrated on the operational forest fire Decision Support System (DSS) software called fiRESPONSE.

fiRESPONSE is the integrated DSS software for wildland fire detection, management and assessment based on information technology emergency standards developed on the European project OASIS. www.oasis-fp6.org. The main objective of fiRESPONSE is to provide the fire emergency responders with a system that facilitates the management of (i) fire detection, (ii) the resources during the response to wildland fires and (iii) its posterior assessment to aid evaluation and improving understanding and optimisation of the response to wildland fires.

This forest fire DSS is implemented on the major fire agencies of most Spanish autonomous communities.

Added Value to the activity provided through GMES

With its focus on fire risks, fiRESPONSE uses elements of the wider PREVIEW FP6 project, under the GMES initiative. GMES data sources provide essential information for the Fire Parameter module upon which the Wildfire Analyst depends.
The information gathered by GMES is a vital source of timely and up-to-date information for the benefit of individual citizens and decision-makers in Wildfire fighting at different levels.

Future developments and Needs

The next step of the fiRESPONSE software is to turn it into a global integrated system used at international level to aid Wildland fire prediction, response and assessment where it is most needed.

Figure 3: Wildfire Analyst Output File

Participants:

PREVIEW was jointly developed by a consortium of 58 partners from 15 nations, gathering a wide range of technical skills and key representatives in risk management.

Contact e-mail of lead author : jramirez@tecnosylva.com

REGIONE LOMBARDIA (ITALY)

www.regione.lombardia.it

"Geological and hydro-geological monitoring through interpretation of radar Permanent Scatter data in the provinces of VARESE, Como, Sondrio, and Brescia"

A. Ceriani[1], A. Zaccone[2], M Ceriani[2]

IRER[1], Regione Lombardia, Unità Organizzativa Sistema Integrato di Prevenzione[2]

Abstract

Interferometry is an innovative technique that uses satellite-borne radar images to accurately measure ground. The main aim of the research has been the geological interpretation of these kind of data in Lombardia, thus to identify phenomena such as landslides, subsidences in urban area and vertical displacement of buildings occurred during the period 1992-2007 in order to improve and update local hazard and risk maps.

Regional Objectives for Application of GMES

- Providing a list of territories sensitive to geological risks thus to both identify new study areas and update already known areas;
- Developing a new monitoring system, that will allow a periodical analysis of the regional territory and the previous identification of anomalous vertical displacements of buildings, urban areas or landslides;
- Defining a methodology for storage and first analysis of a huge amount of data;
- Updating the inventory of the landslides and instabilities (IFFI project Inventario dei Fenomeni Franosi in Italia).

Figure 1: Studied area

Results or Performance using GMES in this regional application

A methodology for the interpretation of PSInSAR™ data on regional scale and with a high potential for reuse was defined on a vast area of about 13.500 square km (Fig. 1).

Global and thematic data bases of Regione Lombardia were used to verify the suitability of the methodology.
2751 study areas, presenting ground displacements were identified. In these areas authorities could focus future detailed geological studies, observe wide areas with limited costs, and undertake actions for the risk reduction.

A data base with information related to the above mentioned areas was developed (Fig. 2).

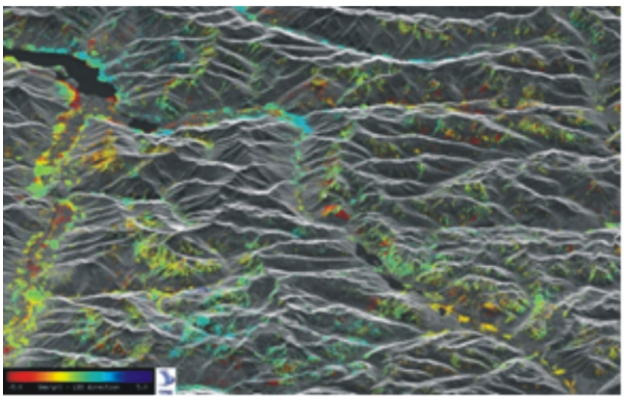


Figure 2: Example of (PSInSAR) radar data colours point out ground displacements

Finally, the causes for the anomalous displacement were identified and related to: instability/unbalance of slopes, subsidence due to the overlap of external loading (e.g. buildings), sinking of buildings (Fig. 3).

Operational Status of the Activity

In the geological field, this methodology turns out as an effective means for the monitoring of slow speed displacement phenomena, such as slow landslides, deep-seated slope gravitational deformation, and for the identification of areas subject to potential subsidence or local soil compaction.

The monitoring of possible vertical displacements, expressed in average mm per year, could be on a wide scale (e.g. regional or provincial) or on a local scale (specific buildings or specific landslides).

The study is aimed at providing a first list of sensitive areas from a geological point of view, to both define new study areas and update already known areas.

By means of PS analysis, the inventory of the landslides could be updated (IFFI project), notably as far as the activities and the geometric definition are concerned.

This technique has been applied on most of the Alpine, pre-Alpine and Apennine areas of the region, with the achievement of more than 3 millions of analysis points. The work will be completed by the end of 2010.

Added Value to the activity provided through GMES

The monitoring of wide areas of the regional territory, enriched with high definition motion data, is made possible by this particular technique that allows the analysis of radar data obtained from satellites since 1992, to evaluate the temporal evolution of these phenomena.

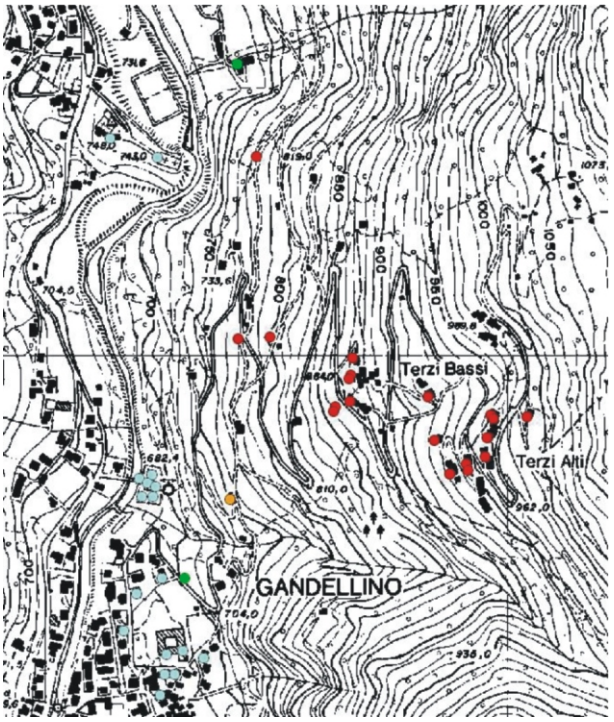


Figure 3: Buildings (red points) affected by a landslide

Future developments and Needs

In the context of the PST (Piano Straordinario di Telerilevamento) coordinated by the Ministry of Environment and with the contribution of all the Italian regions, a snapshot of the whole national territory by ERS 1 and 2 radar satellites between 1992 and 2001 will be available.

Moreover the use of new radar datasets, derived from the Cosmo-Skymed Constellation, will add high quality level information in terms of real time monitoring of all the sensitive situations such as displacements, subsidence phenomena, deep-seated slope gravitational deformation, displacement and soil compaction in plains and in Alpine and pre-Alpine valleys.

Finally, Regione Lombardia is completing the monitoring of the whole mountains and hill territory by means of data obtained from the Canadian satellite RADARSAT 1 between 2003 and 2009, with a testing of artificial standard reflectors on specific landslides.

Participants:
Regione Lombardia, Unità Organizzativa Sistema Integrato di Prevenzione
Regional Research Institute IReR
Università degli Studi di Pavia, Dipartimento Scienze della Terra
Università di Milano-Bicocca,, Dipartimento di Scienze Geologiche e Geotecnologiche
Globo s.r.l.
Contact e-mail of lead author: andrea_zaccone@regione.lombardia.it, alberto.ceriani@irer.it, massimo_ceriani@regione.lombardia.it

MIDI-PYRENEES & AQUITAINE (FRANCE)
www.midipyrenees.fr & www.aquitaine.fr

Forest Fire Management: from risk mapping to post-season analysis

Agnès Salvatori[1], Eric Maneux[2]
Spot Infoterra - Astrium Service[1], Bordeaux University - Valorisation and transfer cell[2]

Abstract

During the summer season, forest fires cause dramatic damage all over southern Europe. Forest fire risk is also related to storm impact and damage.

The Aquitaine region and its pine forests are particularly at risk. Thus, Aquitaine region hosts research institutes and civil protection agencies developing or validating new products addressing prevention and vulnerability assessment.

The Midi-Pyrénées region hosts the company (Spot Infoterra) which commercializes a fully operational service dedicated to forest fire management with the main emphasis on:

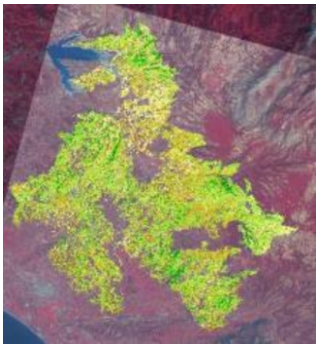
- Vulnerability assessment.
- Fire monitoring & mapping.
- Fire damage assessment.

This service uses data provided by satellites to which the service provider has privileged access combined with products provided by the GMES Land and Emergency Response Services (ERS) which can provide part of the geo-information elements. The objective of this service is two-fold:

- Logistic assistance to the Civil Protection for planning resources and during the fires.
- Damage assessment to feed institutional database and historical analysis, support re-construction plans and provide unambiguous information to insurance and reinsurance companies.

Regional Objectives for Application of GMES

In the case of major fires, the Civil Protection may trigger the GMES Emergency Response Service as it was the case in 2009 for some fires in Corsica and in Greece.



Code	Class Name	Surf_ha	%
21x	Arable land	6833.62	21.0
223	Olive groves	8445.85	26.0
311	Broad-leaved forest	131.11	0.4
312	Coniferous forest	2575.78	7.9
321	Grassland	2117.16	6.5
323	Sclerophyllous vegetation	12218.50	37.7
	Other		0.5
	Total:	32415.20	100.00

Figure 1: Analysis of the land cover classes distribution inside the burnt area (including statistics over burnt areas per type of land cover class).

The satellite acquires the image which is downlinked for analysis - see figure 1.The additional regional service offered here will thus benefit from the rapid mapping products produced by the GMES Emergency Response Servise (ERS) (namely assessment maps before the event and damage assessment) and will complete it with the necessary image acquisition and value-added layers necessary to satisfy the local user's expectation.

Results or Performance using GMES in this regional application

The service consists of 3 elements which can be independently procured by institutional or private customers:

A. Vulnerability assessment: This aims at identifying isolated habitations within areas at risks. Civil Protection will therefore be able to plan for specific evacuations in case of fire.

B. On request fire mapping (typically up to end October):

- The Civil Protection indicates the fire position to the service contact point. Up to now, the operational customers did not require a 24/7 service but it could easily be implemented.
- The service Contact Point tasks the satellites for image acquisition (Spot Infoterra operate its own fleet of satellites

Figure 2: End of Season GIS Product; Corsica 2007. Fire locations are shown on the GIS image; Burn Scar maps can be extracted from the GIS page by clicking on fire locations - www.emergencyresponse.eu

- The satellite acquires the image which is downlinked for analysis. Reports include::
  - Mapping of the burnt area.
  - Analysis of land cover within burnt area.
  - Damage assessment.
- Delivery: Information of burnt area is disseminated to Civil Protection or any other user through a local contact point.
  -Burn Scar maps (fire contours) are provided in digital formats for integration in a user database (standard GIS formats) or KMZ files for GoogleEarth etc.)
  - Spacemap within burnt area (A3-size paper)
  - Damage assessment report.
  - Post-fire image ortho-rectified.

Those products are delivered within a few days.

C. End of season global assessment: This consists in the exhaustive mapping of all fires affecting more than 5 ha over the territory for the complete season (based on high-resolution satellite images). First results are delivered by end-of-December (year of the fire season) and final report end of April the year after. Global assessment includes Burn Scar map (fire contour), damage assessment report and stand-alone GIS applications. A typical end of season global assessment is shown in figure 2.

Operational Status of the Activity

The service is fully operational and is used today by some local entities of the French Civil protection. GIS pages in the public domain are found on the SAFER website, www.emergencyresponse.eu

Figure 3: Ymittos forest – Greece : Burn scar map (fire contour).

Added Value to the activity provided through GMES

Regional users who activate the GMES ERS service in case of fire are provided with rapid mapping products.

However, regional users may also make use of additional services for three major reasons:

1. The GMES ERS service is very "crisis-focused" and does not yet deliver vulnerability-, prevention- or reconstruction-related services. Many users want to plan ahead for crisis periods (e.g with maps identifying the local assets) or precisely assess the disaster (e.g with the classification and quantification of the burnt species.)
2. The format of the GMES ERS service products is not negotiable on a case by case basis; it is pre-defined and accessible through a web-portal. Local users may want a specific delivery format.
3. In case of simultaneous crises GMES ERS services will manage priorities to avoid conflicts in product delivery.
4. The GMES Land Monitoring Services products can also be used to support vulnerability and detailed damage assessment.

Future developments and Needs

The current operational service, partially or in its entirety, could be more systematically used by French public bodies in the South of France. It is also exportable across Southern Europe (Portugal, Spain, South of France, Greece, Croatia, Albania, Turkey etc.) and outside Europe (Australia, Africa). This NEREUS publication will hopefully contribute to its communication across regional and international boundaries.

The service could be further enhanced in the area of vulnerability assessment and also tailored to more specific regional needs. Joint work and dialogue must be pursued with the research Institutes and the local users to enlarge the scope of the services deliveries.

Participants:

Spot Infoterra, INRA Bordeaux, XYLOFUTUR for the forest/wood/paper industry in Aquitaine, GIP ATGeRi (Groupement d'Intérêt Public Aménagement du Territoire et Gestion des Risques), Civil protections (e.g : SDIS of Provence-Corse-Côte d'Azur regions)

Contact: agnes.salvatori@astrium.eads.net ; e.maneux@epoc.u-bordeaux1.fr

ACKNOWLEDGEMENTS

Many people have contributed to this publication “25 Uses of GMES in the NEREUS Regions”. We thank all Earth Observation/GMES Working Group members and their colleagues who have contributed to the papers. The President, M Alain Bénéteau, and the NEREUS Management Board gave us their support at the beginning and Roya Ayazi, our NEREUS Secretary-General, has provided encouragement and advice throughout.

The editorial team have set the high standards achieved in this publication. Thanks are due to Paola Carrara, CNR-IREA, Lombardia Region; Franck Durand-Carrier, CNES, Midi Pyrenees; Silvano DeZorzi, Veneto Region; Alain Podaire, Mercator-Ocean and Edward Adams, University of Leicester, for their careful work and considered advice.

Rob Tebbutt and Stewart Chalmers, from All In One Print Leicester, are thanked for the professional quality of the printed publication.

Any mistakes or inaccuracies found in the publication are entirely our responsibility.

Alan Wells
East Midlands Region, UK
EO/GMES Working Group Co-Chair.

Sonia Nicolau
Azores Region, Portugal.
EO/GMES Working Group Co-Chair.

Designed and printed by All In One Print Ltd

T:: 0116 289 4445 F:: 0116 289 4454
Email:: sales@allinlprint.co.uk
Web:: www.allinlprint.co.uk

NEREUS a.i.s.b.l. ★ c/o Regione del Veneto - Avenue de Tervuren 67 - 1040 Brussels, Belgium - Enterprise nr 898.367.280
Tel: +32 (0)2 743 70 33 - Fax: +32 (0)2 743 70 19 - email: nereus.bruxelles@euroinbox.com - http://www.nereus-regions.eu/home