



SpaceTec Partners for G-MOSAIC

WINDOW ON GMES

FOCUS ON GMES APPLICATIONS FOR THE SAFETY AND SECURITY OF THE EU

SPECIAL ISSUE

WINDOW ON GMES

A G-MOSAIC PUBLICATION

Discover the “S” in GMES

FOCUS ON GMES APPLICATIONS FOR THE SAFETY AND SECURITY OF THE EU

GMES: A tool for EU policies

Window on GMES walks you through the contribution of GMES to EU policies such as CSFP and CSDP

Opinions on GMES

The Security dimension of GMES through the eyes of its key stakeholders

Success Stories

GMES and the Libyan uprising: the contribution of GMES services to crisis management operations during the Arab Spring

- OPINIONS ON GMES **State of play of the Security dimension of GMES** Dimitrios Papadakis
- FOCUS GMES and Border Surveillance: the Frontex perspective Erik Berglund
- THE BIG PICTURE **Civil-military synergies in the field of Earth Observation** Denis Moura
- PEOPLE OF GMES **An interview with Pascal Legai**, Deputy Director of the European Union Satellite Centre
- STATUS REPORT **The G-MOSAIC project: Outcomes and the way ahead** Sergio Proietti
- SUCCESS STORY **Monitoring natural resources in conflict areas: the case of the DRC** Elisabeth Schoepfer
- PROGRESS REPORT **Developing geo-spatial intelligence applications in GMES** Federica Mastracci
- PROGRESS REPORT **New techniques for safer seas: what GMES brings to Maritime Surveillance** Paola Nicolosi
- SUCCESS STORY **Securing Europe’s Borders: Earth Observation supports the surveillance of the Greek-Albanian border** Dave Halbert
- SUCCESS STORY **Mapping ‘conflict minerals’ in the DRC** Elisabeth Schoepfer

SPECIAL ISSUE



The “S” of GMES draws closer to realisation

Welcome to this Special Issue of *Window on GMES*, focused on the “S” of GMES, which stands for Security, and refers to Space-based services supporting EU External Action, Maritime Surveillance and Border Control.

The publication of this review marks the closure of the *G-MOSAIC* project (GMES services for Management of Operations, Situation Awareness and Intelligence for regional Crises). This research and development project, co-funded by the European Union’s Seventh Framework Programme, has involved a consortium of 36 partners from 13 Member States.

As some of our readers may already know, GMES is a European Union programme for developing information services which combine data from satellites and non-Space (*in situ*) data. For those who are not familiar with GMES, the article on page 8 offers an easily-digestible overview.

The review reports on some of the many success stories in which GMES pre-operational services for Security applications have supported users in their operations. These include the United Nations Department of Field Support during the earthquake in Haiti (see pages 20 and 26), the Italian Ministry of Defence in international peacekeeping operations (see p. 24), and the International Peace Information Service in identifying illegal mining sites in the Democratic Republic of the Congo (see p 82). The consortium is proud to have supported such a diverse range of users in improving the accuracy and effectiveness of their activities and decision-making, and in demonstrating the potential and applicability of GMES services for Security applications.

Although *G-MOSAIC* has been dedicated to the development of services in support to EU External Action, this review will also touch upon the areas of Maritime Surveillance (see p. 68) and Border Control (see p. 76), in order to represent the global context of GMES’ Security dimension. We are also pleased to present contributions from key European institutions such as the European External Action Service (see p. 22), FRONTEX (the European agency for the coordination of actions strengthening external border security, see p. 36) and the European Defence Agency (see p. 30).

The ambitious goal of this special edition of *Window on GMES* is to increase awareness of how the Security component of GMES will contribute to strengthening the international dimension of EU policies, while directly benefitting individual Member States and, last but not least, European citizens. Consequently, this goal has served as the main rationale governing the selection of topics and the identification of contributing authors.

In view of the future operationalisation of GMES services for Security applications, we hope that this review goes some way towards demonstrating their usefulness and highlighting the unquestionable added value which they can bring to Europe.

The members of the *G-MOSAIC* consortium



GMES demystified

GMES: GLOBAL MONITORING FOR ENVIRONMENT AND SECURITY - ONLY FOUR LETTERS ARE REQUIRED TO ENCAPSULATE THE ESSENCE OF AN IDEA, BORN ALMOST FIFTEEN YEARS AGO IN THE MINDS OF A FEW PIONEERS. THESE VISIONARIES, AWARE OF THE FUTURE CHALLENGES TO BE MET IN EUROPE IN ORDER TO PRESERVE OUR ENVIRONMENT AND GUARANTEE THE SECURITY OF ALL ITS CITIZENS, WERE ALSO MINDFUL OF THE NEED TO ACT AT THE PAN-EUROPEAN LEVEL.

NCESSITY KNOWS NO LAW. GMES gathers, in order to share it, all the countless pieces of data about our environment and Security, accumulated from all European countries and born from years of fruitful research, that have enabled our common technological developments to reach maturity.

Born from years of fruitful research

So, GMES was designed. GMES is a huge and ambitious programme for environmental monitoring, to be used by all players – both public and private – aiming to protect the environment as well as the lives of European citizens.

The “G” of “Global” encompasses both the global dimension and the diversity of the data to be taken into account.

The “M” of “Monitoring” includes the observation activities required for monitoring.

The “E” of “Environment” and the “S” of “Security” are precisely the two important fields benefiting from the GMES initiative.

The GMES programme is a joint undertaking by the European Commission, its Member States, the European Space Agency (for the Space infrastructure) and the European Environment Agency (for the *in situ* infrastructure).

GMES aims to coordinate the use of Earth Observation technologies with

existing and future data collection systems.

One of its biggest challenges is to compile the vast number of very different data sets, collected from the ground, from altitude by balloons or aircraft, from the depths of the sea or the surface of the ocean, by networks of probes and sensors, as well as from Space for the observation of the Earth. These data resources are then made compatible with statistical data including, particularly, socioeconomic data gathered for the European Union, its Member States and their local and regional authorities.

The other great challenge is to be able to deliver the data and information to those decision-makers, public authorities, and private companies who are assigned the task of implementing policies or responding to crisis situations and who need such information at the right time.

Enabling decision-makers and users to access a myriad of information

The first GMES services have now entered into Initial Operations¹, others are being delivered in a pre-operational mode. They already enable decision-makers and end users – institutional as well as those from the private sector – to access a great deal of information, such as: the occupation and condition of our soils; the quality of the water we

drink and the air we breathe, as well as the nature and degree of the pollution affecting them; the direction of marine currents and level of the ocean's surface; the movement of animal populations and variations of the flora; the behaviour of airborne particles and the extent of the ozone hole; and, the monitoring of glaciers and polar ice cover. **All of this is GMES.**

Ensuring that operators are prepared and equipped

Such information will enable users to:

- organise city and regional planning, with management plans that are more attuned to our natural resources;
- control our agricultural production and our fish resources effectively;
- monitor the factors of pandemic disasters and their evolution more accurately, minimise the consequences of natural disasters more effectively, and even anticipate their occurrence and implement the necessary mitigation actions.

In the field, GMES services ensure that operators are better prepared and equipped to act during floods, forest fires and landslides, as well as marine pollution events and illegal dumping, and to provide more effective support for humanitarian missions responding, for example, to the impacts of earthquakes, volcanic eruptions, tsunamis and famine.

These services allow political decision-makers and all of those whose mission is to be at the service of the citizen's security, to have the necessary data at their disposal during international negotiations. At the national, regional or even local levels, these data will also be most useful to enable decision-makers to fulfil their obligations more efficiently, and to improve the precision of their budgetary planning.

Other GMES services will be developed based on scientific or technological evolution and the provision of necessary budgets. Services at the European level respond to the collective needs of institutional agents, and address the more specific demands of end users at the national, regional and local levels.

Help give Europe a leading role in the monitoring of our environment

GMES is an essential tool in the fight against the consequences of climate change that affect our entire planet, without exception. Eventually, GMES is also intended to give Europe a leading role in the monitoring of the global environment.

GMES is a tool of international cooperation, following the example set by meteorological services and constitutes the contribution of the European Union to the creation of a vast and worldwide system of observation systems, the Global Earth Observation System of Systems (GEOSS).

The Security dimension of GMES refers to the services in three areas: support to EU External Action, Border Control and Maritime Surveillance. EU External Action includes peacekeeping, crisis management and reconstruction missions after conflict. Services in this domain also monitor critical assets (such as gas pipelines and oil refineries) and compliance with nuclear non-proliferation treaties. Services for Border Control support the reduction of cross-border crime and illegal immigration, whilst Maritime Surveillance services focus mainly on monitoring the sea borders of the EU.

¹ GMES Initial Operations (GIO) refers to the period 2011-2013, in which the first GMES services have become operational. The GMES Regulation provided a legal basis for the Initial Operations, and made available €107 million in EU funding.

G-MOSAIC in a nutshell

G-MOSAIC, A GMES RESEARCH AND DEVELOPMENT PROJECT IN THE AREA OF SPACE-BASED SERVICES FOR SECURITY APPLICATIONS, HAS BUILT UP PILOT SERVICES FOR THE MONITORING OF OPERATIONS AND THE PROVISION OF SITUATIONAL AWARENESS AND INTELLIGENCE IN SUPPORT OF EU EXTERNAL ACTION.

THE G-MOSAIC project (GMES services for Management of Operations, Situation Awareness and Intelligence for regional Crises) was co-funded by the European Commission's Research Executive Agency under the Seventh Framework Programme, and lasted for three years. Under the coordination of e-GEOS, thirty-six partners have been involved in the project, representing industrial service providers, institutional stakeholders, the research sector, SMEs and academia (see p. 95 for the full list of consortium members).

The aim of the G-MOSAIC project was to identify and develop methodologies, products and pilot services for the provision of geo-spatial information in support of EU External Action. In so doing, the project has contributed towards further defining the Security dimension of GMES and demonstrating its relevance, utility and sustainability.

The External Action of the European Union refer to EU missions and operations conducted outside the Union for peace-keeping, crisis management or Security purposes. An example of such a mission is EUNAVFOR-Atalanta, a mission to combat piracy in the Gulf of Aden. Such activities are subject to EU external relations policies, specifically, the Common Foreign and Security Policy (CSFP) and the Common Security and Defence Policy (CSDP). G-MOSAIC has served a wide range

of European and international users, including Member States authorities, international organisations and NGOs by providing geo-spatial intelligence in support of crisis prevention and early warning, crisis management and rapid interventions in crisis hot-spots across the globe. These included Libya (see p. 47) in connection with the civil unrest at the beginning of 2011, and Haiti, in the aftermath of the 2010 earthquake (see p. 20, 26).

G-MOSAIC has developed services in order to:

1. **Support intelligence and early warning**, with services contributing to the analysis of the causes leading to regional crises, such as weapons proliferation, fight for natural resources, population pressure, land degradation, and illegal activities.
2. **Support crisis management** and operations, with services contributing to planning for EU interventions during crises, citizen repatriation, consequence management, reconstruction and resilience.

G-MOSAIC has built up and demonstrated the technical capabilities necessary for the delivery of these services, in close coordination with users. Two user workshops have been held during the lifetime of project (June 2010 and June 2011), and the feedback received from these reinforces the project's success in effective user engagement.

G-MOSAIC addresses five domains of application. Within these domains, sixteen pilot services have been developed.

Crisis management: Supporting peacekeeping and conflict-related crisis management operations abroad through rapid geo-spatial intelligence; post-crisis reconstruction, rehabilitation and resilience monitoring.

Critical assets: Monitoring and assessment of manmade structures or natural elements, the disruption, destruction or alteration of which may cause problems for the security of EU Member States and citizens.

Migration and borders: Monitoring of borders, migration routes and temporary settlements, improving the intelligence available and informing the allocation of Security resources along a border.

Natural resources: Monitoring the exploitation and/or degradation of natural resources and other potential indicators of regional conflict, in order to facilitate the preparedness and effectiveness of EU interventions.

Non-proliferation: Monitoring nuclear decommissioning sites in support of the monitoring of compliance with non-proliferation treaties, both as a deterrent to treaty non-compliance and as an aid to enforcement operations.



The map above shows an overview of the G-MOSAIC Areas of Interest (AOI), signifying the locations for which services were triggered (Credits: G-MOSAIC).

PAGE 1	EDITORIAL
PAGE 2	GMES DEMYSTIFIED
PAGE 4	G-MOSAIC IN A NUTSHELL
PAGE 8	OPINIONS ON GMES State of play of the Security dimension of GMES Dimitrios Papadakis
PAGE 16	PEOPLE OF GMES An interview with Pascal Legai, Deputy Director of the European Union Satellite Centre
PAGE 20	PORTRAITS OF GMES USERS The United Nations Department of Field Support The Situation Room of the European External Action Service The Italian Ministry of Defence The Spanish Red Cross The French Navy in the Caribbean
PAGE 30	THE BIG PICTURE Civil-military synergies in the field of Earth Observation Denis Moura
PAGE 36	FOCUS GMES and Border Surveillance: the Frontex perspective Erik Berglund
PAGE 41	STATUS REPORT The G-MOSAIC project: Outcomes and the way ahead Sergio Proietti and Annalaura Di Federico

E O F C O N T E N T S

-  PAGE 47 SUCCESS STORY
The GMES response to the Libyan uprising
Pablo Vega Ezquieta, Denis Bruckert, Alessandra Ussorio
and Gracia Joyanes
-  PAGE 54 SUCCESS STORY
**Monitoring natural resources in conflict areas: the case of
the Democratic Republic of the Congo**
Elisabeth Schoepfer, Kristin Sproehle, Xavier Blaes and
Thomas Kemper
-  PAGE 62 PROGRESS REPORT
Developing geo-spatial intelligence applications in GMES
Federica Mastracci
-  PAGE 68 PROGRESS REPORT
**New techniques for safer seas: what GMES brings to
Maritime Surveillance**
Paola Nicolosi and Maria Angelucci
-  PAGE 76 SUCCESS STORY
**Securing Europe's Borders: Earth Observation supports the
surveillance of the Greek-Albanian border**
Dave Halbert
-  PAGE 82 SUCCESS STORY
**Mapping 'conflict minerals': how GMES supports the
International Peace Information Service (IPIS)**
Elisabeth Schoepfer, Kristin Sproehle and Filip Hilgert
-  PAGE 89 OPINIONS ON GMES
**GMES support to EU External Action: the institutional
framework**
Sandra Mezzadri
-  PAGE 95 G-MOSAIC PARTNERS

State of play of the Security dimension of GMES

by Dimitrios Papadakis

THE SECURITY DIMENSION OF GMES HAS UNDERGONE SIGNIFICANT EVOLUTION IN THE FOURTEEN YEARS SINCE THE GMES INITIATIVE WAS FIRST CONCEIVED. THE RESEARCH AND DEVELOPMENT EFFORTS TO BUILD UP PRE-OPERATIONAL SERVICES OVER THE LAST TEN YEARS ARE GRADUALLY BEGINNING TO BEAR FRUIT. AS GMES SERVICES FOR SECURITY APPLICATIONS DRAW CLOSER TO OPERATIONS, SEVERAL IMPORTANT CHALLENGES STAND TO BE ADDRESSED.

The contribution by GMES services to operational applications in the field of Security has become increasingly tangible as a result of a dedicated stream of research. Over the last ten years, collaborative research and development activity has taken place across the European Union, in the form of a series of projects funded by the European Commission (through its Framework Programmes for Research and Technological Development) and the European Space Agency (through its GMES Service Elements)¹. These projects have contributed towards outlining the possible contours of a future set of GMES services focused on Security applications, and continue to serve as a vehicle for further improvements, pilots and demonstrations.

With the adoption of the GMES Regulation² by the Council of the

¹ These projects include *MARISS*, *LIMES* and *GMOSS*, *G-MOSAIC* and the ongoing projects *DOLPHIN*, *NEREIDS*, *SIMTISYS* and *BRIDGES*.

² Regulation 911/2010 on GMES and its Initial Operations, September 22nd, 2010.



Damaged buildings in Haret Hreik, Beirut, Lebanon, following the conflict with Israel in July of 2006. GMES services for Security applications can provide, inter alia, support to EU External Action such as peacekeeping operations and post-conflict reconstruction missions (Credits: UN-OHCHR).

European Union in September 2010, the GMES initiative acquired a legal foundation on which to build operational services, thus becoming a programme in its own right. The Regulation included broad stipulations on the content of the services in the Security dimension. The scope of the activities covered by the “S” in GMES was formally, if rather generally, defined by the GMES Regulation as follows:

“Security services shall provide useful information in support of the challenges

which Europe is facing in the Security field, notably **Border Control, Maritime Surveillance and support for EU External Action.**" [bold text added]

Despite these advances, the Security dimension of GMES nonetheless remains relatively underdeveloped in comparison to the environmental and Emergency Management services. Beyond the stipulation of three areas of activity (referred to as "challenges") in the Regulation, the definition of future operational services for Security applications currently remains largely unformalised. This is partly due to the complexities and political constraints inherent in the Security field, as well as the broad definition of the Security area and the partial overlap between the Security and Emergency domains. The relevant stakeholder and user communities are heterogeneous, embodying and expressing a wide range of potential requirements and user needs. This combination of ambiguity and heterogeneity forms the backdrop against which GMES services for Security applications must evolve.

Towards the identification of user requirements

The federation of user needs across the different communities of interest in the Security domain of GMES is an ongoing process, with a long history. An early milestone in this respect was a seminar entitled "GMES: The Security Dimension" organised by the Institute for Security Studies in March 2007, which was described as "the first event of its kind". The General Secretariat of the European Council and the European Commission (EC) set out to define priorities and strategy with a range of key stakeholders. Amongst these were the European Space Agency (ESA), the

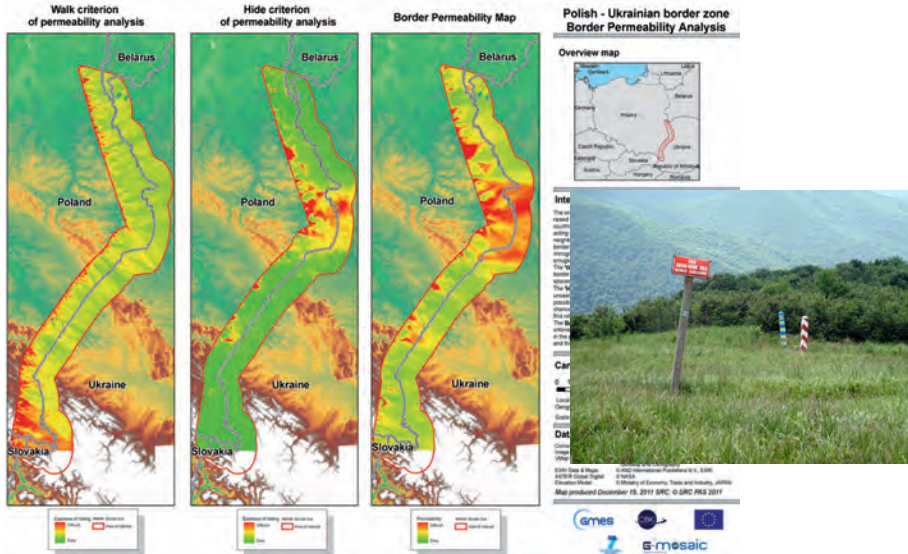


The 2nd User Workshop of G-MOSAIC, held at the premises of the European Union Satellite Centre in Torrejón de Ardoz near Madrid, saw the participation of 30 user organisations, representing EU Council entities, various UN agencies and organisations, Member State national ministries, and national and international civil organisations (Credits: SatCen).

European Defence Agency (EDA), the European Union Military Staff (EUMS), the European Union Satellite Centre (SatCen), the European Maritime Safety Agency (EMSA), and the Joint Research Centre (JRC) of the European Commission. The event drew together over one hundred participants, representing government, think tanks and international organisations as well as the European agencies and institutions. The recommendations stemming from the workshop highlighted the political nature of services in the Security domain and encouraged continuing interactions between stakeholders, as well as the creation of more permanent structures, in the form of working groups.

As indicated above, the Security dimension of GMES has relevance for a wide range of users and stakeholders. The three areas of application (as specified in the GMES Regulation) have unique users with specialised concerns and consequently differing information and technological needs, whilst simultaneously, certain overlaps exist between these users and their information requirements.

Opinions on GMES



Border permeability analysis of the Polish-Ukrainian border (Credits: (map) Space Research Centre of the Polish Academy of Sciences, Poland; (photograph) Ondrej Zvacek).

To highlight this point, in the area of support to EU External Action, key users may include Member States Armed Forces, Ministries of Defence and Offices of Home and Foreign Affairs, law enforcement agencies, national and EU civil organisations, EU and UN peace-keeping missions, NGOs and European Union agencies and institutions, with the European External Action Service (EEAS) being a political reference.

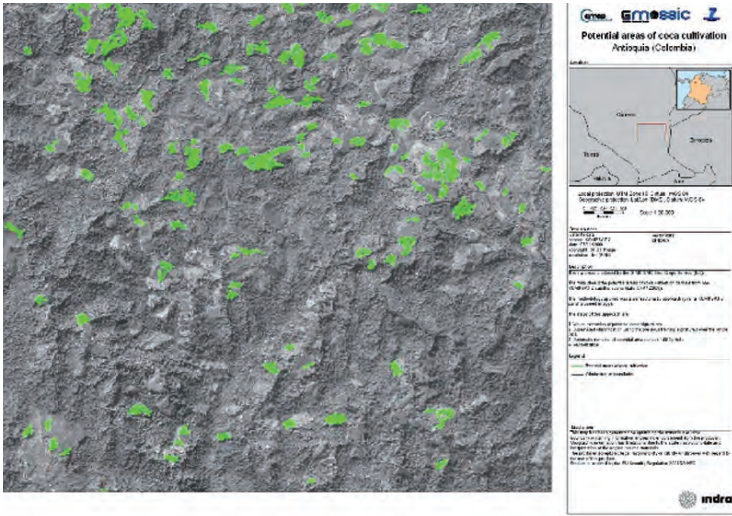
For Border Surveillance, users include most notably Frontex (the European agency for the security of external borders), border guards, port authorities, Member State Offices of Home Affairs, coast guards and European agencies and institutions.

In other areas in the Maritime Surveillance domain, however, users represent coast guards and related organisations (which are highly heterogeneous across Member States),

port authorities and coastal administrations, navies, law enforcement agencies and national ministries, as well as EU entities, in particular EMSA. The heterogeneity of civil and military governance of specific areas in this domain across the Member States adds to the political complexity of federating user needs.

A dedicated working group on Border Surveillance was set up in February 2008, bringing together technical, policy-making and user communities. This coincided with the publication of a communication³ from the European Commission on the development of a European Border Surveillance System (EUROSUR), which embodies three main objectives: reducing illegal immigration, increasing the internal security of the EU and enhancing search and rescue capacities (leading to reduction in the unacceptable loss of life of migrants

³ COM (2008) 68.



Potential coca cultivation map of Antioquia, Colombia, produced within G-MOSAIC. Monitoring of illicit crops is one area in which GMES services can support EU External Action (Credits: Indra).

attempting to cross sea borders). In 2009, this was supported by the production of a technical concept of GMES support to EUROSUR. Three scenarios were envisaged in this proposal: tracking vessels on the high seas, monitoring of third-country ports and coasts, and monitoring of pre-frontier land areas. The ongoing development of EUROSUR was highlighted in 2010 and 2011 by the elaboration of a concept of operations (CONOPS) for the application of surveillance tools in support to the European border surveillance system. Whilst this document remains a work in progress, it serves as the foundation for testing the EUROSUR pilot services.

Regarding services in support to External Action, an *ad-hoc* working group has been active since 2010, and is expected to issue a report identifying possible application areas towards the end of 2012. An approach based on scenarios has been set out, identifying the potential areas in which GMES services can contribute to operational applications in

the field of Security. Some areas of action could include support to Common Foreign and Security Policy (CFSP) operations, and the provision of information needed for risk assessment or post-crisis analysis, in complement to existing GMES services, in particular to the Emergency Management Service (EMS), operational as part of the Initial Operations of GMES (GIO).

“The Security dimension of GMES is gaining momentum, both in terms of the federation of users and their requirements, and the development of pre-operational services.”

In the Maritime Surveillance area, user requirements have been gradually assessed through the research and development projects under FP7⁴. Three

⁴ The European Union’s Seventh Framework Programme for Research and Technological Development.

Opinions on GMES

such projects are currently in progress (*DOLPHIN*, *NEREIDS* and *SIMTYSIS*) and are working towards an analysis of common themes under the joint banner of GMES support to Maritime Surveillance. *DOLPHIN*, for example, aims to address a number of technological limitations, with promising potential applications in this field⁵:

- detecting very small and/or fast boats;
- reconstructing and monitoring of ship routes;
- discriminating between small and large boats;
- detecting and classifying objects other than ships.



Projects developing services for GMES support to Maritime Surveillance are under way, with applications including the prevention of drug trafficking and piracy, and the reduction of illegal immigration (Credits: French Navy).

Two parallel studies commissioned by ESA on Space segment infrastructure requirements have been completed (November 2011). The studies sought to identify gaps, based on an analysis of existing GMES and Member State Space assets, and propose system concepts in order to complement the available revisit time and resolution capabilities. The studies took into account scenarios based on the working groups on Support to External Action and Border Surveillance, and as such

⁵ See p. 68 for a more detailed discussion of the Maritime Surveillance domain.

benefited from the involvement of the EDA, Frontex, EMSA, the JRC, related FP7 application projects, the SatCen and other EU stakeholders. A new study is planned on the further definition of architecture, technical feasibility and required technologies for the ground segment, drawing on the outcomes of the working group on support to External Action. The EDA is also conducting a similar ground segment study addressing defence-related needs.

Challenges and the way ahead

The Security dimension of GMES is gaining momentum, both in terms of the federation of users and their requirements, and the development of pre-operational services through the current FP7 projects and their predecessors. In the interests of increasing synergy and avoiding duplications, stakeholder interactions for the identification of requirements should make use, where possible, of existing fora (such as, for example, the EUROSUR expert group meetings).

“The stage for operational services from 2014-15 onwards is being set.”

For services in support to External Action, the next steps will be focused on the prioritisation of actions based on a gap analysis. The outcomes of the working group on support to External Action will be a key input, and cross-fertilisation with the ongoing studies on the Space segment is expected, as well as the development of synergies with the Emergency Management Service. Work on financing, regulatory and programmatic issues for 2014 and onwards is needed, and this will also draw on the outputs of the *BRIDGES* project, which will analyse possible

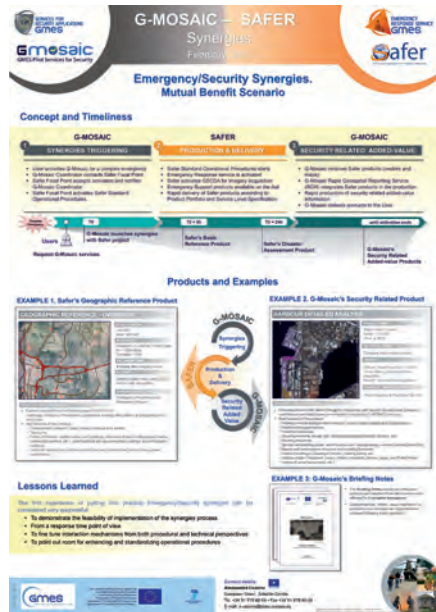
governance and implementation scenarios. The stage for operational services from 2014-15 onwards is being set by the projects arising in response to the 2012 call for FP7 research projects in the field of Space, in terms of the further definition of service specifications and the validation of services. The current projects are being steered towards areas of higher maturity in terms of user uptake and technology, and in line with the preliminary user needs and application scenarios of the working group on Support to External Action.

For Border Control, two topics in the same call for projects are expected to yield initiatives in support of the testing and validation of the EUROSUR concept of operations, for intelligence-driven and high time-critical scenarios on one hand, and for low time-critical applications on the other.

At the time of publication, proposals from the last Space Call should be entering into the negotiation phase, and projects are expected to commence towards the end of 2012.

“Emergency and Security are part of the same problem, and GMES services should fully take this into account.”

One important challenge which will need to be addressed within the Security dimension of GMES is the potential for synergies between Emergency- and Security-related services. The two domains share many commonalities and similar needs - time-sensitivity, the need for rapid tasking and mapping capabilities - since crisis situations are often coupled with emerging Security-related requirements (for example, the safety and possible evacuation of foreign nationals from a crisis-afflicted area, the



Synergies between Emergency and Security-related services have been explored in the frameworks of G-MOSAIC and SAFER, and further elaboration of synergetic interaction between these domains is needed (Credits: G-MOSAIC, SAFER).

monitoring of critical infrastructure, borders and temporary settlements).

There is, therefore, significant scope for synergetic arrangements to be put in place in order to avoid duplication of activities and improve the efficiency of services. Emergency and Security are part of the same problem, and GMES services should fully take into account the implications of this fact in their operational deployment.

In addition, there is the possibility for a synergetic requirements analysis on topics (such as food security), in which other GMES services (in this case, Land Monitoring) have a major role to play. The synergy between civil and military capabilities (dual-use systems, see article on p. 30) also requires further development.

Opinions on GMES



GMES services for Security applications can support the evacuation of citizens during crisis situations (Credits: UK MoD, Crown Copyright).

There are certain technological constraints standing in the way of service evolution. Security applications call for high (HR) and very high (VHR) image resolutions, rapid revisit times and short delivery lead-times, in comparison to most GMES services. In some cases, services for Security applications will also require guarantees surrounding data security, which may include the provision of secure processing centres and data transfer capabilities. The GMES Security Board is tackling issues related to data security, and a dedicated study on the topic commissioned by the EC has recently been completed.

The formalisation of a data policy for GMES, which includes provisions for data security where needed, is of prime importance for the operationalisation of services. This message has been reiterated on many occasions by key stakeholder groups, such as in the resolution⁶ passed by the ESA-EU Space Council on the December 6th, 2011. Whilst progress has been made, notably through a workshop at the beginning of this year⁷, the finalisation of a data policy for GMES remains a

⁶ Resolution on "Benefits of Space for the security of European citizens", 3133rd Competitiveness Council meeting, December 6th, 2011

⁷ Workshop on GMES Data and Information Policy, January 12th and 13th, 2012

major challenge, and one which must be resolved before 2014.

"The deployment of operational services [...] is a question only of funding and governance, not of technical maturity."

But by far the biggest concern in the current state of play goes beyond the Security dimension, and affects the GMES programme as a whole. In June 2011, the European Commission proposed to fund GMES outside the next Multiannual Financial Framework (MFF, 2014-2020) in its communication "A Budget for Europe⁸", on the grounds that it (along with ITER⁹) posed too high a risk of resulting in cost overruns. This announcement was met with strong criticism from stakeholder groups, including several Member States and the European Parliament, calling for the re-inclusion of GMES into the MFF. The European Council held a meeting on the on June 28th and 29th, 2012 on the remaining questions of the MFF (the so-called "negotiating box"), amongst which the fate of the GMES programme was included. The Council welcomed the progress by the Danish Presidency on the MFF negotiations but did not arrive at substantive conclusions, stating simply that agreement should be reached by the end of 2012, in line with the principle that "nothing is agreed until everything is agreed¹⁰".

As the articles in this publication seek to demonstrate, the Security dimension of

⁸ COM (2011) 500.

⁹ International Thermonuclear Experimental Reactor; an international collaborative effort to produce electrical power from nuclear fusion.

¹⁰ EUCO 76/12, http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/131388.pdf

The monitoring of critical assets is a component of the Security dimension of GMES. This analysis was produced during an activation of the Rapid Geo-spatial Reporting Service of G-MOSAIC, with support from the Critical Assets service. It shows the ENAP refinery in Concepción, Chile, after the 2010 earthquake (Map produced by: Eurosense. Credits: Eurosense; GMV; SatCen).



GMES is rapidly evolving towards maturity, and the benefits of the services are already being felt by the users engaged with the pre-operational and pilot services. Several challenges remain to be addressed, at programmatic, policy and operational levels, and the next six months will prove decisive for the programme as a whole. It is clear though, that certain pilot services, such as the Rapid Geo-spatial Reporting service of G-MOSAIC, have demonstrated their full capabilities under live operational conditions, and that their deployment for the benefit of the European Union, its

Member States and its citizens is a question only of funding and governance, not of technical maturity. There are other services which still require research and development or large-scale demonstrations in order to reach operational maturity, and such development work is either ongoing or set to start in the near future. With these considerations in mind, and subject to GMES being reinstated into the Multiannual Financial Framework, a considerable array of GMES services for Security applications could be deployed operationally as early as 2014.



Dimitrios PAPADAKIS is a consultant at SpaceTec Partners, with whom he has been working on GMES projects and studies since 2010. His work is primarily focused on cost-benefit analyses, economic modelling and governance studies. He coordinated a task on this topic within the G-MOSAIC project, and served as a subject expert in a European Commission study on cost-benefit analysis of the GMES programme. Prior to this, he was primary researcher and task leader on business models and organisational analysis for the BOSS4GMES project, through his role as Research Associate at the University of the West of England, Bristol. He has also authored and edited communication materials for several projects in the fields of Emergency (SAFER, GARNET-E, linkER), Security (G-MOSAIC, BRIDGES) and Maritime Surveillance (DOLPHIN). He is part-way through the completion of a social sciences PhD at the University of Lincoln, focusing on the processes of interdisciplinary knowledge creation in project settings. He holds a BA (Hons) in Business Information Systems, and an MSc in Research Methods, from the Nottingham Trent University.

Interview with Pascal Legai, Deputy Director of the European Union Satellite Centre

Roadmap towards operationalising the Security dimension of GMES

THE EUROPEAN UNION SATELLITE CENTRE (SatCen) IS CONSIDERED TO BE A KEY STAKEHOLDER IN GMES, THANKS TO ITS RECOGNISED EXPERTISE IN IMAGERY ANALYSIS. WINDOW ON GMES ASKED THE DEPUTY DIRECTOR OF THE SatCen TO REFLECT ON THE PROGRESS MADE TOWARDS OPERATIONALISING THE SERVICES IN THE SECURITY DIMENSION OF GMES, AND HOW THE ACTIVITIES OF THE SatCen CONTRIBUTE TOWARDS THE ATTAINMENT OF THIS GOAL.

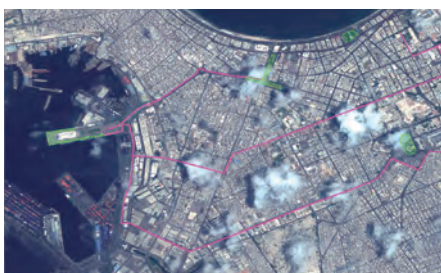


Pascal LEGAI

Could you describe the SatCen's activities in the context of GMES?

Member States' representatives at the SatCen's Board gave the mandate to the SatCen to be involved in GMES, and in particular, in its Security dimension. Our involvement in GMES is mainly focused on supporting the SatCen's mission, with a particular focus on Support to External Action (SEA), but also oriented towards

exploring areas where the SatCen could support users outside its established user community (e.g. Frontex and Member States' Civil Protection Departments). Strong cooperation with the European Commission is also part of the mission; it is important to not duplicate services funded by the EU tax payer at an EU level, by taking advantage of established operational expertise.



Evacuation routes and gathering areas in Alexandria, Egypt identified by the G-MOSAIC Rapid Geo-spatial Reporting service. The routes lead towards an evacuation point – the ferry terminal – located in the harbour (Credits: SatCen).

"The Rapid Geo-spatial Reporting service (RGR) of G-MOSAIC has demonstrated its technical maturity."

What are the key contributions and achievements of the SatCen within G-MOSAIC?

The main achievement is certainly having been able to establish a mutually beneficial approach with the other GMES actors. The SatCen took advantage of results from the research and

pre-operational activities and from additional resources whilst making its particular expertise available for the coordination of the users' requests and for the definition and consolidation of the services. Concrete results have been achieved in support of EU decision making and EU Missions and Operations, in which the *Rapid Geo-spatial Reporting* service of G-MOSAIC has been able to demonstrate its technical maturity, with users submitting very enthusiastic feedback. Clear examples are the Haiti case, the North Africa crisis and many others. The evacuation plans, in particular are an example of specific expertise where the SatCen strongly contributed to the development of services in support to evacuation of EU citizens (e.g. Egypt, the Democratic Republic of the Congo).

“We have seen a strong interest from our users during G-MOSAIC, and one of their main recommendations is to ensure the continuity of the services.”

What do you see as the next key milestones for the operationalisation of GMES services for Security applications?

Everybody is anticipating the results of the discussion on the financial perspective for GMES. We expect that operational services will be available in 2014. Nevertheless, we see that there is still a lot of work to be done with regards to the Governance issues and the Data Security Policy. We will concentrate our efforts in order to strongly support the process, especially in the framework of the BRIDGES project. We have seen a strong interest from our users during G-MOSAIC, and one of their main recommendations is to ensure the continuity of the services.



Map of Alexandria Harbour, Egypt, prepared in respect of evacuation support activities during the civil unrest (Credits: SatCen, GMV, e-GEOS).



Sharm el-Sheikh International Airport (Credits: SatCen, Indra).

What are the key enablers and major obstacles, and how can these best be addressed by the GMES community?

The users expressed a strong interest in accessing the GMES services, and these users are definitely the main driver, along with the need to develop the European industrial Space sector. Both these drivers are closely interlinked. Furthermore, we should not overlook the fact that Space is a global resource and should be shared. It goes without saying that the financial crisis is one of the main obstacles, but in a certain way it is also an advantage, because it encourages the pooling of common resources.

THE BRIDGES PROJECT



BRIDGES (Building Relationships and Interactions to Develop GMES for European Security) is a project funded by the European Commission under the Seventh Framework Programme. *BRIDGES* is coordinated by the SatCen, and will last for two years from the January 1st, 2012. The project held its Kick-Off meeting on the January 18th, 2012 in Brussels, with the participation of the Research Executive Agency, the GMES Bureau, and several of its key stakeholders, which include the European External Action Service (EEAS), the European Space Agency (ESA), the European Defence Agency (EDA) and the Monitoring and Information Centre (MIC) of the European Commission Directorate-General for Humanitarian Aid and Civil Protection.

The objective of the *BRIDGES* project is the development of several potential models of governance for the GMES services for Security applications. These address three areas: Support to EU External Action, Border Control and Maritime Surveillance. Scenarios and implementation options for the governance of the Security dimension of GMES will be set out through analysis of stakeholders' positions at both Member State and European Union level, and through interaction with ongoing service development projects. The scenarios will examine the potential role of the SatCen in GMES and the operational coordination of access to Space data in the Security field, and will include an evaluation of costs and benefits.

The *BRIDGES* consortium collectively possesses extensive expertise in the areas of policy studies, communication, Security and GMES.



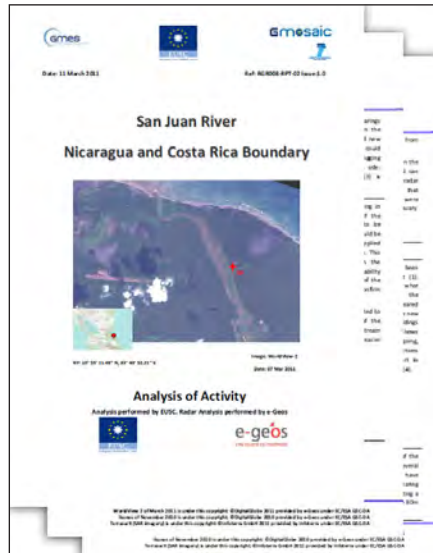
Several major user organisations were represented at the BRIDGES Kick-Off Meeting, held in Brussels on January 18th, 2012 (Credits: Julia Yague).

The SatCen is coordinating a new GMES project: BRIDGES. Can you describe in brief what this project is about and what it expects to achieve?

BRIDGES aims to bring GMES services for Security applications closer to operational status by helping to shape appropriate governance options and by supporting the European Commission and the Member States in analysing their technical, legal and financial implications. The main tool in achieving these goals will be a structured dialogue among stakeholders.

What are the goals of the SatCen regarding its involvement in GMES?

The first goal is to maximise the use of the services available within the Security dimension of GMES for the user community. The SatCen is also prepared to harmonise its approach and establish synergies as provider of geo-spatial information with the other geo-spatial information providers in the EU, in particular, GMES. Finally, the SatCen remains keen to be part of the ambitious GMES programme, and to contribute as much as other EU Agencies (for example, the European Environmental Agency). Due to



Briefing notes are short documents which summarise the results of imagery interpretation. The image shows a briefing note produced by the Rapid Geo-spatial Reporting service of G-MOSAIC in the context of an activation on the occasion of the border dispute between Costa Rica and Nicaragua (Credits: SatCen).

the complexity of the Security area, and the shared responsibility between the European Commission and the Member States, this will take time, but we are confident that we will reach the goal.

Pascal LEGAI has devoted the majority of his career since 1988 to serving the French Air Force as an Intelligence Officer. His primary areas of expertise are geography and imagery. He served as a geographer in the French Air Force staff in Paris (1994-1999), and as Commanding Officer of the French Imagery Intelligence Centre (2004-2006) and of the Grenoble Air Force Base (2008-2010). He holds a PhD in International Relations, a Masters degree in Imagery Processing and an Engineering Degree in geographic sciences. Pascal Legai is the Deputy Director of the European Union Satellite Centre, an agency of the European Union based near Madrid, Spain, which provides geographic and imagery intelligence products in support of the Common Foreign and Security Policy (CFSP).

The United Nations Department of Field Support uses G-MOSAIC products to support relief operations after 2010 Haitian earthquake

THE UNITED NATIONS DEPARTMENT OF FIELD SUPPORT (UN-DFS) IS RESPONSIBLE FOR SUPPLYING UN PEACEKEEPING AND POLITICAL MISSIONS WITH LOGISTICAL, TECHNICAL, FINANCIAL AND OTHER SUPPORT. IN RESPONSE TO THE JANUARY 2010 EARTHQUAKE IN HAITI, THE UN-DFS ACTIVATED THE G-MOSAIC RAPID GEO-SPATIAL REPORTING SERVICE, REQUESTING DAMAGE ASSESSMENTS AND TRAFFICABILITY ANALYSES IN SUPPORT OF THEIR RAPID RELIEF OPERATIONS.



Kyoung-Soo EOM

"The input and resources provided by G-MOSAIC supplementing the UN capacity are an excellent example of understanding the end-user requirements in a timely and efficient manner. These products have helped to meet the information needs for rapid relief operations in Haiti.

I would like to stress the fact that the activation of the G-MOSAIC project has been a great opportunity to successfully test how a GMES project can efficiently contribute, in the operational domain of Rapid Service Provision, to having the "enduser perspective" fully met during the disastrous earthquake that has severely affected the people of Haiti.

[...] I am certain that the Cartographic Section and consortium will further cooperate to develop mutual synergies as the project progresses, increasing our collaboration bonds with the European Commission and contributing to United Nations operational efficiency and effectiveness."

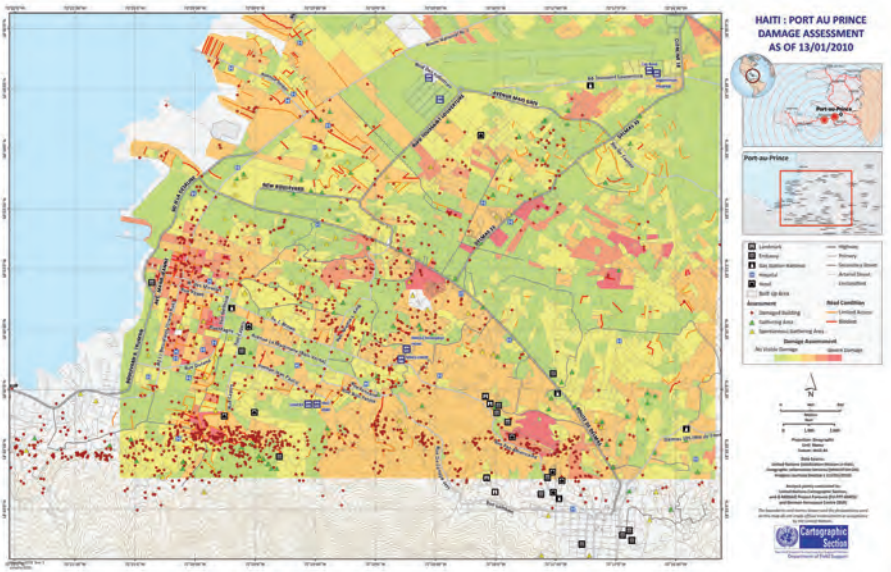
Kyoung-Soo EOM
Chief, Cartographic Section
United Nations Department of Field Support.

G-MOSAIC PRODUCTS IN RESPONSE TO THE EARTHQUAKE IN HAITI

The G-MOSAIC Rapid Geo-spatial Reporting pilot service supplied the UN Department of Field Support with a wide range of products covering four Haitian areas of interest (Port-au-Prince, Leogane, Carrefour and Jacmel). Damage assessment products were created using optical imagery and visual interpretation from image analysis experts. When deemed necessary, multi-temporal coherent analysis (MTC) and automated change detection methods were used. Trafficability maps showing no-go areas and serviceable vehicle routes, and briefing notes summarising the effects of the earthquake on critical infrastructure (such as Port-au-Prince's airport and harbour) were also provided.



A UN field officer examines information provided by G-MOSAIC during support operations in Haiti (Credits: UN Photo/Guillaume Criloux).



Damage assessment for Port-au-Prince, produced jointly by G-MOSAIC and the Cartographic Section of the UN Department for Field Support (Credits: UN-DFS, G-MOSAIC).

The EU Situation Room at the European External Action Service

THE EU SITUATION ROOM WAS INAUGURATED BY THE EU HIGH REPRESENTATIVE FOR FOREIGN AFFAIRS AND SECURITY POLICY, CATHERINE ASHTON, ON JULY 18TH, 2011. IT PROVIDES SITUATION MONITORING AND ASSESSMENT, SITUATIONAL AWARENESS, EARLY WARNING AND ALERTING FOR THE BENEFIT OF THE HIGH REPRESENTATIVE FOR THE EUROPEAN EXTERNAL ACTION SERVICE (EEAS), THE MEMBER STATES AND OTHER INSTITUTIONS OF THE EUROPEAN UNION. IN THIS CAPACITY, IT IS A REGULAR USER OF PRE-OPERATIONAL GMES SERVICES FOR SECURITY APPLICATIONS.



Catherine ASHTON

“With the creation of the new EU Situation Room, the European External Action Service (EEAS) has taken another important step in strengthening the EU’s capabilities in the field of crisis response and crisis management.”

Catherine ASHTON
High Representative for Foreign Affairs and Security Policy.

The EU Situation Room provides daily information updates on political events occurring worldwide. In this context, the use of accurate and real-time information on crises derived from satellite imagery is very important...



Lady Ashton visiting the EU Situation Room at the EEAS. Also pictured are Mr Agostino Miozzo, Managing Director of the EEAS Crisis Response Department (left) and General Ton Van Osch (far right) (Credits: the Council of the European Union).

The EU Situation Room, as the EEAS as a whole, has been set up by combining different elements of the General Secretariat of the Council with those of the former Directorate-General for External Relations (DG RELEX) of the European Commission, which has had a long history of dealing with geo-spatial data. In this respect, the EU Satellite Centre (SatCen), the Joint Research Centre (JRC) of the European Commission and a number of GMES projects have been long-standing collaborators with the EU Situation Room's predecessors.

GMES products and services have provided geo-spatial information to the EU Situation Room in two different ways: either by means of direct contact with GMES projects, or through the major EU institutional partners, the SatCen and the JRC. Cooperation in this field has included the use and activation of the *RESPOND* project as of 2007, and later, of other GMES projects such as *LIMES* and *GMOSS*.

Since 2009, pre-operational GMES projects such as *SAFER*¹ and *G-MOSAIC* have developed and have been extensively used by the European External Action Service. Whilst *SAFER* was focused on rapid mapping and short-term crisis response, *G-MOSAIC* provided insights into longer-term issues related to conflict prevention and supporting reconstruction operations following crises.

Products and services from GMES projects have been distributed to the desk-officers of various countries in the EEAS and EU Delegations around the world. The involvement of GMES projects has proven useful and has enlarged the palette of possible information sources at the disposal of EEAS personnel.



Geographic reference map of Benghazi city centre, Libya (Credits: SERTIT, SAFER).

¹ The *SAFER* project developed the pre-operational GMES Emergency Response Service and paved the way for the GMES Emergency Management Service – Mapping, which is fully operational since April 1st, 2012.

Supporting the Italian Ministry of Defence in preparing contingency plans

THE CITY OF TYRE IN LEBANON MAKES AN INTERESTING TEST SITE FOR THE CREATION OF MAPS FROM HIGH RESOLUTION (OPTICAL AND RADAR) SATELLITE IMAGES DUE TO SEVERAL GEOGRAPHICAL FEATURES: ITS PROXIMITY TO THE BORDER WITH ISRAEL AND THE GOLAN PLATEAU; THE PRESENCE OF SETTLEMENTS OF PALESTINIAN REFUGEES; AND THE FACT THAT SEVERAL UNITED NATIONS STRUCTURES ARE LOCATED IN THE CITY. THE G-MOSAIC PROJECT PROVIDED THE ITALIAN MINISTRY OF DEFENCE WITH UPDATED MAPS OF THIS AREA, DEMONSTRATING THE POTENTIAL OF COSMO-SKYMED RADAR DATA FOR THE IDENTIFICATION OF FEATURES.



Lieutenant Colonel Sabato RAINONE

“There are two aspects of the Italian Armed Forces missions that have a tremendous impact on the Military Geo-spatial Staff and Services: the contribution to international crisis management, with the increasing need for rapidly deployable packages of forces, able to react at short notice should a crisis arise, and the contribution to the safeguarding of democratic institutions, with the need to cooperate with other national organisations, to relief operations in case of disasters, other national emergencies or high Security public events management.

In such cases, geo-spatial support is essential in the theatre of operations, but it is also an integral part of the homeland Security management system. In this context, the use of adequate and timely geo-spatial information is the key to achieving interoperability in real-time activities and in complex scenarios, characterised by the coexistence of actors, organisations, and civil and military realities that are both multinational and diversified. In other words, unlike in the past, the military contribution to national Security can no longer depend exclusively on the capacity to guard and provide static Defence of metropolitan areas (“Homeland Defence”); it must develop the capacity to dynamically face threats whenever and wherever they occur. Italian soldiers are engaged in many different operations in 24 countries outside the national territory in missions of peace-keeping, stabilisation, reconstruction and humanitarian aid, as the changing international situation requires.

The geo-spatial information provided by the G-MOSAIC products have been used both in the case of our contribution to supporting humanitarian missions, as for the Haiti earthquake, and in updating tactical cartography in those areas where maps are not available or obsolete, as for the Tyre urban map updates. The fruitful collaboration established with the G-MOSAIC project included our involvement in the entire service chain product workflow, starting from the definition of product requirements through the validation and assessment phase.”

Lieutenant Colonel Sabato RAINONE
Chief, Geo-spatial and METOC Section
Italian Defence General Staff, Information and Security Division

GMES SERVICES FOR CONTINGENCY PLAN PREPARATION

The Italian Ministry of Defence is involved in an international collaboration which aims to define a map legend based on standards developed by the Multinational Geo-spatial Co-production Programme (MGCP). The area of Tyre was selected as a test area to establish the level of detectable detail. An analysis of ancillary data¹ was conducted in support of the feature extraction, thanks to the accurate reference data provided by the Italian Ministry of Defence to validate the products.

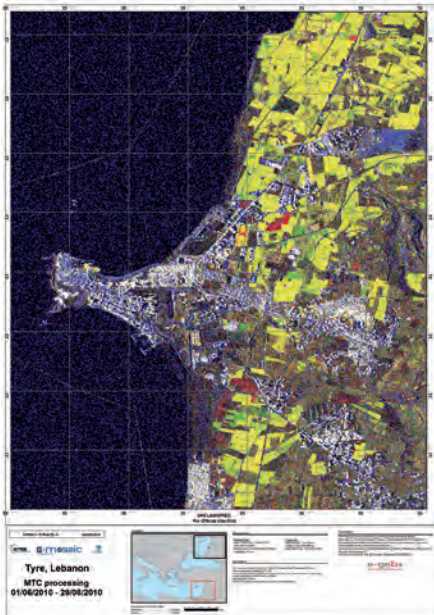
Within the Contingency Plan Preparation pilot service of G-MOSAIC, e-GEOS produced an Urban Map of Tyre. The map was created from very high resolution (VHR) optical satellite images in combination with a MultiTemporal Coherence analysis (MTC).

MTC analysis is a radar image processing technique in which two images from different points in time are combined, in order to show which changes have occurred in the target area. The MTC product shown below was obtained by combining two Synthetic Aperture Radar (SAR) images acquired by the COSMO-SkyMed constellation approximately six months apart. The map shows the two images and their combination (coherence), as follows:

- Red indicates the image acquired on the first date;
- Green indicates the image acquired on the second date;
- Blue indicates the interferometric coherence of the two images.

The product delivered to the user includes a report on the MTC map, highlighting changes to specific features of interest.

¹ 'In digital image processing, data from sources other than remote sensing, used to assist in analysis and classification or to populate metadata' (source: ESRI.com).



Urban Map of Tyre, Lebanon (Credits: e-GEOS).

COSMO-SkyMed multi-temporal images with interferometric coherence (MTC) over Tyre
Red: The First COSMO-SkyMed acquisition
Green: The Second COSMO-SkyMed acquisition
Blue: The interferometric coherence of the two images (Credits: e-GEOS).

G-MOSAIC supports Spanish Red Cross Emergency response units in Haiti

IN THE AFTERMATH OF SEASONAL TROPICAL STORMS, THE CITY OF GONAÏVES IS DESOLATE: MUD FOR MILES, ROOFTOPS JUTTING FROM WAVES OF DIRT, CHILDREN IN STARVATION. AS IT OFTEN HAPPENS, AN ENVIRONMENTAL DISASTER HAS EVOLVED INTO A SECURITY CRISIS. IT IS IN SUCH MOMENTS THAT THE ROLE OF CRITICAL ASSETS IS BROUGHT SHARPLY INTO RELIEF: THE NORMAL FUNCTIONING OF TRANSPORTATION, POWER OR WASTE SANITATION IS NECESSARY FOR THE CITY TO RECOVER FROM THE CRISIS, WHILST THE DISRUPTION OF SUCH SERVICES CAN LEAD TO FURTHER LOSSES OF PROPERTY AND LIFE, AND CREATE CHAOS FOR THE LOCAL POPULATION.



Spanish Red Cross strategic planning at IFRC Base Camp, Port-au-Prince, Haiti, after the earthquake (Credits: International Spanish Red Cross).

Spanish Red Cross teams are primarily in charge of two critical assets: fresh water distribution at critical points and secure telecommunications; in fact, these are only two of the many features defined as critical infrastructure by the European Programme for Critical Infrastructure Protection (EPCIP). Such critical features are considered key Security elements both within the EU, and in scenarios supporting EU External Action.

The *G-MOSAIC* Critical Assets service supported the work of the Spanish Red Cross by generating key geographic information about the area: a detailed ground elevation model of the city and its surroundings, strategic water distribution points, population gathering places, access ways, low-laying polluted wetlands, power stations, reservoirs and port infrastructure.

Resolving Red Cross needs in this particular activation required Very High Resolution (VHR) satellite image processing. The critical assets depicted included not only an array of man-made, civil engineering critical assets (roads, port infrastructure, depots, energy exchange knots, particular buildings), but also a number of natural critical assets (steep slopes, terrain breaks, flooded lowlands, mud channels). The provision of *G-MOSAIC* Critical Assets products was supported by a training session for more than 40 Red Cross international crisis volunteers, mostly telecommunications experts.

The Spanish Red Cross has a permanent presence in Haiti in support of the Haitian Red Cross. Field teams activated *G-MOSAIC* right after the massive earthquake of January 12th, 2011, for which specific services were provided.

Salva Ramírez (pictured), IT and Telecommunications Coordinator of the International Federation of Red Cross and Red Crescent Societies (IFRC) Base Camp in Port-au-Prince, Haiti, made the following statement one month after the earthquake:

"Since the earthquake happened, [G-MOSAIC] have worked speedily, producing [large amounts] of terrain information we were in need of. Thank you."

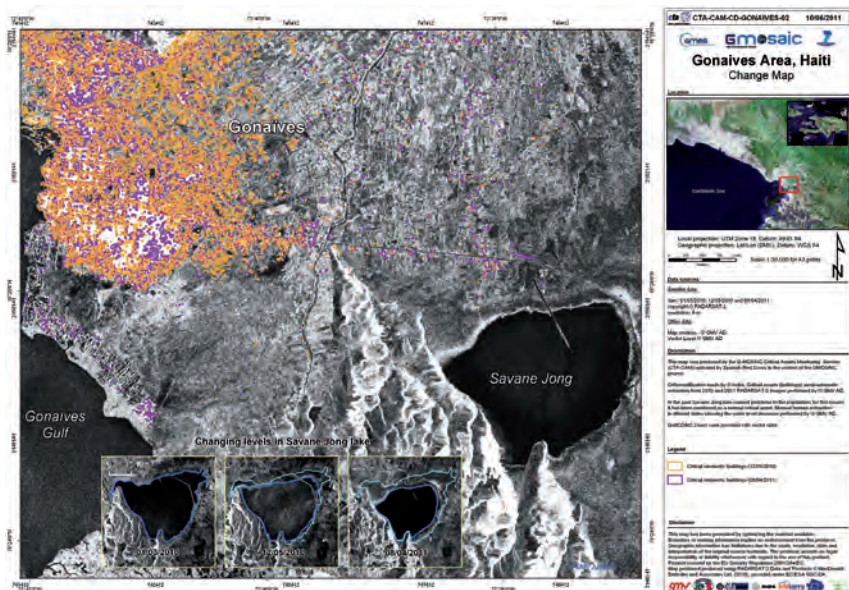


Salva Ramírez of the Spanish Red Cross during a training session at which the G-MOSAIC products which were provided during the response to the Haiti earthquake were validated (Credits: GMV/Julia Yagüe).

G-MOSAIC SERVICES FOR CRITICAL ASSETS MONITORING AND ASSESSMENT



The G-MOSAIC services in the Critical Assets domain deal with the monitoring of manmade or natural structures considered to be “critical” with respect to the Security implications of their disruption, destruction or alteration. Examples include energy pipelines, storage tanks, power stations, reservoirs and water treatment plants. The G-MOSAIC Critical Assets Monitoring (CAM) and Critical Assets Event Assessment (CAE) services offer products which monitor such critical assets over the mid- to long-term (CAM) and in the very short term following a crisis (CAE). Critical Assets products combine Synthetic Aperture Radar (SAR) and optical Earth Observation (EO) imagery. Within G-MOSAIC, these services have been coordinated by the Spanish firm GMV, and delivered with the collaboration of the San Marco Project Research Centre of the University of Rome, the University of Basilicata, Indra, Astrium GEO-Information Services, TNO and Eurosense.



G-MOSAIC Critical Assets product (Credits: GMV).

Experiment demonstrates the potential of GMES to contribute to the fight against drug trafficking in the Caribbean

THE CARIBBEAN BASIN IS A VORTEX FOR DRUG SMUGGLING BY SHIP BETWEEN PRODUCTION ZONES IN SOUTH AMERICA AND DESTINATION MARKETS OF EUROPE AND NORTH AMERICA. LIMES, A GMES PROJECT, TESTED NEW MONITORING SERVICES TO SUPPORT NAVAL AND LAW ENFORCEMENT ACTIVITIES IN THE AREA.



Lieutenant Commander
Benoît-Xavier HUET

“Sea surveillance of ships suspected of drug smuggling poses specific sets of challenges. In the Caribbean zone, located far from France’s main coastline, France has no permanent surveillance equipment such as signal stations, and some portions of the sea expanses are hard to monitor because of their sheer size. In addition, drug traffickers use a broad range of ship types – from slow ships of varied materials ranging from wood to resin, all the way to « go fast » boats as we call them.

We were pleasantly surprised with the information we received from GMES service providers through LIMES. Only two hours after the satellite overpass, we would be handed pre-processed imagery from which we could work.

Of course nothing replaces the human eye and there are limitations. For the time being, some of the satellites come around only every 48 hours, while optical sensors will never see through clouds. On certain sets of images ships less than 30 metres long are not visible and, finally, the 2-hour delay required for processing and transmission can be significant if you need to locate a ship in order to prepare an immediate intervention at sea.

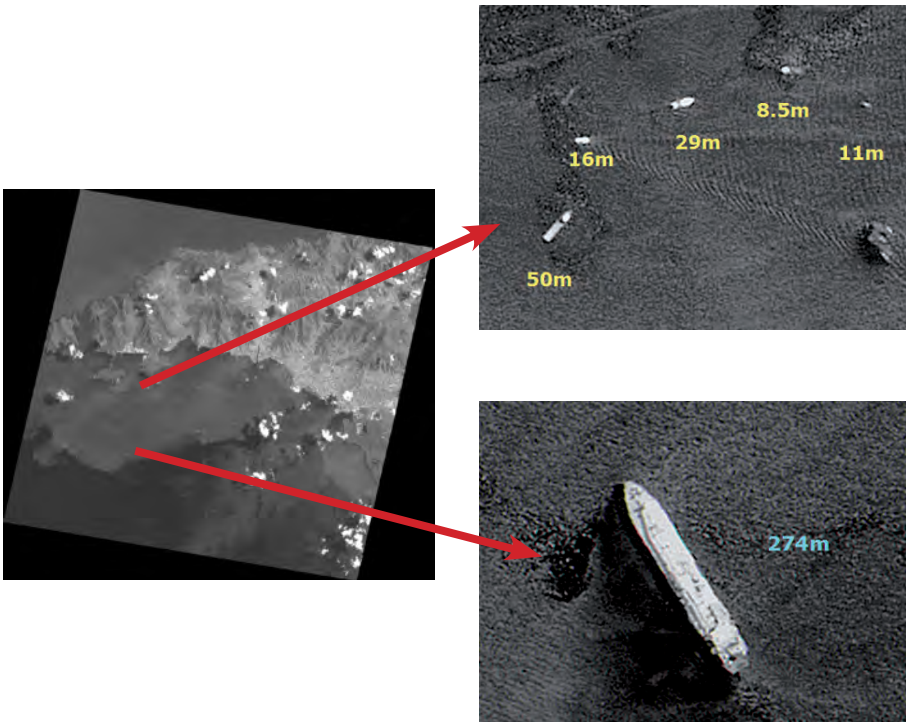
That being said, GMES products are very promising tools, as they are well suited for large oceanic areas with little ship traffic. They also allow for the sort of low-profile surveillance that such operations require. Finally, performance is likely to get even better as:

- *GMES imagery gets integrated with data from other sources;*
- *Processing techniques further progress to allow detection of ships under ten metres, while processing time is brought under half an hour;*
- *More optical and radar satellites become available, allowing at least a daily coverage of the area.”*

Lieutenant Commander Benoît-Xavier HUET,
Head of the Maritime Intelligence Coordination Cell (at the time of the experiment),
West Indies Maritime Area Command, French Navy.

THE LIMES CARIBBEAN EXPERIMENT

Within LIMES (a GMES Security project which ended in 2010), a 30-day long experiment in the Caribbean was conducted in June 2008. Its purpose was to provide satellite imagery (optical and radar) of boat traffic in distant maritime areas. It focused on two main requirements specific to the job at hand: sorting through a broad range of observation targets, and quickly processing and delivering information. The end user was the French Navy (COMAR Fort de France, in the French *département* of Martinique) which participates in the anti-smuggling operations for the benefit of OCRTIS (the French anti-drug law enforcement unit). The LIMES partners operated out of four locations on both sides of the Atlantic: in Cayenne, French Guyana (EADS Astrium, Spot Image and Nevantropic), in Fort-de-France where the European Union Satellite Centre (SatCen) had positioned a GMES image analyst to assist the user throughout the experiment, in Ispra (Italy) at the European Commission's Joint Research Centre, and in Spain at SatCen's facilities. As many as five satellites were used. Imagery was of two types – very high resolution for coastal and island zones, and high resolution for larger high sea areas.



Ship detection from a wide-area satellite picture enabling determination of ship size and direction (Credits: LIMES).

Civil/military synergies in the field of Earth Observation

by Denis Moura

THANKS TO ITS DUAL CHARACTER, SPACE IS AN ATTRACTIVE DOMAIN TO IMPLEMENT CIVIL/MILITARY SYNERGIES. AT EUROPEAN UNION LEVEL, IN THE RECENT PAST THIS APPROACH HAS RECEIVED STRONG POLITICAL SUPPORT AND TODAY SEVERAL FRAMES EXIST TO EXPLORE AND IMPLEMENT THESE SYNERGIES, PARTICULARLY IN THE FIELD OF EARTH OBSERVATION.

The civil/military duality of Space

The Space domain is a privileged field for duality at technical, programme, application and strategy levels. The European Council's resolution of May 2007 on the European Space Policy (ESP), jointly developed by the European Commission and the European Space Agency, expressed this technical duality: "Space technologies are often common between civil and defence applications and Europe can, in a user-driven approach, improve coordination between defence and civil Space programmes"¹. The ambition to explore synergies between the civil and defence programmes is also fully endorsed by the European Union Member States who, in the 2008 Council resolution "Taking forward the European Space Policy"², identified Space and Security as one of four new priority areas for the ESP and highlighted the need to "define the way and means to improve the coordination between civil and defence



The civil uses of Earth Observation data cover a very broad range of applications, as illustrated by the GMES programme (Credits: www.gmes.info).

Space programmes in long-term arrangements".

On the other hand, the 2010 Space Policy Resolution of the Council "invites the European Commission, the European Union Council, assisted by the European Defence Agency, together with Member States and the European Space Agency, to explore ways to support current and future capability needs for crisis management through cost-effective access to robust, secure

¹ Resolution on the European Space Policy, Council document 10037/07, May 2007, section B.8.

² 2891st Competitiveness Council meeting Brussels, September 26th, 2008.

and reactive Space assets and services (...), taking full advantage of dual-use synergies as appropriate"³. In addition, in December 2011, the Council resolution on "Orientations concerning added value and benefits of Space for the security of European citizens"⁴ "stressed that Space assets can contribute significantly to the objectives of the Common Security and Defence Policy (CSDP)". More recently, in January 2012, the European Parliament also insisted on the need for cooperation between military and civil Space-use strategies⁵.

The Duality of Earth Observation

The term Earth Observation is generally used when referring to satellite-based remote sensing which provides a whole range of information regarding the Earth's land masses, oceans, atmosphere and, in general, the environment and situational awareness, based on imagery or physical measurements. Earth Observation data, integrated with *in situ* data gathered from wider information systems, generate products allowing decision makers to directly access crucial information, to support their policies and to influence the conduct of other actors or competitors. This paradigm is applicable to both the civil and military domains.

"Space assets can contribute significantly to the objectives of the Common Security and Defence Policy, taking full advantage of dual-use synergies."

³ Resolution "Global challenges: taking full benefit of European Space systems", Brussels, November 25th, 2010.

⁴ Document 2011/C 377/01.

⁵ Resolution on a Space strategy for the European Union that benefits its citizens, January 19th, 2012.

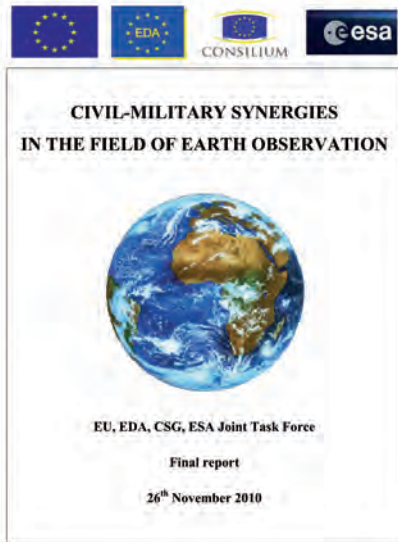
The civil uses of Earth Observation data cover a very broad range of applications spanning across scientific, economic and Security domains, as demonstrated for example by the GMES applications and services. They can include physical measurements such as the chemical composition of the Earth's atmosphere, reflectance, gravity, magnetism, etc. Earth Observation also has implications for Security and Defence. The information provided by satellites can help in shaping the Security decisions of a nation, or a community of nations, through the evaluation of the economic, geographic and military situation of a given region of interest anywhere in the world, and the corresponding evolution over time.



Earth Observation has implications for civil applications as well as for Security and Defence (Credits: sxc.hu).

The 2010 joint Task Force on civil/military synergies in the field of Earth Observation

To address civil/military synergy issues in the field of Earth Observation and identify potential areas of implementation, a Joint Task Force was set up in 2010 by the European Commission, the European Defence Agency (EDA), the Council Secretariat-General and the European Space Agency (ESA).



To address civil/military synergy issues in the field of Earth Observation, a joint Task Force has been set up in 2010 at European level and recommended several concrete actions (Credits: EDA).

The main aims of this Task Force were to:

- Improve harmonisation and standardisation in Europe in the field of Earth Observation;
- Identify complementary research and technology activities among European actors;
- Address appropriate synergies between military and civil programmes under development.

This Task Force elaborated on various areas such as harmonisation, standardisation, research and technology and programmatic issues and delivered its final report in November 2010⁶.

The resulting implementing actions have been investigated in coordination between the relevant Europeans

⁶ See <http://www.eda.europa.eu/Capabilitiespriorities/coredrivers/Space/Earthobservation/Taskforce>.

stakeholders and several activities are now under development in various frameworks, which include particularly the civil-military synergies initiative of the Political and Security Committee, the EDA/ESA Administrative Arrangement and the joint Space critical technologies initiative.

Political and Security Committee and civil-military synergies

Promoting civil-military synergies in the development of capabilities is a political priority for the European Union. Based on an initiative launched under the Swedish Presidency (2nd semester of 2009), a work plan was adopted by the Political and Security Committee (PSC) in May 2010, concentrating on 13 domains. The use of Space capabilities is one of them, and includes Earth Observation. In December 2010, the PSC approved the way ahead and actions were firstly defined, and then endorsed in July 2011 for immediate implementation. Two outputs of the 2010 Task Force report having a political dimension and requiring direct support from the EU Member States were proposed and accepted in that context.

“The pooling and sharing of ground reference targets, used for calibration, and of image analyst training are concrete activities done under PSC endorsement.”

The first action is related to the pooling and sharing of ground reference targets used by the European Earth Observation Space systems for in-flight geometric and radiometric calibration/validation. The objective of this action is to collect, on a voluntary basis, data on existing ground reference targets,

as well as their associated conditions of sharing, in view to issuing a first catalogue. Indeed, such a catalogue would result in a larger number of calibration points which will benefit all systems by improving their performance: for the same performance, the ground image processing as well as the satellite design may be simplified.

“Promoting civil-military synergies in the development of capabilities is a political priority for the European Union.”

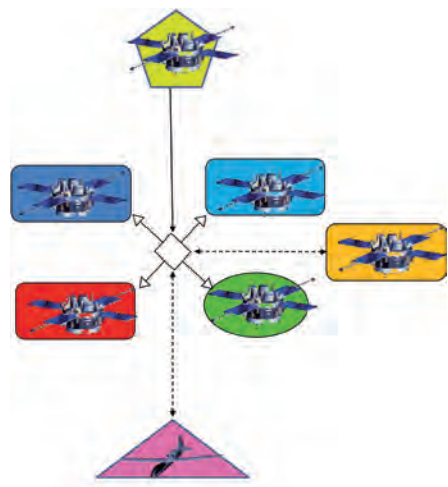
The other action is aimed at proposing to military and civilian personnel from governmental and institutional bodies a panel of training courses providing a common understanding of procedures, tools, standards and techniques of imagery analysis. Indeed, the analysis of Earth Observation images to generate products and services is currently mainly performed using human expertise. The possibility to network civilian and military analysts training courses would mitigate the current lack of trained imagery experts, avoid duplications and contribute to the sharing of the best practices and standardisation in image analysis processes.

EDA/ESA Administrative Arrangement

In June 2011 the European Defence Agency and the European Space Agency signed an Administrative Arrangement. This Arrangement allows the consolidation of the already close and fruitful working relationship between both agencies with a view to exploring further synergies between the needs of the defence and civil communities, to the benefit of their respective Member States. It provides a

structured relationship and a mutually beneficial cooperation between EDA and ESA through the coordination of their respective activities. The cooperation aims, in particular, at exploring the added value and contribution of Space assets to the development of European capabilities in the area of crisis management and the Common Security and Defence Policy.

In that frame, and following an output of the 2010 Task Force report, the EDA and ESA decided at the end of 2011 to address together the networking of the future generations of Earth Observation systems, characterised by large heterogeneity in terms of ownership (national, bilateral, European), type (civil, dual use, military), assets (satellites, UAVs, planes, *in situ*) and operational setting (permanent, mission-oriented). Such networking represents a real challenge



The EDA and ESA have signed an Administrative Arrangement to explore synergies between the defence and civil communities. Common activities have started on networking Earth Observation systems (Credits: EDA).

THE EUROPEAN DEFENCE AGENCY



The European Defence Agency's (EDA) mission is to support the European Council and the Member States in their effort to improve the European Union's defence capabilities in the field of crisis management, in support of the Common Security and Defence Policy (CSDP). This mission is enacted by promoting collaborations and launching initiatives to be implemented and delivered by its participating Member States (all EU members, except Denmark). The EDA reports to the European Council, and is governed by its Steering Board, comprised of the participating Member States' Ministers of Defence along with a representative from the European Commission.

Four main strategies guide the activities of the EDA:

- **The Capability Development Plan**; which defines future capability needs from short to longer term;
- The **European Defence Research and Technology** strategy; which aims at enhancing more effective research and technological development in support of military capabilities;
- The **European Armaments Cooperation strategy**; which promotes more effective European armaments co-operation in support of CSDP capability needs;
- The **European Defence Technological and Industrial Base** strategy; which aims to make the future European defence industrial landscape more integrated and interdependent whilst reducing duplication.

The priorities of the EDA include addressing the problem of improvised explosive devices; improving medical support capabilities; developing improved intelligence, surveillance and reconnaissance capabilities; increasing the availability of trained helicopter pilots, enhancing cyber defence; improving multinational logistical support for crisis management operations; promoting civil-military synergies in strategic and tactical airlift management; tackling a range of issues related to energy and fuel, and mobility assurance.

Despite being relatively young (the EDA was established in 2004), the Agency has already achieved considerable progress in developing maritime mine counter-measures; improving chemical, biological, radiological and nuclear defence; taking measures against man-portable air defence systems; and improving training programmes for military human intelligence.

whilst offering, on the other hand, the possibility to maximise the overall performance in the future (“System of Systems” concept).

“Civil-military synergies, as well as capacity pooling and sharing, constitute important tools to enhance the efficiency of European expenditure, particularly in the field of Earth Observation.”

The Space critical technologies initiative

It is acknowledged that the European Space programmes, including those related to Earth Observation, depend on critical non-European technologies, mostly from the United States and Japan. Although a large number of these technologies are mission-critical, the absence of commercial prospects

means that public funding is required to put an end to this dependence. The European Commission, European Defence Agency and European Space Agency have joined forces to determine relevant Space technologies for European strategic non-dependence. The aim is to coordinate subsequent investments in the respective institutional frameworks. At the end of 2009, together with Member States, a list of urgent actions for 2010-2011 was drafted, opening the floor to several implementation actions, which included Earth Observation. In December 2011, a joint workshop, in cooperation with Member States’ delegations and industry, mapped the ongoing developments, relevant capabilities, needs, strategic interests and recommendations which resulted in a new list of urgent actions for the 2012/2013 period.



Prof. Dr. Ing. Denis MOURA is Officer for Space programmes at the European Defence Agency in Brussels. Before taking these responsibilities, his career has been within the French Space Agency (CNES) where he was in charge of various Telecommunication, Earth Observation and Space Science pre-projects and programmes, and then the CNES representative in Italy. D. Moura is the Chairman of the “Dual Use” Sub-Committee of the International Astronomical Federation and also organises conferences, workshops and courses on Space in Austria, Belgium, France and Italy. He holds a graduate engineering degree in Aerospace from Ecole Centrale Paris, and the diploma from the French Defence Academy.

GMES and Border Surveillance: the FRONTEX perspective

by Erik Berglund

THE EU MEMBER STATES AND THE FRONTEX EUROPEAN BORDER AGENCY ARE DEVELOPING THE EUROPEAN BORDER SURVEILLANCE SYSTEM (EUROSUR) TO IMPROVE THE SURVEILLANCE OF THE EXTERNAL BORDERS OF THE EU. AS PART OF EUROSUR, SATELLITE SURVEILLANCE WILL BE TESTED FOR MARITIME SURVEILLANCE IN A JOINT EFFORT INVOLVING FRONTEX, THE EUROPEAN MARITIME SAFETY AGENCY (EMSA) AND THE EU SATELLITE CENTRE (SATCEN) IN THE FRAMEWORK OF GMES.

European borders

Our lives in the globalised world depend increasingly on efficient, convenient and secure worldwide mobility of persons and goods. To this end, the European Union has abolished internal borders within the Schengen area and has started to develop a common policy on Integrated Border Management. The objectives of this policy are to keep the external borders of the EU open for trade and the movement of persons, facilitate regional cooperation with neighbouring countries, and keep the borders closed against criminal activities such as smuggling and

terrorism. Furthermore, the abolishment of the internal borders of the European Union has underlined the need for Member States to collaborate in order to maintain Security at the external borders. As part of the Integrated Border Management policy, Frontex has been created as a European agency tasked with coordinating such collaboration.

Role of Frontex

According to the EU legal framework, the Member States maintain responsibility for the control and surveillance of their external borders, while Frontex facilitates and renders more effective the application of existing and future Union measures relating to the management of external borders. Furthermore, Frontex shall contribute to an efficient, high and uniform level of control on persons and surveillance of the external borders, thus adding value at a European level. This means that the role of Frontex is to help the Member States reach a high and uniform level of border management.

Apart from providing risk analyses and coordinating joint operational activities conducted by the Member States, Frontex plays a key role in harmonising



Frontex is the European agency for coordinating efforts amongst Member States to improve the Security of the EU external borders. Pictured is a member of the Frontex Rapid Border Intervention Team (RABIT) (Credits: Frontex).

and developing capabilities through efforts in the fields of training and research and development. One of the main R&D areas relates to the creation of new solutions for border surveillance.

EUROSUR

Surveillance of the borders, especially maritime border areas, is one of the fields in which Frontex currently coordinates European collaboration. A system called the European Patrols Network has been established for coordinating patrolling activities between neighbouring countries and for sharing the information gathered.

An initiative that takes this collaboration to a higher level is the European Border Surveillance System (EUROSUR). EUROSUR is an information sharing and cooperation mechanism that enables Member State authorities carrying out border surveillance activities and Frontex to collaborate at tactical, operational and strategic levels. The aim is to:

- Increase the internal Security of the EU by preventing cross-border crime;
- Reduce the number of irregular migrants entering the Schengen area undetected;
- Considerably reduce the unacceptable death toll of migrants at sea.

“EUROSUR should also facilitate cooperation between national law enforcement authorities in and between Member States.”

EUROSUR will provide Member States with an operational and technical framework that increases their situational awareness and improves the reaction capability of national authorities responsible for controlling the external borders. EUROSUR should also facilitate

cooperation between national law enforcement authorities in and between Member States (border guards, police, customs, coast guards etc.) for internal Security purposes.

The idea of EUROSUR was conceived by the European Commission in 2008¹ and, after the concept was fine-tuned, the Commission presented a legislative proposal² for EUROSUR in December 2011. The legislative proposal is currently being processed by the Council and the European Parliament and should enter into force in 2013.

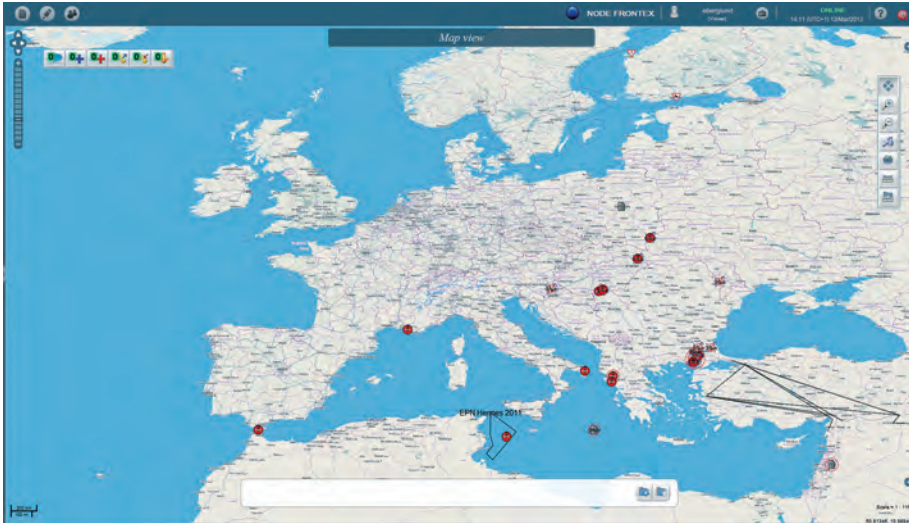
Since the presentation of the original concept, the progress towards the establishment of EUROSUR has been significant. Between 2008 and 2010, the Member States, Frontex and the Commission defined the main technical components of EUROSUR. Furthermore, the EUROSUR network has been developed under the direction of Frontex, and has been operational on a pilot basis since the end of 2011, initially involving Frontex, Finland, France, Italy, Poland, Slovakia and Spain, and extended during 2012 to cover all 18 Member States with external borders.

The key components of the EUROSUR technical framework are as follows:

- A National Coordination Centre (NCC), to be set up by each Member State coordinating (24/7) the activities of all national authorities carrying out external border surveillance activities and exchanging information with the other National Coordination Centres and Frontex. The National Coordination Centres form the backbone of EUROSUR;

¹ COM(2008) 68, February 13th, 2008.

² COM(2011) 873final, December 12th, 2012.



A snapshot of the European Situational Picture as it is shown in the current EUROSUR Pilot. Events reported by the Member States are displayed on the map. In the future, an input from satellite surveillance will be added by Frontex as a service to the Member States (Credits: Frontex).

- Frontex provides the National Coordination Centres with services such as the European Situational Picture or the Common Pre-Frontier Intelligence Picture;
- Frontex provides the National Coordination Centres with services for the common application of surveillance tools at the EU level;
- The EUROSUR network, encompassing nodes in NCCs and at Frontex, provides communication tools and enables data exchange between the National Coordination Centres and Frontex.

Common application of surveillance tools

One of the key components of EUROSUR is the development of new solutions for the common application of surveillance tools at EU level (e.g. satellite imagery and ship reporting systems). Here, Frontex plays key roles in the development of both new technologies and new services.

To meet the requirements for surveillance in conditions ranging from the open Atlantic to the Greek archipelago requires a multitude of systems, using sensors mounted on Space-based and airborne platforms as well as on ships and land. Whilst the areas to be covered by EUROSUR are very wide, the objects of interest for the maritime application can be very small, ranging from large ships to small wooden, inflatable or improvised craft such as tyres. Furthermore, EUROSUR will need to cover such wide areas with sufficient continuity and detection capabilities to ensure that action can be taken against suspicious vessels.

“Frontex works closely with the Commission and the European Space Agency to make the best possible use of GMES.”

Regarding the development of new technologies, Frontex works very closely

with the European Commission to steer and make use of the investments in research and technological development performed in the Seventh Framework Programme (FP7). In addition, Frontex works closely with the Commission and the European Space Agency to make the best possible use of GMES. Currently there are approximately half a dozen major FP7 projects in the fields of sea and land border surveillance, in which Frontex assumes the role of end-user and of assisting the Commission in coordination issues. The projects on maritime surveillance mainly explore different solutions for detecting small boats (see article on p. 76).

Jointly with EMSA and the SatCen, Frontex is currently developing operational services to be made available to the Member States through EUROSUR. This is based on a concept of operations (CONOPS) addressing the application of surveillance tools developed in the framework of GMES to border surveillance.

According to the CONOPS, EMSA will provide satellite-based information about vessels at sea, while the SatCen will provide information about land areas of interest, e.g. ports of departure. The eastern land border also presents

various challenges that could be addressed by satellite surveillance. However, due to the complexities of detecting small objects along a border of thousands of kilometres spanning ten European countries with forests, mountains, and rivers, this is currently not a priority.

Nevertheless, the surveillance of land areas can play an important role for the development of the Common Pre-frontier Intelligence Picture (CPIP) that Frontex is developing. The CPIP covers information about neighbouring areas that can be of relevance for border security. The importance of awareness of the situation in neighbouring areas has recently been aptly demonstrated by the events in North Africa and the Middle East.

Experience so far

The experience of using satellite-based information for border surveillance is still rather limited. However, satellite surveillance has been tested in a number of joint operations coordinated by Frontex. The most recent example is the so-called “Joint Operation Indalo”³ in the western Mediterranean, which involved several European agencies (Frontex, EUROPOL - the European Police Office, EMSA and the *Centre de coordination pour la lutte anti-drogue en Méditerranée - CeCLAD-M*), in which EMSA provided satellite-based information used by both Frontex and CeCLAD-M to address irregular migration as well as drug smuggling. The experience from Joint Operation Indalo provided some positive examples, but also indicated the difficulties of accurately detecting small boats at sea with sufficient time to act.



The detection of small and fast boats is a challenge for border surveillance authorities (Credits: Armed Forces of Malta).

³ Joint Operation Indalo has run annually since 2007.



The Joint Operation "INDALO 2007" (Credits: Armed Forces of Malta).

Future

The development of EUROSUR will be gradual, starting with measures to exchange information that is already available in the Member States and with pilot activities to test and evaluate other information sources, e.g. satellites. To be of interest, satellite surveillance will need to prove its value in economical terms compared to other solutions, e.g. airborne surveillance. As Space-based systems offer economies of scale, Frontex, together with

other European agencies (EMSA and SatCen) will coordinate the use of satellite-based information at a European level. The testing and validation of the cooperation between Frontex, EMSA and the SatCen is planned for 2012 and 2013. If successful, it is envisaged that this service will be funded by the GMES programme as of 2014.

Longer term, new technologies for detecting small craft at sea and for merging intelligence information with sensor data are being developed within EU research projects. Here, Frontex supports the Commission in directing the research to fit the needs of border security. Frontex also follows the relevant projects as end-users to ensure an adequate transfer of knowledge between the border guard community and researchers.

In summary, the European Union is giving heightened priority to Security at the external borders and GMES has the potential to play a major role in providing the necessary surveillance of European border areas.



Erik BERGLUND is Director of Capacity Building at Frontex. He joined Frontex in March 2007 as Head of the Research and Development Unit and assumed his current post in June 2008. His previous experience includes 20 years in various positions at the Swedish Defence Research Agency and two years as Senior Policy Officer at the Organisation for the Prohibition of Chemical Weapons in The Hague. Mr. Berglund holds a Master's degree in Engineering Physics from the Royal Institute of Technology in Stockholm, an Engineer's degree in Aeronautics from the US Naval Postgraduate School, and an MBA from Stockholm University.

The *G-MOSAIC* project: outcomes and the way ahead

by Sergio Proietti and Annalaura Di Federico

THE *G-MOSAIC* PROJECT RAN FROM JANUARY 1st, 2009 TO MARCH 31st, 2012. IN THIS ARTICLE, THE AUTHORS DISCUSS THE PROJECT'S KEY ACHIEVEMENTS, OUTCOMES AND RECOMMENDATIONS, AS WELL AS OUTLINING THE WAY AHEAD FOR GMES SERVICES IN SUPPORT TO EU EXTERNAL ACTION.

During the three years of the *G-MOSAIC* project, a set of pilot GMES services for Security applications has progressively evolved from research and development activities into pre-operational services. Five Security domains have been addressed by the services developed during *G-MOSAIC*:

- a. Natural resources and conflicts;
- b. Migration and border monitoring;
- c. Non-proliferation and treaty monitoring;
- d. Critical assets, and
- e. Crisis management and assessment.

These domains fall into two categories: "Intelligence and Early Warning" (a-d), and "Crisis Management and Operations" (e).

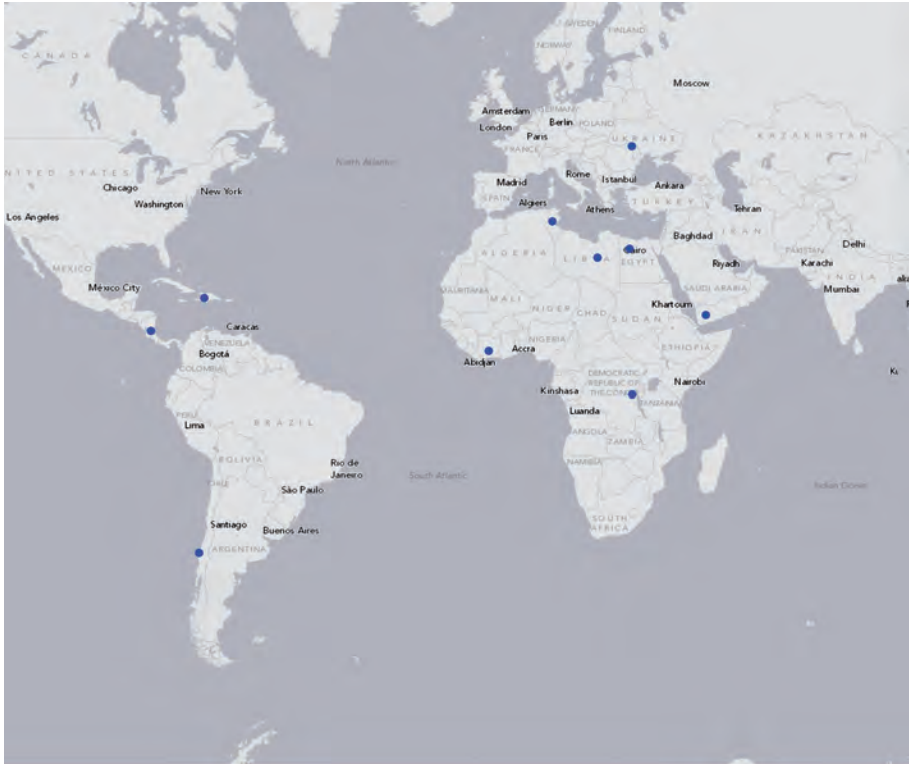
The European Commission's GMES Bureau, in consultation with key European Union stakeholders, has further defined the scope of the Security dimension of GMES and – through interaction with users – has investigated service perimeters and a possible *modus operandi* for the three principal Security domains indicated in the EU Regulation¹ on GMES and its Initial Operations, namely: Border Control, Maritime Surveillance and support to the External Action of the European Union.

¹ Regulation 911/2010 on GMES and its Initial Operations

Governance and Data Security policy are pre-requisites for the operational phase of GMES services in the Security field. To this end, a GMES Security Board was established, in order to take into account the recommendations on GMES Data Security policy adopted by the Council Security Committee (CSC) on January 26th, 2010.

Industrial partners, who have been involved primarily as service providers in GMES projects for Security, have progressively developed pre-operational services which have proven to be both sufficiently advanced and technically mature. In *G-MOSAIC*, this is particularly the case for the Crisis Management products and services.

During the course of the project, Crisis Management and Assessment services were provided on the basis of round-the-clock availability (24 hours a day, 7 days a week). Service production was organised through cooperative 'service chains', in which service providers worked closely with the European Union Satellite Centre (SatCen) to build the services up to the required level. The involvement and contribution of users in this process, as well as the contributions from research and institutional partners in the *G-MOSAIC* consortium have been highly valuable, with regard to both the detailed technical requirements and the assessment of the final products.



Activations of the Rapid Geo-spatial Reporting Service, one of the services in G-MOSAIC's crisis management and assessment domain (Credits: G-MOSAIC).

“The involvement and contribution of users in this process [...] have been highly valuable.”

The G-MOSAIC project has responded effectively to the needs expressed by EU Member States and international organisations. Users such as these have provided positive feedback on the services delivered during the course of the project. The consortium received official letters of appreciation from the United Nations Department for Field Support (UN-DFS; see page 20) and the United Nations Operation in Côte d'Ivoire (UNOCI), expressing their gratitude for the support provided to their respective operations.

G-MOSAIC has shown that GMES can deliver tangible support to the External Action of the European Union. A number of EU missions and operations have used G-MOSAIC products and services, and subsequently reported favourably on their effectiveness and usability. Two notable cases are the European responses to the civil unrest in North Africa in early 2011 (refer to p. 47 for a detailed report), and the Haitian earthquake in 2010 (see the User Portrait on p. 26).

G-MOSAIC has also demonstrated the capability to provide products and services across a very wide range of thematic areas related to monitoring and early warning. These services are considered to be less mature than the Crisis Management and Assessment activities, however, and

further research and development work is necessary in order to bring them up to an equivalent level of maturity.

Outcomes of the G-MOSAIC project

The G-MOSAIC project has enabled substantial progress to be made in building up pre-operational services within the Security Dimension of GMES, notably through the mobilisation and involvement of users. In the area of crisis management and assessment, the project contributed towards supporting real-world operations in a 'rapid response' mode. The set of products and services supporting "Intelligence and Early Warning" operations, while also responding directly to the needs expressed by users, still require further development and improvement to reach a pre-operational status.

Many activities are likely to converge in order to make possible future services in the Security dimension of GMES. These include the progress made within G-MOSAIC in developing services in support of the EU Security policies, the work of the GMES Bureau in defining requirements and a *modus operandi* within the Security dimension of GMES (in close coordination with the European External Action Service EEAS- and relevant stakeholders), the involvement of the SatCen in the technical coordination of users and services and efforts undertaken towards defining a strong Data Security policy.

During the third year of the project, services in support to crisis management and a number of other areas reached operational maturity. Several important issues remain unresolved, however, and must be taken into account in the further evolution of services:

- **The continuity of service provision.** GMES services in the Security domain have established a strong and active base of users, who regularly take

advantage of the services in support of their activities. Any discontinuity in the provision of services is likely to have an adverse impact on both user and stakeholder confidence.

- **Data Security policy.** In the Security field, certain data and information handled by, and exchanged between GMES service providers and users could be deemed sensitive, for political or strategic reasons. The need for a consensually-defined and properly implemented Data Security policy is therefore a necessary condition of service provision, in order to avoid the potentially detrimental dissemination of sensitive data or products.
- **Cooperative workflow production.** This was a very significant characteristic of the service development process within the G-MOSAIC project. This type of service organisation maximises the collective potential of the specific expertise available within the consortium. The G-MOSAIC consortium therefore supports the view that similar styles of working should be implemented in future GMES initiatives.
- **Flexible product design, tailored to user needs.** One of the major lessons learned through working with the GMES community of users in the Security field is that each crisis or event is unique, deferring in terms of both observation and information requirements. Consequently, each product calls for specialised customisation. The quality of the individual tailoring of products to user needs is a function of the effective collaboration between service providers and users, in the definition of the areas of interest and the observation modes. The evolution towards operational services relies on the effectiveness of two parallel assessment processes:



The G-MOSAIC services support relief operations as part of the crisis management process (Credits: French Ministry of Defence).

- 1) The assessment of the service by the final user. The user assesses the products against the initial requirements and expectations, and evaluates both the usefulness of the information and its potential for integration into the user's operational workflow.
 - 2) The assessment by the consortium partners. This occurs through a number of internal processes, which include the quality assurance process within the different service chains, and the independent validation carried out by partners who are not directly involved in the product generation process.
- **The cost-benefit analysis.** Beyond the technical assessments, enhancements and improvements to services must also be evaluated in terms of cost. Thus, a rigorous analysis of costs and benefits should accompany the evaluation of the service portfolio.
 - **User involvement.** The engagement of users in the Security dimension of GMES was a very significant – and ultimately successful – activity within the G-MOSAIC project. The strategy for the involvement of users should consist principally in stimulating and maintaining a dialogue between user communities and project partners. A variety of methods, including direct meetings and common events, can be used to develop and maintain this dialogue. As a recommendation to future projects, and as a follow-up to the user workshops organised during G-MOSAIC, technical workshops and training sessions should be organised in order to elicit feedback from users and encourage open discussions. Such User engagement activities will assist in identifying areas of improvement in the products and services, thus preparing for the operational implementation of GMES services for Security applications in 2014.
 - **Synergies between GMES services in the Emergency and Security domains.** The need for the exploitation of synergies between the recently operational Emergency Management Service (EMS) and the community of Security users was identified during the early stages of the G-MOSAIC project. A protocol for synergetic work between the two services was designed and implemented. Synergies with parallel and past GMES projects and initiatives should be ensured in order to optimise resources, capitalise on past experience and ensure that proper continuity in the relationship with the user community is sustained.
 - **An external validation service:** Within G-MOSAIC, validation was performed internally on a best-effort basis by consortium partners. As a recommendation to ongoing and follow-up Security-related projects, a system of independent validation should be set up, with a specific budget, to provide production support as well as quality control. Ideally the validation should be undertaken by an external agent and integrated into the production

chain. In order for such an external validation system to have a genuine impact on the quality of the products, validation should be carried out before the delivery of the product to the user. There is a risk, however, that such an arrangement may delay the final delivery of products – especially in the case of rapid mapping activities.

- **Governance.** One of the main concerns emerging as an outcome of the *G-MOSAIC* project is the lack of a governance model for GMES Security-related services. The need to design and implement a sustainable governance structure has been expressed both in recommendations from the user community and by several key actors involved in setting up operational services for GMES services for Security applications. The ongoing *BRIDGES* project, coordinated by the SatCen (see p. 18), will contribute to this process by proposing potential governance models, implementation options, stakeholder positions and cost-benefit analyses. *BRIDGES* should build on the preliminary assessment work carried out within *G-MOSAIC*.
- **Harmonisation of the user-related activities** between FP7² projects in the framework of Support to External Action should be ensured, in order to provide the user community with a general and complete view of the GMES capabilities in Support to External Action and to ensure a coordinated approach to user engagement. This may, for example, lead to shared events (workshops and co-located meetings) and communication and dissemination strategies.

- **Integrated and centralised imagery analysis.** The development of an integrated and centralised architecture for imagery analysis is a recommendation from *G-MOSAIC*. The service architecture should allow secure access for retrieving, viewing and analysing all available (spatial and non-spatial) information for a given site. The information provided should include including satellite imagery, Geographic Information System (GIS) information, external databases and collateral information. Symbology and map legends should be customisable by the service providers. A centralised model will maximise the return on the costs and resources committed in respect of fully operational activities and improve usability, both for users and for service providers.

The way ahead

Progress in the areas of governance and data security policy is a key factor for the successful transition from pre-operational to operational services. It will be necessary, in particular, to set up mechanisms for the operational and technical coordination of both user requests and service delivery. Such mechanisms should build on the experience gained through the initial operations of the Emergency Management Service, whilst further developing the synergetic interactions between the Emergency and Security service areas.

For the Initial Operations of services for Security applications, emphasis should be placed on the most mature pilot services with the largest user base, within the scope of the policies addressed by the Security dimension of GMES. Such services will have to be developed in coordination with the respective Security working groups.

² Seventh Framework Programme for Research and Technological Development of the European Union.

“Stakeholders have benefited from the coordinated approach to the provision of Security and Emergency-related services.”

The G-MOSAIC consortium considers that research and development is a key factor for the development of future services in those service areas that are less mature. Enhancing and maintaining continuous user involvement during the transition from pre-operational services into operations is necessary, in order to sustain user confidence and garner support for future operational funding in this area. G-MOSAIC users have expressed concern about the continuity of the services, and it is therefore of paramount importance that user engagement and consultation activities are sustained. The consortium recognises that GMES implements a phased approach, bringing progressively pre-operational services to operational status. This phased approach

is reflected in the recent calls for proposals, through which services should be prepared for operations at the end of 2014.

Users of both G-MOSAIC and SAFER, including the Monitoring and Information Centre (MIC) of the Directorate General for Humanitarian Aid and Civil Protection (DG ECHO), the United Nations, Member States' Civil Protection Agencies, and other stakeholders have benefited from a coordinated approach to the provision of Security and Emergency services. The G-MOSAIC consortium therefore believes that synergies that arose between the SAFER and G-MOSAIC projects should be further developed in the context of follow-on projects as well as in the Initial Operations of GMES.

G-MOSAIC partners look forward to capitalising on the experience gained through the project, and will participate in future projects aimed at further developing the Security dimension of GMES, taking into account the lessons learned and the challenges to be overcome.



Sergio PROIETTI has a Degree in Electronic Engineering from the Università degli Studi di Roma “La Sapienza”. He has more than 10 years of experience of managing proposals and projects in the Security domain, including *LIMES* (FP6, ended in May 2010), *G-MOSAIC* (FP7, ended in March 2012), *EMSA CleanSeaNet*, *DOLPHIN* (FP7, started in 2011), *G-Next* (FP7, under negotiation). He is the Head of Programme

Management within the Emergency department of e-GEOS.



Annalaura DI FEDERICO has a Master's Degree in Environmental Engineering from the Università degli Studi di Roma “La Sapienza”, which was obtained in December 2000.

She has more than three years of experience in the provision of highly time-critical geo-spatial services, and has been involved in the active management of complex disasters on behalf of e-GEOS (e.g. Haiti earthquake, 2010). She has been involved in several GMES projects, both GMES Service Elements (GSE) and FP7 projects (*Risk EOS*, *Respond*, *WIN*, *LIMES*, *G-MOSAIC*), in different capacities, from image processing up to project management. Mrs. Di Federico is the Project Manager of the Rush Mode Mapping component of the GMES Emergency Management Service (EMS), part of the GMES Initial Operations (GIO).

The GMES response to the Libyan uprising

by Pablo Vega Ezquieta with Denis Bruckert, Alessandra Ussorio and Gracia Joyanes

ON FEBRUARY 22nd, 2011 THE *RAPID GEO-SPATIAL REPORTING SERVICE* OF THE *G-MOSAIC* PROJECT RECEIVED AN ACTIVATION REQUEST. THE ITALIAN MINISTRY OF DEFENCE REQUESTED GEO-SPATIAL INFORMATION IN RELATION TO THE ONGOING CRISIS IN LIBYA. THIS WAS THE TRIGGERING MOMENT OF A VERY CHALLENGING ACTIVATION INVOLVING SEVERAL USERS WITH DIFFERENT REQUIREMENTS, AND REQUIRING COORDINATION AMONGST SEVERAL GMES INITIATIVES. THESE INCLUDED THE SAFER GMES EMERGENCY RESPONSE PROJECT, WHICH RECEIVED REQUESTS FROM ITS OWN USERS WHILE THIS CRISIS DEVELOPED.

Multiple users: needs and product design

In the weeks leading up to the activation, the escalating violence in Libya was growing out of control, and many potential users were in urgent need of rapid reports about the situation in the area. In fact, after the initial call of February 22nd, 2011, other users also requested the activation of the *Rapid Geo-spatial Reporting* (RGR) service. By February 24th, the Cartographic Section of the UN Department of Field Support (UN-DFS), the European External Action Service (EEAS), and the Monitoring and Information Centre of DG-Humanitarian Aid and Civil Protection (DG-ECHO MIC) had joined the activation as requesting users. The duration of the activation was longer than average, as users came up with new requests in the frame of the evolving crisis. The WFP (World Food Programme) launched a request on March 2nd for geo-spatial information to organise a logistical operation in order to bring food supplies into the area.

THE RAPID GEO-SPATIAL REPORTING SERVICE OF G-MOSAIC



The SatCen (European Union Satellite Centre) coordinated the RGR (*Rapid Geo-spatial Reporting*) service of G-MOSAIC, with the participation of several partners (e-GEOS, the Centre for Geoinformatics of Salzburg's Paris-Lodron University, Indra, Astrium GEO-Information Services and GMV). This service aimed at providing users with relevant information in the context of a crisis. This rapid mapping service was active throughout the project. In 2011 a peak of activity was reached in response to the civil unrests in Northern Africa (the early phase of what came to be termed the "Arab Spring"), with activations occurring for both Libya and Egypt.

Success Stories

The RGR service of G-MOSAIC then faced a situation not unusual for a rapid mapping service, but uncommon to standard geo-spatial operating environments: namely, the need for production to commence before precise user requirements had been finalised. Instead, the production workflow had to evolve as draft requirements became more and more specific.

This means that production had to be designed in a way that is flexible enough to adapt to changing requests throughout the activation. For the Libyan activation, the first user call arrived on February 22nd, 2011 and the last one on March 2nd. On the production side, the first satellite imagery arrived on February 23rd, and the final product was delivered to the user on March 11th.

The particular challenge of this activation was the large number of users requesting

products at different times, and the necessity to coordinate the many entities involved in order to avoid duplication. Security-related users requested situation reports, whilst those users oriented towards humanitarian aid focused on the need for population-related data and situation assessment. In summary, a situation which combined different user requirements, areas of interest, product types, delivery deadlines, and stakeholders led to a very complex and challenging activation.

“The particular challenge of this activation was the large number of users requesting products at different times, and the necessity to coordinate several involved entities in order to avoid duplication.”

	Date	User Request	Arrival of Imagery	Notification of Production
Start of Activation	22 February	Italian MoD		
	23 February	DG-ECHO MIC	12:12 Tripoli	
	24 February	UN -DFS	15:35 Benghazi, Tobruq	
	25 February			01:54 Overview of Tripoli
	26 February		18:18 Darnah	
	28 February			21:47 Tripoli Evacuation Plan, Detail Maps and Harbour Analysis
	1 March			19:58 Tripoli International Airport
	2 March	WFP		22:47 Benghazi Airport, Harbour, Evacuation Plan and Detail Maps
	3 March		15:00 Ra's Ajdir 21:59 Benghazi Airport 23:03 Ra's Ajdir Border Crossing Point	
	4 March			
End of Activation	5 March			00:40 Benghazi Airport Update 02:05 Ra's Ajdir Border Crossing Point Update
	11 March			21:05 Tubruq and Darnah

Activation Timetable

The production system of the RGR service is designed to be flexible and responsive to changing needs. As soon as the first call arrived, the first steps on product design were taken, anticipating the arrival of new requests, both thematic (new issues of interest) and spatial (new locations). The production was subdivided into the following steps:

- **Satellite Imagery Pre-processing**, to ensure the accuracy of the geographic information;
- **Basic Information Extraction**, to provide the user with reference information, indicating transportation infrastructure, points of interest in the area (hospitals and airports), etc.;
- **Specific Analysis**, to support the decision-making of the user, providing information such as the number of people gathered in a particular location;
- **Change Detection**, to analyse the evolution of the situation using imagery from different moments over the same area.

The main input data for a service such as RGR is satellite imagery. In order to supply the production line with this resource, the GMES programme has set up a system of satellite imagery provision managed by the European Space Agency (ESA). This is funded by the European Union's 7th Framework Programme and is known as GSC-DA (GMES Space Component Data Access). This system allows a multimission approach, centralising requests for different kinds of imagery.

Satellite imagery acquisition is impacted by weather conditions and orbital factors affecting the availability of acquisition, and this has to be taken into account when designing the production workflow.



The RGR Service of G-MOSAIC received several requests on multiple locations over the area, from the border crossing point of Ra's Ajdir to the city of Tubruq in the West, including the main cities of Benghazi and Tripoli (Credits: ESRI).

Production: a flexible approach to an evolving challenge

The pre-operational RGR service was considerably challenged and tested during the time of the activation over Libya, responding operationally to this complex crisis. The effort required to accommodate multiple user requests in due time was unprecedented. The essence of the approach of RGR was not altered for this occasion.

A central coordination point (SatCen) was in charge of analysing the tasks as they arrived; dividing them into subtasks that were then assigned to the different consortium partners contributing to the service. In this manner, the range of expertise of the partners was used to its best, improving the quality and speed of production, by assigning subtasks to the most appropriate partner.

Before delivery to the user, the coordination point (SatCen) integrated the data and performed the necessary control of the product's final quality, and its validity in relation to the user's needs. The interactions with users were not limited to the moment of triggering. Users were encouraged to maintain continuous communication, ensuring that the products were well adapted to their needs throughout the crisis. In addition to the new requests (in the form of new locations and themes of interest), updates



Ra's Ajdir Border Crossing Point map, analysis of the situation of the displaced population in the area (Credits: SatCen).

of the emerging situation were also required.

This was a consequence of the characteristic of the Libyan activation as a living and evolving crisis.

As the situation on the ground changed, the validity of the products initially delivered began to expire. The RGR service reacted by acquiring new satellite

imagery and producing updates of the products to reflect the new situation. A specific example of the evolving situation is the detailed analysis of the airport of Benghazi.

“As the situation on the ground changed [...] the RGR service reacted by [...] producing updates of the products to reflect the new situation.”



Analysis of the new image of March 3rd over the airport of Benghazi, overlaying the previous analysis performed and delivered on March 2nd (Credits: SatCen).

Starting with a product delivered in rapid response mode on March 2nd, changes to the situation in the field triggered a new request for updated information. This update was produced and delivered by the evening of March 4th.

Combining the expertise of the consortium partners participating in the RGR service, with the specific expertise of the SatCen in the field of Security,

specific customised products were delivered to the users.

Besides the basic reference geo-spatial information (including layers such as roads, or built up areas), the RGR service is designed to make an extra effort in the provision of detailed quality analysis. In this context, users received information such as evacuation support products (for Tripoli, Benghazi, Darnah and Tubruq). These products include, for example, information about the optimal evacuation routes in the area, or the areas potentially suitable for helicopter landings.

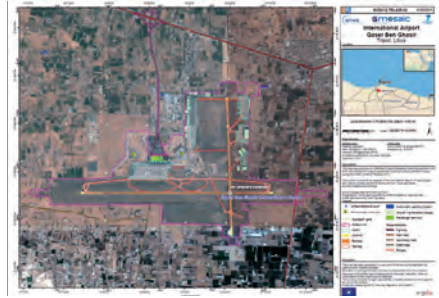
Other products received by the users were critical infrastructure analysis, in which the configuration and status of infrastructures such as airports and harbours was reported.



Example of a specific analysis over a border control point. An estimate of the number of displaced people is provided (Credits: SatCen).



Critical infrastructure analysis performed over the port of Benghazi using Geoeye-1 imagery of June 17th, 2009 (Credits: SatCen).



Detailed analysis of Tripoli International Airport Qaser Ben Ghasir (Credits: SatCen).

Furthermore, responding to the specific situation, products such as the analysis of displaced population at the border crossing points were designed and produced following specific user requirements.

Finally, the fact that the RGR service is available 24 hours a day, 7 days a week brought another advantage to the fore. The service aims for world-wide coverage, and is not affected by the time zone in which the user is located. Regardless of the time or the location, the RGR service is available and operational, ready to provide the user with the “rush mode” products necessary to support decision-making during a crisis.

In order to maintain this flexibility and continuous support, the RGR service set a 24/7 availability system. This way, user requests could be processed at any time, and products rapidly delivered to the user at any time of the day. Besides that, continuous production ensured the fastest possible delivery to the user.

Synergies: SatCen, G-MOSAIC and SAFER

So far, what has been discussed is the complexity arising from the multiplicity of users participating in the activation (multiple requirements arriving at different moments, the inclusion of these

requirements into the production workflow, and the integration of products). This activation also added another degree of complexity. If on the user side, many concurrent needs were expressed, the situation was similar on the production side. Service providers specialised in both Emergency Management and Security-related services worked together to provide a unique and coordinated response.

A common issue in the case of large-scale events is the risk of duplication. In cases of crisis, users rely on their known sources of information and reporting. For this reason, users coming from different frameworks request different services working under different conditions (GMES R&D projects, Operational

Intelligence Institutions, Open Source based solutions, etc.). The SatCen, thanks to its institutional position and its deep involvement in GMES, coordinated the production efforts of the RGR service and the synergies between the SAFER project (GMES Services and Applications for Emergency Response) and G-MOSAIC since the beginning of the Libyan activation in order to avoid duplications and provide users with the most complete and integrated set of products in the fastest possible way.

Service evolution: the application of lessons learned

Looking back over G-MOSAIC, the response to the crisis in Libya can be compared to the case of the earthquake in Haiti. From the point of view of information requirements, the Arab Spring was to 2011 what the Haitian Earthquake was to 2010. Even if the two cases differ in their thematic content, and in the fact that the Libyan crisis was characterised by its evolving nature, there are nonetheless many commonalities between them.

“GMES Support to the monitoring of the Libyan crisis represented a unique effort to provide a coordinated (Emergency-Security) response to an evolving and complex situation.”

The activation over the Haitian Earthquake (January 2010) highlighted the necessity to establish a mechanism for synergies between Emergency- and Security-related responses. This mechanism was implemented in order to avoid the duplication of efforts, and to take advantage of the parallel efforts of the Security and Emergency communities, in cases where complex crises call for

THE EUROPEAN UNION SATELLITE CENTRE



The mission of the European Union Satellite Centre (SatCen) is to support the decision-making of the European Union by providing analysis of satellite imagery and collateral data.

The SatCen is an Agency of the European Union. It is one of the key institutions for the European Union's Security and Defence policy, and the only one in the field of Space.

The SatCen participates in the GMES programme under several roles. In G-MOSAIC the participation consisted mainly in the coordination of the RGR service: interfacing with users, designing the products, controlling the quality of the final product before delivery and managing the collaborative efforts of industrial partners.

the intervention of users from both communities.

GMES support to the monitoring of the Libyan crisis represented a unique effort to provide a coordinated response to an evolving and complex Emergency situation. Given the manifest complexity of this crisis, efforts to ensure synergy were put into motion from the outset. In this manner, the synergy mechanism acted as a framework to channel the efforts of both the *SAFER* and *G-MOSAIC* projects towards a more efficient and user-oriented result.

Conclusions and lessons learned

The Libyan crisis triggered the response of a pre-operational GMES rapid mapping service. As such, it is important to highlight the potential of such services. The rapid mapping service of *G-MOSAIC* – the *RGR* – was able to deliver geo-spatial solutions in a timely fashion, responding accurately to an operational need.

This response was conducted in the context of a complex crisis, involving other GMES projects and with *SatCen* coordinating an operational task responding to a multiple set of users.

This successful activation nonetheless

leaves open questions for the refinement of the service towards its operational status, which is foreseen in 2014.

Considering the level of maturity which pre-operational services have reached – and in technical terms, *RGR* has demonstrated its ability to respond with high quality products delivered in times of crisis – another question remains to be addressed.

“Regardless of the time or the location, the *RGR* service is available and operating, ready to provide the user with the “rush mode” products necessary to support decision-making during a crisis.”

The fully operational implementation of such a service in the future will need to address governance aspects. The need for clear governance was one of the major lessons learned in the experiences of Rapid Geo-spatial Reporting under *G-MOSAIC*. The *BRIDGES* project, which started in January 2012, is a Coordination and Support Action led by the *SatCen*, which will support the identification of models of governance for the Security Dimension of GMES.



Pablo VEGA EZQUIETA holds a Master’s (Laurea) in GIS from Universidad Pontificia de Salamanca (2005). He has 7 years of experience in Geo-spatial Information, working in a number of different roles, such as participating in large projects (e.g. Darfur Mapping Projects) at the United Nations (2007-2009). Since his appointment at the GMES Unit of the European Union Satellite Centre in 2009, he has coordinated the operational production of geo-spatial information for all the activities related to GMES. In particular, his main area of expertise is implementing the production of such information in crisis situations, providing Rapid Mapping services.

Monitoring natural resources in conflict areas: the case of the Democratic Republic of the Congo

by Elisabeth Schoepfer, Kristin Sproehnle, Xavier Blaes and Thomas Kemper

SOME COUNTRIES IN THE WORLD ARE RICH IN NATURAL RESOURCES BUT POORLY DEVELOPED AND POLITICALLY UNSTABLE. THE MINERAL WEALTH OF THE DEMOCRATIC REPUBLIC OF THE CONGO (DRC) HAS PLAYED A PIVOTAL ROLE IN THE DEVELOPMENT OF THE CONFLICT. SEVERAL STUDIES HAVE REVEALED THAT THE DRC'S ABUNDANT NATURAL RESOURCES – INCLUDING TIMBER, DIAMONDS, COPPER, COBALT, GOLD, URANIUM AND COLTAN – ARE A DOMINANT FACTOR IN FUELLING THE CONFLICT. THE OVERALL SCOPE OF THE G-MOSAIC SERVICES PRESENTED IN THIS ARTICLE WAS TO PROVIDE INFORMATION SUPPORT FOR THE SURVEILLANCE AND SITUATIONAL AWARENESS IN THE FIELD OF "NATURAL RESOURCES AND CONFLICT PREVENTION".

Environment and natural resources can play a role in the onset, duration, and termination of conflicts. A typical example is the DRC, where the ongoing armed conflict is fuelled by the militarisation of the mining sector. Uncontrolled, extensive or illicit exploitation of natural resources is accompanied by highly unsustainable practices leading to large-scale environmental destruction (e.g. using mercury or cyanide for gold extraction) and livelihood insecurities. Conflicts are not caused purely by environmental factors; these can, however, play a key role in their dynamics. This role is complex, and has a greater impact when combined with other socio-economic factors. Generally speaking, it is the lack of vital goods (such as food) or the availability of valuable resources (such as diamonds, gold, etc.) coupled with poor economic conditions and weak government (State governance,

influence of neighbouring countries, etc.) that can lead to (violent) conflict.

"Conflicts are not caused purely by environmental factors, but these can play a key role in conflict dynamics."

In this respect, the three pilot services *Exploitation of Natural Resources, Illegal Mining and Illegal Timber Logging*, developed within G-MOSAIC (GMES services for Management of Operations, Situational Awareness and Intelligence for regional Crises), have provided geo-spatial information on conflict related to environmental and socio-economic factors in the regions of interest. The different services have operated at two spatial levels:

- 1) Sub-national (province, district or territory): provision of conflict-related information for countries at risk of armed conflict (or with ongoing

The DRC has been at the centre of a long-lasting conflict which also involves its neighbouring countries. A UN-supported peace agreement in 2002 and the formation of a transitional government in 2003 aimed at stabilising the country. Despite the signing of peace accords in 2003, fighting continues in the East of the country, and the DRC continues to appear on top of the Failed States Index ranking (The Failed States Index is published by Foreign Policy magazine, and is available at <http://www.foreignpolicy.com/failedstates>).

Drivers of the Congo conflict are poverty, weak state authority, the illegal exploitation of natural resources, the availability of weapons, and the manipulation of local communities along ethnic and identity lines in a bid for political power. Several studies have revealed that the DRC's wealth in natural resources – including timber, diamonds, copper, cobalt, gold, uranium and coltan – is one of the main factors fuelling the conflict.



This overview map shows the areas of interest for the services; orange/yellow squares were selected for high or very high resolution analysis for the Illegal Mining service; light green squares refer to the Illegal Timber Logging service. The service for the monitoring of the exploitation of natural resources was focused on the provinces of North and South Kivu (indicated by the red boundaries) (Credits: DLR).

Success Stories

conflict) by mapping environmental factors (in the form of land cover changes) from Earth Observation (EO) data, and through situational monitoring using information about conflict-related events, population, socio-economic data and other relevant datasets.

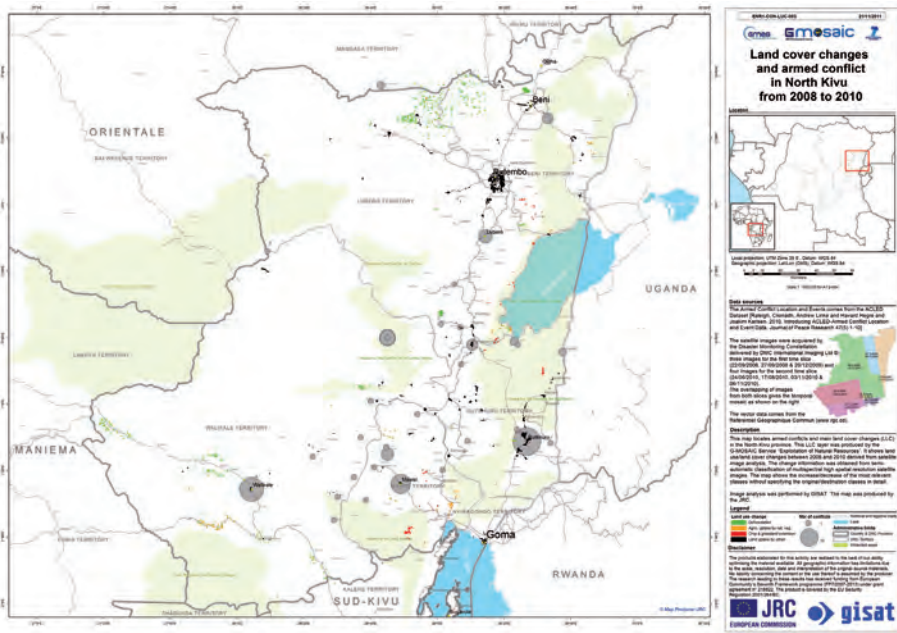
- 2) Local: monitoring of selected environmental resources such as mineral extraction and timber logging.

Service development and product presentation

The aim of the *Exploitation of Natural Resources (ENR)* pilot service was to provide conflict-related information for countries which are either experiencing armed conflict, or are at risk of

such conflict. Information on natural resources and conflicts in these countries was provided in the form of reports and maps at sub-national level. The information was derived 1) from multi-temporal analysis of EO data aimed at identifying possible 'hot spots' for crisis within a country, and 2) through situational monitoring using information about conflict events, population, and socio-economic data (where available) and other relevant datasets.

The ENR service analysed the total surface of primary land resources (fresh water, agriculture, forest, mining areas), and their changes over time, in the context of the conflict situation. The generation of products for the DRC over



This map indicates the intensity of armed conflicts and the main land cover changes (LCC) in the North Kivu province, from 2008 to 2010. The main LCC are deforestation (in green), agriculture area uptake by natural vegetation (orange), cropland and grassland extension (red) and urbanisation (black). Scale 1:600.000 (Credits: JRC, Gsat).

a multi-annual series provided geo-spatial information about changes in land cover and/or land use which indicate the depletion of natural resources in conflict areas, and how this phenomenon may be related to actual conflicts.

The service provided refined geographical and thematic information related to conflicts and offered products which can be used in domains other than Security. Areas such as Kivu and the DRC suffer from a lack of geo-information. Even basic situational maps are useful for local institutions working in fields not related to crisis management. A land use/land cover map (LULC) of North and South Kivu provinces was produced and delivered to local institutions, who also contributed to the validation of the product. However, due to Security issues and accessibility limitations (remote areas without infrastructure), a dedicated protocol was designed for validation purposes. It relies on the knowledge of field operators that are not especially trained in cartography. A paper-based validation form was used to capture the local knowledge of five NGOs (Non-Governmental Organisations) actively working in North and South Kivu. Indeed, due to the lack of infrastructure (no IT resources, and limited funds), hard copies (rather than digital versions) of the LULC map, showing the sample of validation points, were preferred by local stakeholders.

“Vast territories have to be observed within a narrow time frame, as exploitation activities can easily be shifted from one area to another.”

Following the two-level spatial approach (sub-national and local), two further

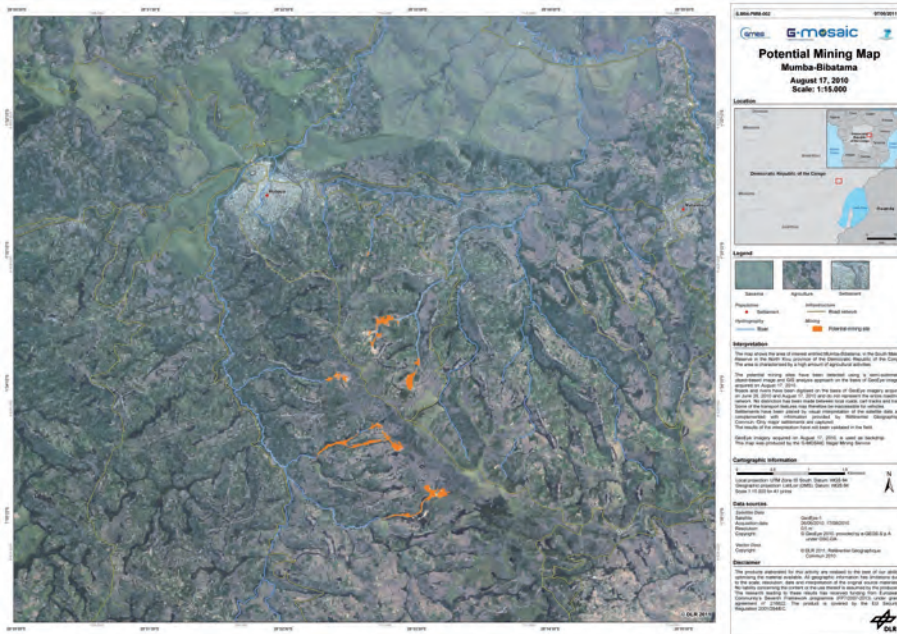


Map validation exercise with a local NGO, organised in Goma city, DRC, in October 2011 (Credits: Clementine Burnley).

services have been developed within G-MOSAIC to monitor exploitation of environmental resources: minerals and timber. The lack of precise geographic information on a local scale is a critical limitation in the design of appropriate provisions for the prevention of, and response to ongoing crises related to the exploitation of natural resources. Vast territories have to be observed within a narrow time frame, as exploitation activities can easily be shifted from one area to another. These areas are usually difficult to access because they are widely dispersed, too remote or too insecure. Conflict situations often prevent research teams from travelling freely: remote sensing offers the potential for complementing more traditional means of monitoring (such as field surveys).

The products of the *Illegal Mining service* focused on the identification of mining areas, but also included additional geofeatures that are important within the overall context – such as road networks, settlements and rivers. The method used for extracting mining sites combines object-based image and Geographic Information System (GIS) analysis using very high resolution

Success Stories



Potential Mining Sites Map of Mumba-Bibatama (DRC), depicting those areas (orange coloured) that could potentially be mining sites; background image: GeoEye-1; scale 1:15,000 (Credits: DLR).

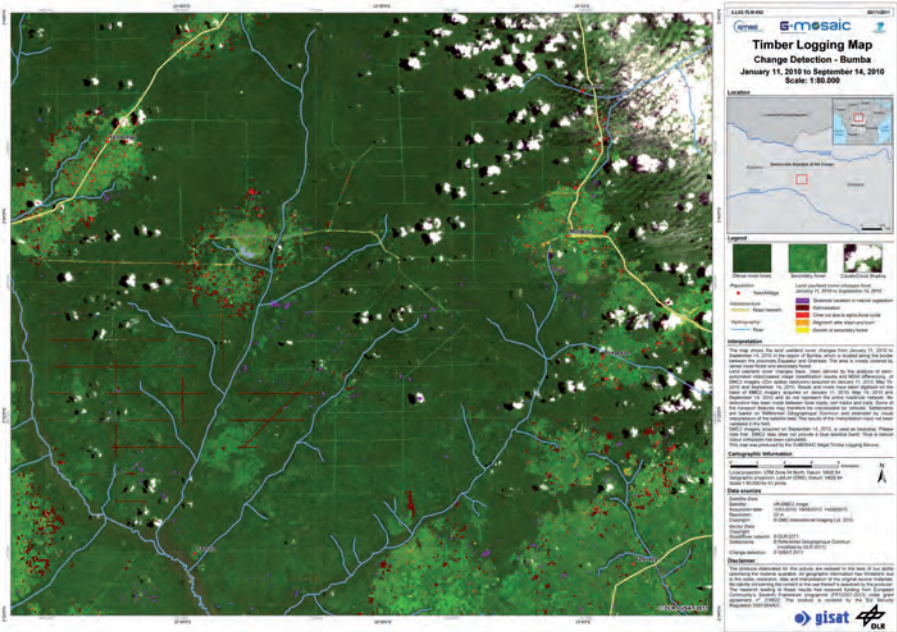
optical data. The advantage of this approach is the integration of expert knowledge within the information extraction cycle, and the transferability of the algorithm to other areas of interest. In this way, the monitoring of specific sites over longer time periods can be performed, and information about the evolution of a mining area can be provided to users. The user receives a map product and an information dossier providing a comprehensive overview about of the situation, which can be integrated into policy recommendations.

In addition, the exploitation of timber was a subject of research within G-MOSAIC. In the 1990s, the main cause of deforestation was industrial activity, including the extractive industries, large-scale cattle ranching, and

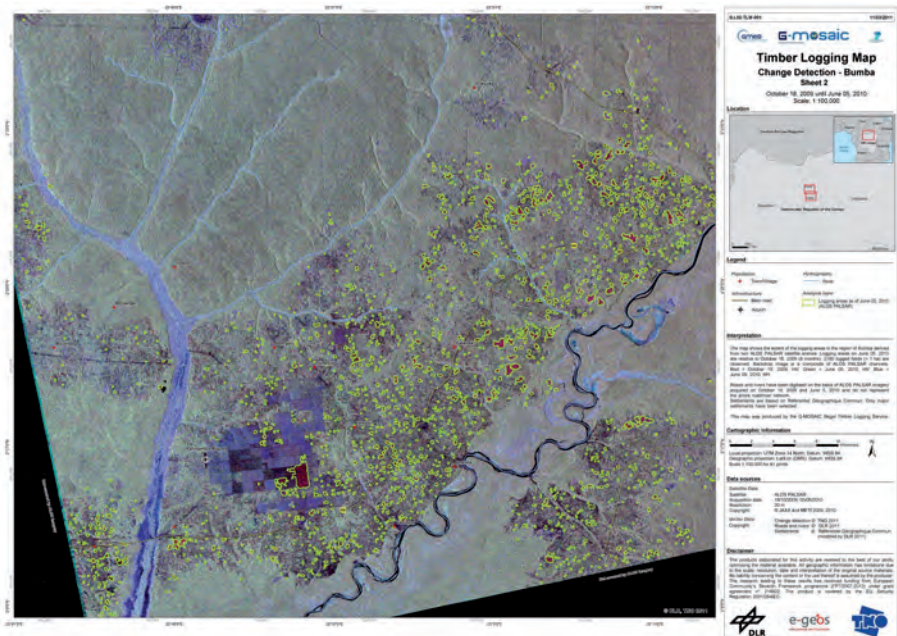
extensive agriculture. Illegal logging is a major driver of deforestation, and the cause of severe social, economic and environmental damage. From 1990 to 2005, forest cover in the DRC decreased by nearly 3%. The United Nations estimates that at the present rate of exploitation, more than two thirds of the Congo Basin forest could be lost by 2040.

“Illegal logging is a major driver of deforestation, and the cause of severe social, economic and environmental damage.”

The *Illegal Timber Logging* pilot service within G-MOSAIC has aimed at evaluating the nature and extent of logging in selected study areas in the DRC, in



Timber logging map of Bumba, DRC, with logged fields labelled according to the changes detected in optical images (background image: UK-DMC2), scale 1:80,000 (Credits: DLR, Gisat).



Timber logging map of Bumba, DRC, showing the extent of the logging areas detected in radar images (background image: ALOS PalsAR), scale 1:100,000 (Credits: DLR, e-GEOS, TNO).

OPTICAL AND RADAR SATELLITE DATA

The radiation of visual and near-infrared bands of optical satellite sensors is reflected by clouds so that features below them cannot be seen from Space. In addition, clouds not only hide the ground underneath, but also cast their shadows on the ground, increasing the area which cannot be analysed. Due to quasi-permanent cloud cover over the inter-tropical region, the use of optical data and its utility in mapping and monitoring activities is limited. A major advantage of radar is the capability of the radiation to penetrate through cloud cover and most weather conditions. Thus, approaches using both radar and optical images to extract information, and fusing them together, have been studied and applied in the G-MOSAIC project.

order to support intelligence and early warning. Similarly to the *Illegal Mining* service, three different product types have been developed, i.e. geographic reference maps, timber logging maps and information dossiers. The Timber Logging Maps are produced using both optical and radar satellite data. Since

optical radiation does not penetrate through clouds, a special emphasis was placed on the combination of optical and radar data (see box). Radar-based analysis provides information about logged areas in a region irrespective of cloud coverage, whereas detailed information about land cover changes is obtainable using optical satellite data. The latter information was derived by means of multispectral image land cover classification and differencing analysis. In this respect, the use of vegetation indices derived from satellite data (such as the Normalised Difference Vegetation Index, NDVI) proved to be useful in identifying vegetated and non-vegetated areas. Five types of transformation are described and mapped: seasonal variation in natural vegetation, deforestation, clearances due to the agricultural cycle, regrowth after "slash-and-burn", and the growth of secondary forests.

The products developed within the *Illegal Timber Logging* and *Illegal Mining* pilot services of G-MOSAIC, and the subsequent feedback from the users, have clearly demonstrated the usefulness and viability of GMES products supporting surveillance and situational awareness in the field of "Natural Resources and Conflict Prevention".



Elisabeth SCHOEPFER received a degree in Geography and Geoinformatics at the University of Salzburg in 2001 and her PhD in 2005. Since March 2009, she has been working with the German Remote Sensing Data Center (DFD) of the German Aerospace Center (DLR) as member of the research team on “Civil Crisis Information and GeoRisks” after several years of experience in remote sensing working at the Centre for Geoinformatics (University of Salzburg) and at the European Space Agency (ESA). Her main application field is Security issues (*GMOSS*, *LIMES*, *G-MOSAIC*) in which she has gained a significant scientific and technical expertise related to humanitarian crisis monitoring.



Kristin SPROEHNLE received a degree in Geography at the Otto-Friedrich University Bamberg in 2010. She wrote her academic thesis about the environmental impact in the surroundings of refugee camps in Darfur on the basis of SPOT-4, IKONOS and QuickBird data. In October 2010, she joined DLR-DFD and is currently involved in operational and method development activities at the Center for Satellite Based Crisis Information (ZKI). Her main research activity is in the area of IDP (Internally Displaced Persons) camp monitoring and natural resources in conflict.



Xavier BLAES received his PhD from the Catholic University of Louvain, Belgium. He joined the Environmetrics and Geomatics Research Laboratory, Catholic University of Louvain, in 1998. His research activities focused on operational crop discrimination and biophysical parameters retrieval using temporal evolution of optical images as well as interferometric and polarimetric SAR signals. From 2007 to 2010, he was in charge of the Geographical Information Systems for the United Nations Development Programme in the Democratic Republic of the Congo. He joined the Joint Research Centre of the European Commission in 2010, and has been involved in the *G-MOSAIC* project and Global Human Settlement Layer production from very high resolution satellite images.



Thomas KEMPER worked as a PhD grant holder at the European Commission’s Joint Research Centre (JRC) and obtained a PhD (2003) from the University of Trier for his work on mapping soil contaminants using reflectance spectroscopy. He continued to work for the JRC in the field of soil contamination and desertification. From 2004 to 2007 he worked for the German Aerospace Center (DLR), where he helped in setting up the Center for Satellite Based Crisis Information (ZKI) which provides rapid mapping information after natural disasters. Since 2007, he is a permanent staff member of the JRC’s Global Security and Crisis Management Unit, working on the analysis of settlements, in particular informal settlements such as slums and IDP/refugee dwellings.



Developing geo-spatial intelligence applications in GMES

by Federica Mastracci*

THIS ARTICLE IS BASED ON A PAPER PRESENTED BY MEMBERS OF THE G-MOSAIC CONSORTIUM TO THE "LET'S EMBRACE SPACE" CONFERENCE HELD IN BUDAPEST IN MAY 2011. THE AUTHORS PROVIDE A DETAILED DISCUSSION OF THE AIMS, SCOPE AND SERVICE DEVELOPMENT WITHIN THE G-MOSAIC PROJECT, AS WELL AS HIGHLIGHTING THE POTENTIAL BENEFITS OF OPERATIONAL GMES SERVICES IN THE FIELD OF SUPPORT TO THE EUROPEAN UNION EXTERNAL ACTION.

The G-MOSAIC project, led by e-GEOS, focused on the development of pilot services relating to Security in the framework of the GMES programme, by applying innovative solutions based on geo-spatial intelligence applications.

During the three years that the project lasted, G-MOSAIC provided services to support intelligence and early warning activities (pre-crisis) and crisis management operations (during the different phases of a crisis, namely preparedness, intervention and post-crisis assessment). G-MOSAIC services have been designed and tailored to meet the needs of those institutions whose mandate is to take part in global peace-keeping and peace-making processes:

- European Union entities, such as the Council, the Directorates General and the agencies;
- Member States and national bodies, including Ministries of Foreign Affairs (and their respective crisis units), Ministries for Internal Affairs participating in Security-related activities in cooperation with European entities on the basis of the subsidiarity principle;

- Civil organisations, non-governmental organisations (NGOs), and United Nations agencies.

G-MOSAIC brought together a heterogeneous team with skills and expertise in a range of disciplines:

- Satellite-based information services
- Information services infrastructure
- Innovative research on Earth Observation (EO) products
- Economic models
- Service architecture models

Two user workshops have been organised within G-MOSAIC: in June 2010 at the Joint Research Centre in Ispra (Italy), and in June 2011 at the European Union Satellite Centre in Madrid. Attending users represented EU and non EU countries, EU entities, national authorities and NGOs.

Approximately forty user organisations were involved at different levels in the G-MOSAIC project, representing the entire range of stakeholders interested in the Security dimension of GMES:

- 4 EU entities
- 10 EU national ministries

* In collaboration with Maria Michela Corvino

- 3 Ministries of Defence
- 3 Ministries of Foreign Affairs
- 2 Ministries of Home Affairs
- 1 other Ministry
- 4 Armed Forces
- 10 international organisations
- 6 national civil organisations
- 3 cartographic centres

“Europe needs to improve its ability to detect and monitor trans-regional Security threats and to improve its response capacity to emerging regional crises outside the EU.”

Political context in Europe and priority areas for Security applications

The European Security Strategy (ESS) is a fundamental document for the European consensus on a long-term approach to international cooperation and crisis management.

The ESS recognises that *“preventive engagement can avoid problems for the future [...] with the new threats, the first line of defence will often be abroad”* and notes that *“none of the new threats is purely military; nor they can be tackled by purely military means”*.

The ESS recalls that Europe’s Security can be compromised, directly or indirectly, by global challenges such as disease, poverty, competition for natural resources and energy dependence, and highlights a number of key threats:

- Global terrorism;
- The proliferation of Weapons of Mass Destruction (WMD), in particular in combination with international terrorism;
- Regional conflicts, which themselves become a source of other threats, such as extremism, terrorism, State failure, organised crime and WMD proliferation;
- State failure, often due to bad

governance, which creates the conditions for other threats;

- Organised crime.

In the past three years, the Security dimension of GMES has made significant steps forward (for an overview, see page 8).

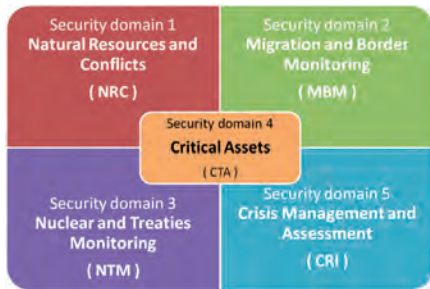
The following projects of GMES have demonstrated and evaluated the use of satellite capabilities to support the Security dimension:

- **LIMES**: This project aimed at prototyping innovative Security applications both in the land and maritime domains;
- **G-MOSAIC**: Focused on consolidating the user base and developing pre-operational service production capacity in the area of support to EU External Action;
- **MARISS**: Currently in a scaling-up phase, the project is focused on the maritime domain;
- **BRIDGES**: Having commenced in early 2012, the project will contribute to proposing future governance models for the “S” of GMES.

Security domains and service portfolio

The design of the G-MOSAIC project was based on a review of available technologies and service elements in order to build up a pre-operational service portfolio aimed at supporting a variety of thematic domains. The service portfolio was based on successful outcomes in the following activities: scenario definition, user needs collection, service operation and validation. The definition of scenarios led to the combination of specific technological applications (known as “building blocks”) into pilot services. The G-MOSAIC product portfolio was consolidated during the second phase of the project, following the initial activities of the first phase, which included

product validation and appraisal and the definition of observation modalities by the service providers, in cooperation with the users.



G-MOSAIC Security Domains.

The G-MOSAIC service portfolio is comprised of the following services:

- **Natural Resources and Conflicts**
 - o Exploitation of Natural Resources
 - o Population Pressure
 - o Land Degradation
 - o Illegal Mining
 - o Illegal Timber Logging
 - o Illicit Crops
- **Migration and Border Monitoring**
 - o Border Area Monitoring
 - o Monitoring Migration Routes and Settlements
- **Nuclear and Treaties Monitoring**
 - o Monitoring of Nuclear Decommissioning Sites
 - o Continuous Surveillance of Nuclear Facilities
- **Critical Assets**
 - o Critical Assets Monitoring
 - o Critical Assets Event Assessment
- **Crisis Management and Assessment**
 - o Contingency Plan Preparation
 - o Rapid Geo-spatial Reporting
 - o Damage Assessment for Post Conflict Situations
 - o Support Reconstruction Missions After Conflicts

Reference cartography (baseline maps) applicable to all the service domains

was created, and this served as the basis onto which thematic layers were overlaid and to which change detection methodologies were applied. Different levels of detail were made available based on the final scope of the services (taking into account multiple parameters, such as legend, accuracy and scale).

G-MOSAIC services were based on change detection techniques, specifically aimed at producing the following service types:

- **Periodic updates of cartography:** applicable to services focusing on the seasonal observation of phenomena (for example, in the case of agricultural targets) or analysis of historical data (e.g. population distribution).
- **On-demand surveillance:** applicable to services triggered by users on demand, which can be further sub-divided into:
 - o **Off-line mapping:** One-off observations for which the information delivery is not subject to tight temporal constraints;
 - o **Monitoring:** Recurring observations, for which the time window, update frequency, and timeliness of service delivery are pre-defined;
 - o **Rush mapping:** One-off observations, for which the products are delivered with tight temporal constraints in relation to the time of activation (ranging from 12 to 48 hours). The service allows for a degree of flexibility regarding the customisation of products.

Data and geo-spatial information within the G-MOSAIC project have been distributed to users and to the consortium with different levels of security, according to a project-specific classification system based on the sensitivity of the information:

- **Public:** Available to the project and to the general public for subscription

and download. Information about the requesting user, the Area Of Interest (AOI) and the products is not restricted.

- **G-MOSAIC restricted - Level 1:** This level applies to datasets which are not included in the European Space Agency's (ESA) catalogue but which are also available to other projects for subscription. Such datasets may only be re-used in cases where other projects make a request for satellite data over the same area. Transparency is maintained with the project which originally requested it; ESA maintains records of this information. In such cases, either the products are adapted for wider dissemination, or their publication is delayed until the information is "declassified".
- **G-MOSAIC restricted - Level 2:** The dataset is not included in the ESA catalogue. Information about the area of interest can be disseminated, but the distribution of products is non-public and subject to restrictions specified by the user.

G-MOSAIC Security domains

The Security domains within G-MOSAIC were developed with the cooperation of users, who participated by providing requirements and contextual data, and by assessing and evaluating the services. The domains bring together different services within the context of specific geographic or thematic boundaries. A short description of the G-MOSAIC Security domains follows, with some examples of the kinds of products delivered.

Natural Resources and Conflicts

This domain is focused on exploring the concept of early warning crisis indicators of regional conflicts. The exploitation of natural resources (such as timber and minerals), increases in population and the degradation of land are amongst the phenomena which have been

examined in relation to occurrences of regional conflict. The core information used in this service is land use and land cover change, which is combined with socio-economic data and local conflict information. The services also address the identification and characterisation of potential illegal activities (illicit crop plantations, timber logging and mining), in relation to their role in the development of conflict.

The following figure shows one of the Land Cover Change maps delivered within the "Exploitation of Natural Resources" service.

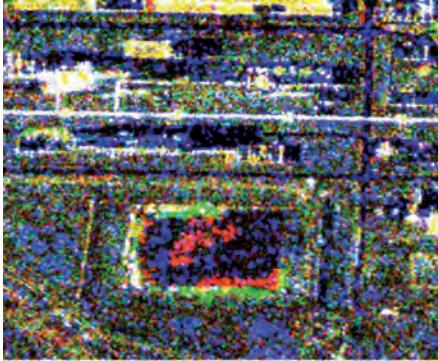


Virunga National Park, DR Congo (Credits: JRC, GIsat).

Migration and Border Monitoring

The activities performed in the Migration and Border Monitoring domain are in alignment with the provisions of the European Security Strategy (ESS).

The products offered within this domain are aimed at improving existing monitoring and surveillance services and support situational awareness in border areas and along routes subject to migration and temporary settlements or urban extensions. They provide intelligence and decision support to stakeholders involved in border control and migration issues. Generally, interested stakeholders are public authorities, Civil Security and military actors. Although the services have potentially worldwide coverage, the



Change detection analysis on a nuclear plant obtained by combination of multi-temporal Synthetic Aperture Radar (SAR) images (Credits: Indra, e-GEOS).

focus within G-MOSAIC was on Eastern Europe, and Central and Northern Africa.

Nuclear and Non Proliferation Monitoring

This domain supports efforts to prevent and combat proliferation of Weapons of Mass Destruction (WMD), and to verify compliance with relevant treaties. There are two services in this domain:

- **Monitoring of Nuclear Decommissioning Sites**, in order to verify compliance with nuclear non-proliferation treaties;
- **Continuous Surveillance of Nuclear Facilities**, with the objective of verifying that nuclear material and facilities in selected sites are being used for civil purposes, and the assessment of whether the initial declaration of material and facilities was complete and correct.

Critical Assets

Critical assets comprise a wide range of man-made or natural structures, of which the disruption, destruction or alteration may cause problems for the Security of States and citizens.

Man-made critical assets include, for example, civil infrastructure, land or waterway transport routes or energy storage facilities. Natural critical assets refer to

geomorphological features which, under certain circumstances can become “critical”, and are therefore monitored on the premise that this may lead to natural and humanitarian chaos, loss of property or economic disruption.

Within G-MOSAIC's demonstration activities, a number of different geographical locations were examined. The aim was the monitoring of transport accessibility, water availability, energy supply, and other critical infrastructure. The services support two different timescales of intervention: long-term monitoring needs (Critical Assets Monitoring service) and short-term requirements for rapid response (Critical Assets Event Assessment).

Crisis Management

The services provided in this domain aim at providing geo-spatial intelligence in response to crisis. “Crisis” in this context refers to wars, civil conflicts or natural disasters leading to humanitarian emergencies. The services developed by G-MOSAIC in the context of crisis management and assessment address different phases of the crisis cycle:

- **Planning and preparedness**, responding to user needs related to a “pre-crisis” situation. The Contingency Plan Preparation service supports planning for civil evacuations and the preparation



Critical infrastructure analysis, Alexandria Harbour, Egypt (Credits: SatCen, GMV, e-GEOS).

of operational plans for strategic missions, through the provision of geo-spatial information (e.g. city maps);

- **Crisis response**, through the provision of information oriented towards rapid response. The service provides information on transportation networks, logistics, facilities (e.g. hospitals), critical assets and infrastructure (e.g. airports, ports), highlighting helicopter landing areas and areas appropriate for use as population gathering sites;
- **Post-conflict damage assessment and reconstruction**, in order to improve the rehabilitation process, notably through the provision of change detection products.

“Satellite-based geo-spatial information is an important tool to support European and Member State authorities involved in Security and stability processes and related activities, including field missions.”

Conclusions

The results of the *G-MOSAIC* project show that satellite-based geo-spatial information is an important tool to support European and Member States authorities involved in Security and stability processes and related activities, including field missions.

European needs in relation to services for Security applications are linked to policies addressing the role of Europe and its Member States in the global Security context, including the terms for participation in peacekeeping and peacemaking operations.

The *G-MOSAIC* project has consolidated a pre-operational service portfolio of services in support to EU External Action, identifying and matching user needs, and thus bridging research activities with the future operational phase. The project has significantly contributed to improve understanding of both the requirements of users and of technological capabilities needed to match these requirements, in terms of suitable service provision mechanisms and reliability and maturity of services.

Moving forward, the design and implementation of end-to-end services requires further development addressing operational issues, such as data procurement, governance, workflow and architecture design, operational management, legal and contractual issues and service agreements. These topics will be dealt with in the follow-up projects to *G-MOSAIC* (expected to start in early 2013) and in the *BRIDGES* project, which commenced in January 2012.



Federica MASTRACCI holds a Degree in Physics (Astrophysics and Space Physics), and a 1st Level Degree in Environmental Engineering. She has been with Telespazio, the leading Italian provider of satellite services, since 1996. She is currently head of the Geo-spatial Products and Services in e-GEOS, after being the head of Telespazio's GMES Programme Office and the head of Application Products in Earth Observation Business Line. Mrs Mastracci is the mother of three children.

New techniques for safer seas: what GMES brings to Maritime Surveillance

by Paola Nicolosi and Maria Angelucci

THE GMES PROGRAMME IS ADVANCING FROM RESEARCH AND DEVELOPMENT ACTIVITIES TOWARDS THE IMPLEMENTATION OF OPERATIONAL GEO-SPATIAL INFORMATION SERVICES BASED ON THE NEEDS OF WIDE-RANGING USER COMMUNITIES AT BOTH POLICY AND OPERATIONAL LEVELS. EUROPE IS CURRENTLY FACING A NUMBER OF CHALLENGES IN MARITIME SURVEILLANCE THAT REQUIRE FLEXIBLE AND RESPONSIVE INFORMATION SYSTEMS PROVIDING HIGH QUALITY DATA IN A TIMELY FASHION. IT HAS BEEN RECOGNISED THAT SPACE-BASED ASSETS CAN OFFER A UNIQUE AND COMPLEMENTARY DIMENSION TO EXISTING SYSTEMS. THE NEED FOR A PAN-EUROPEAN COLLABORATIVE FRAMEWORK FOR MARITIME SURVEILLANCE IS UNDERSCORED BY THE BROAD SCOPE OF EUROPEAN MARITIME POLICY AREAS, THE DIVERSE MARINE CONDITIONS THAT CAN BE FOUND IN EUROPEAN SEAS, AND THE LENGTH OF THE EUROPEAN UNION MARINE BORDER; IN FACT, THE MAJORITY OF EU MEMBER STATES POSSESSES SUCH COASTAL BORDERS. THIS ARTICLE DISCUSSES CURRENT GMES PROJECTS IN THE MARITIME SURVEILLANCE DOMAIN, WITH A PARTICULAR FOCUS ON *DOLPHIN* (DEVELOPMENT OF PRE-OPERATIONAL SERVICES FOR HIGHLY INNOVATIVE MARITIME SURVEILLANCE CAPABILITIES).

Maritime Surveillance domains and service portfolio

Satellite-based geo-information products (integrated with cooperative systems, which rely on signals received from ships) are used in the maritime domain for Security applications, as well as for environmental monitoring. The key products are ship detection and identification reports, oil spill identification and drifting, and wind and wave



Illegal immigration is a key application area of GMES services for Maritime Surveillance (Credits: Armed Forces of Malta).

status reports. Services to be developed within *DOLPHIN* will support the policy-related tasks of fisheries control, traffic surveillance, monitoring of maritime activities and sea pollution prevention. The operational use of satellite data in maritime applications allows sea waters to be monitored worldwide, irrespective of:

- whether the area is within the range of coastal surveillance systems;
- the behaviour of ships (cooperative or non-cooperative);
- the time of day and weather conditions (this is possible with the use of SAR¹ satellite sensors).

The use of Space-based data is a cost-effective way to monitor wide areas in a short time, allowing, for example, the detection of oil spill pollution incidents and the identification of non-cooperative ships.

¹ Synthetic Aperture Radar.

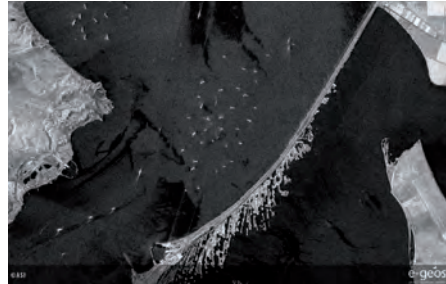
Maritime Surveillance services currently in operation, based on Earth Observation (EO) data integrated with ancillary information (such as vessel identification data and meteorological oceanographic data), respond to the following application requirements:

- to monitor ship routes and traffic, particularly outside the coverage of coastal systems;
- to monitor ports or specific coastal sites;
- to support authorities in case of pirate attacks;
- to complement and support aircraft and vessel patrols;
- to respond to oil pollution incidents at sea;
- to identify offenders;
- to monitor oil rigs and off-shore pipelines;
- to promptly respond to marine accidents.

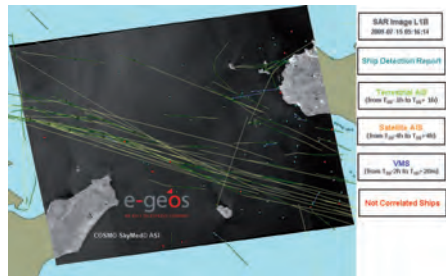
These services already provide active support to several user communities. Ongoing research and development efforts aim to improve the accuracy and performance of services and take advantage of new and emerging technologies.

Political context in Europe and priority areas for Maritime Surveillance applications

In recent years, the need for improved capabilities in Maritime Security has increased considerably. Illegal immigration by sea merely represents the most visible of the problems affecting the European Union's maritime borders. Attention must also be paid to several Security issues. From the point of view of safety, sustainable development of the maritime sectors in both coastal and insular developing countries requires promoting the sound management of



Ships and oil spill detection from COSMO-SkyMed satellite imagery (Stripmap HImage) – Kerch Strait (Credits: e-GEOS).



Non-cooperative vessels. The layer is an extraction from COSMO-SkyMed data – Sicily Channel (Credits: e-GEOS).

fisheries and other marine resources, the protection of sensitive marine habitats, and the management of coastal zones, as defined by the Green Paper on Maritime Policy². From a Security point of view, illegal immigration is only the tip of the iceberg of illegal trafficking activities, whilst the protection of coastal and offshore sensitive assets (from both human and natural threats) is acquiring increasing relevance and importance.

The current state-of-the-art of policy-driven initiatives and projects demonstrates that Europe is very active in the maritime sectors, both through developing operational capabilities and investigating their improvement. The enhancement of

² Towards a future Maritime Policy for the Union: a European vision for the oceans and seas. COM (2006) 275.

Maritime Security, the reduction of pollution and the fight against illegal activities in international waters have also been defined as priority objectives for Europe's Integrated Maritime Policy³.

These considerations led to the delineation of a group of policy areas:

1. **Border Surveillance** targets the issues related to the control and monitoring of European maritime borders, in order to reduce the number of illegal immigrants entering the EU undetected, reduce the death toll of illegal immigrants by rescuing more lives at sea, and increase the internal security of the EU by contributing to the prevention of cross-border crime.
2. **Traffic Safety** deals with the capacity to continuously monitor highly congested areas in order to prevent death, injuries and damages resulting both from ship collisions and environmental accidents.
3. **Fisheries Control**, for the sustainable development of fisheries, requires better marine governance in terms of the effective exercise of jurisdiction by coastal States over their waters, and a coordinated pan-European approach. Fishing management activities deal with: fisheries legislation, stock monitoring and the definition of limits, surveillance monitoring of vessel activities, enforcement operations and the prosecution, where necessary, of vessel owners and operators.
4. **Environmental Protection** refers to both the prevention of environmental disasters (in terms of accurate

monitoring of the possible sources of such events) and to the facilitation of improved responses to such accidents (through instantaneous event detection and classification) in order to support the definition of countermeasures.

5. **Search and Rescue** refers to the capacity to support Emergency missions especially on the high seas, where operations are costly and the coordination of rescue teams has to be carefully optimised.

A link has to be created between political requirements at an EU level, and the advanced technical and operational capabilities provided by EO and telecommunication satellites. Each of the listed policy areas has specific needs which can be fulfilled by EO-based services and products, over and above the cross-cutting requirement for timely and reliable information, for the enhancement of situational awareness, and for the improvement of reaction capabilities. These general user requirements – as well as those listed below for the specific policy areas – cannot be fulfilled by the current state-of-the-art of technologies and available Space-based assets. The list includes:

- the need to detect very small boats (indicatively less than 8 meters), such as those used for illegal immigration or drug smuggling;
- the capability, following ship detection, to backtrack the ship's route;
- the need to discriminate between small and large boats, especially in remote areas, in order to identify rendezvous points for smugglers;
- the enhancement of automatic ship classification, through the detection of the materials they are made of;
- the need to reduce revisit time in order to achieve near-continuous

³ See EU Regulation 1255/2011 establishing a Programme to support the further development of an Integrated Maritime Policy.

monitoring over small/medium size areas;

- the enhancement of accuracy in locating ships in order to validate data provided by declarative systems, such as the Automatic Identification System (AIS);
- the capability to detect and classify objects other than ships, such as fishing cages carried by fishing boats, 'threatening icebergs', submerged ships, and aircraft.

GMES projects developments to improve Maritime Surveillance

Through the operational implementation of EO tools, by using a wide range of satellite sensors as well as a series of support tools managing the integration with non-EO data, GMES projects will put in place services which offer a substantial improvement in target detection capabilities.

The combination (fusion) of multiple data streams will allow the prediction of vessel tracks with dynamic data and the verification of the reported vessel position. Sea state information will also be included.

The following technological improvements with respect to the state-of-the-art are anticipated:

- the improvement of ship detection and classification: new generation satellites, providing high resolution data, together with innovative techniques, allow the classification of ships not only on the basis of their dimensions, but also by estimation of their type and shape;
- the improvement of ship recognition, tracking and prediction: more reliable support will be provided by satellite-based services;
- the improvement of ship behaviour analysis, including the detection of suspicious behaviour;
- the operational integration of sea

state estimation and forecast data into pre-operational satellite-based ship detection services;

- the improvement in the detection of small ships, which is a requirement expressed by many users. This enhancement will also make users more confident with regards to the use of satellite imagery. Many users remain unaware of the potential benefits that new generation satellites offer in this respect.

The most significant limitation to the adoption of new technologies is the time required for their promotion and uptake, in order to reduce the risk perceived by users. This is especially true when service continuity is not ensured (as is the case for the stand-alone use of a single technology) and when new services or products require further development, whether in the organisation of service delivery or in the data processing methodologies. Close and continuous involvement of users is necessary in order to explore potential service provision architectures and generally, to maximise value for the entire chain of stakeholders from service providers onwards, including funding institutions.

The European Commission (EC) has placed particular focus on the cooperation between ongoing Space and Security activities and among the operational service chains that will be set up by the Maritime Surveillance project consortia. The following is a list of the key FP7⁴ projects addressing the Space and Security topics related to the Maritime Surveillance:

- *DOLPHIN - Development of Pre-operational Services for Highly Innovative Maritime Surveillance*

⁴ Seventh Framework Programme for Research and Technological Development of the European Union.

Capabilities, 30-month duration (June 2011 to November 2013), approximately 4M€ in EU funding.

- *SIMTISYS - Simulator for Moving Target Indicator System*, 30-month duration (June 2011 to November 2013), approximately 1,6M€ in EU funding.
- *NEREIDS - New Service Capabilities for Integrated and Advanced Maritime Surveillance*, 36-month duration (June 2011 to May 2013), approximately 4M€ in EU funding.
- *SeaBILLA - Sea Border Surveillance*, 45-month duration (June 2010 to February 2014), approximately 10M€ in EU funding.

The *MARISS* Service Network is also notable with respect to its role in validating the R&D activities carried out within the above-mentioned projects through its operational benchmarking tests. The *MARISS* project (standing for *Maritime Security Services*) is a GMES Service Element (GSE) funded by the European Space Agency (ESA). It is based on a common platform for the coordination of the individual service components (i.e. processing or analysis steps) and their combination into the most suitable service chain for each specific service request. The network connects geographically distributed and cooperating European service providers, operating under specific partnership protocols, and thus allows cost-effective delivery of a portfolio of services.

The *DOLPHIN* project: operational scenarios and cooperation with other GMES initiatives

Taking advantage of the results of previous and ongoing efforts in the GMES context, the *DOLPHIN* project is developing a set of key technological and operational innovations. This will lead

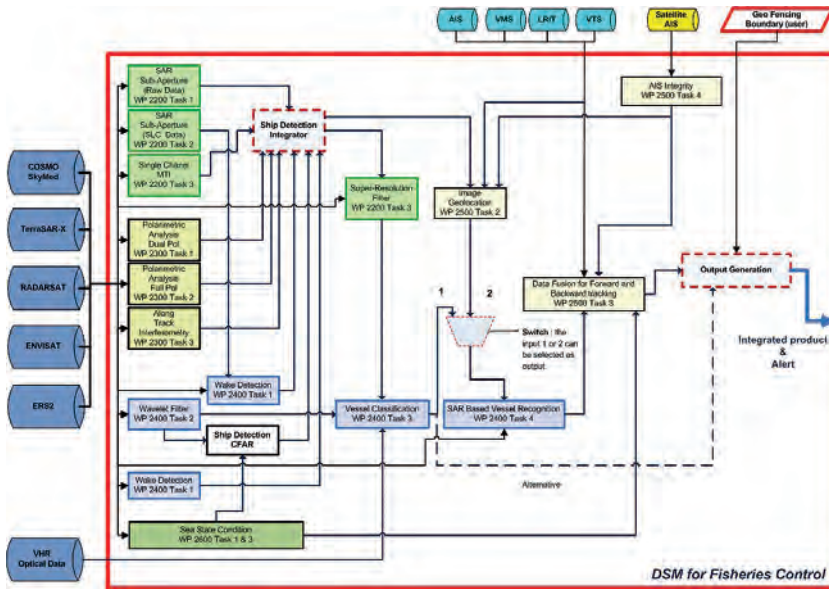
in the mid-term to full and sustainable operational exploitation of EO satellite capabilities in applications for maritime policies, both at the EU and Member States level. *DOLPHIN* aims at developing new tools which offer effective improvements over the current state-of-the-art capabilities in Maritime Surveillance. These tools will be organised into Decision Support Modules (DSMs), designed to be integrated into users' existing operational systems. *DOLPHIN* will respond to specific users needs within three policy areas which have been identified as requiring improvement: Border Surveillance, Traffic Safety and Fisheries Control. Each policy area has quite different user categories and, as consequence, each policy area is addressed separately, through a specific DSM.

In *DOLPHIN*, several preliminary scenarios have been designed in cooperation with users supporting the project to ensure that they are relevant and representative of the complexity of the requirements. The scenarios are being refined in order to achieve the maximum collaboration and cooperation with other ongoing initiatives (e.g. the *SeaBILLA*, *SIMTISYS* and *NEREIDS* projects).

Users will also be involved in the validation of the operational scenarios, in which specific service trials will be arranged to test the integration of the DSMs in operational service chains. Their effectiveness will be measured against pre-defined baseline performance indicators.

Border Surveillance scenarios

The Border Surveillance scenarios test different situations highlighting some of the gaps identified in the current capabilities of the authorities responsible for the control and monitoring of European borders. Surveillance of maritime



Fisheries Control Decision Support Module scheme: managing the complexity (Credits: e-GEOS).

borders against illegal immigration is needed in the Mediterranean more than anywhere else in Europe, whilst also being more costly in this region. This is due, in large part, to the current political situation in Egypt, Tunisia, Libya and Algeria.

One of the major gaps, as stressed above, is the control and detection of very small and fast vessels. This type of vessel is frequently used for drug smuggling, particularly between Northern Africa and the South of Europe. Another relevant gap is the detection of larger vessels in close proximity to one or more small vessels in crowded areas - a "suspicious behaviour", which is also associated with smuggling.

In the following paragraphs, one of the Border Surveillance scenarios is illustrated.

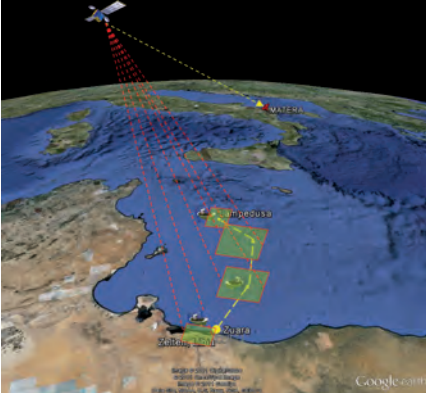
The purpose of this scenario is to simulate the presence of small, fast boats that transport drugs or immigrants. In this context, the performance of the techniques developed for ship

detection will be tested on real targets. During 2011, due to the political crisis in North African countries, the EU Member States – and Italy in particular – was affected by a rapid increase of illegal immigration. Flows of immigrants entered Europe via the Sicily channel to land directly on Lampedusa island (the closest European territory to Tunisia or Libya) aboard small and medium-sized vessels. In the scenario illustrated on the first image page 74, it is assumed that the vessels depart from the area



Border Surveillance - Atlantic area between Morocco and Portugal (Credits: Edisoft).

Success Story



Border Surveillance - Illegal immigration between Libya and Lampedusa (Credits: e-GEOS).

of Zelten/Zuara (Libya) and attempt to reach Lampedusa island in overcrowded boats of about 10-20 metres in length.

Traffic Safety scenarios

The Traffic Safety policy area applies to a wide range of possible scenarios across European seas.

The objective is to detect anomalies and raise early warnings and collision alerts, taking SAR images as input data and integrating these with vessel identification data. This gives an overview of the maritime situation over a portion of the traffic route.

The following image illustrates the case of the English Channel, which is characterised by high traffic density. The flow of vessels is structured by means of a set of traffic separation schemes. This scenario can be divided into three separate sub-scenarios:

- Detection of the arrival of vessels in the proximity of the English Channel traffic scheme, and forecasting of future crossings and groundings as early warnings;
- Provision of collision alerts;
- Provision of grounding alerts.

Fisheries Control scenarios

Both the coastal waters and the high seas of developing countries fall victim to illegal fishing by companies which operate internationally. Simultaneously, port authorities and countries with an interest in maritime resources and fishing find it difficult to share information and cooperate in tracking violators and enforcing regulations. The result is widespread Illegal, Unregulated and Unreported (IUU) fishing.

As recognised by the European Regulation⁵ on compliance with the Common Fisheries Policy, "Remote Sensing" technologies allow the authorities in charge of fishing control to analyse the presence of boats over a given area and to assess the conditions in which fishing activities have been performed.

The following image illustrates a scenario relevant to the South Tyrrhenian Sea. The Italian Coast Guards benefit from receiving integrated information on the open seas, in order to identify suspect fishing vessels. In addition, information on nearby, suspected "favoured ports" sites enables suspicious activities on the shore and near the coast to be monitored.

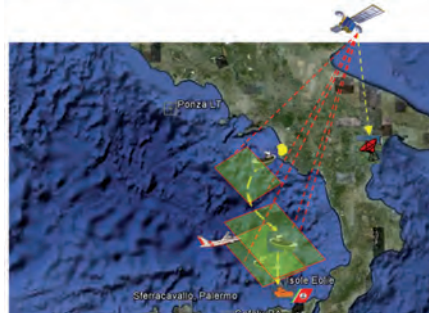
⁵ Regulation (CE) 1224/2009.



Traffic safety - Early warning for potential crossings and groundings (Credits: CLS).

Conclusions

The GMES programme is advancing from research and development activities towards the implementation of operational geo-spatial information services based on the needs of wide-ranging user communities at both political and operational levels. Maritime Surveillance is progressively acquiring importance across Europe. The burgeoning technological maturity of Maritime Surveillance services in the European industrial context is beginning to confer competitive advantages and benefits in both the internal markets, and in more developed foreign markets, such as in the USA and Japan. The accomplishment of the *DOLPHIN* project's objectives will result in the



Illegal, Unregulated and Unreported fishing – The dynamics in the South Tyrrhenian Sea (Credits: e-GEOS).

development of a competitive position for the consortium partners, and will represent a significant step forward for GMES support to European Maritime Surveillance.



Paola NICOLOSI received her Geology Degree and Qualification to practice the profession of geologist from the University of Palermo (Italy). She is an expert in satellite-based 'Near Real Time' maritime services. She has experience as Project Coordinator of European Commission and European Space Agency projects, dealing with oil slick pollution and illegal trafficking through EO-based oil spill and ship detection monitoring services, e.g. the EMSA CleanSeaNet Service and the *DOLPHIN* project, which involves 20 partners from Europe. She has also experience in oil spill and ship detection development products, following the market requirements in the Maritime sector, guaranteeing the technological evolution of the maritime product line. Currently she is responsible for the Maritime Surveillance Business Management at e-GEOS SpA.



Maria ANGELUCCI received her Environmental Engineering Degree and Qualification to practice the profession of engineer from the University of L'Aquila (Italy). She was awarded a 2nd level Masters in "Space and Communications Systems" in June 2007 and joined the Telespazio company in July 2007. She has experience in managing GMES projects (GSE *MARISS* - European Maritime Security Services, and *MarCoast* - Marine and Coastal environmental information services). She joined the e-GEOS company in July 2009, being involved in ESA and FP7 projects, e.g. *MARISS*, *DOLPHIN*, *SeaU*, and she has experience in commercial contracts and institutional project proposal preparation and project management.

Securing Europe's borders: Earth Observation supports the surveillance of the Greek-Albanian border

by Dave Halbert

GMES SERVICES IN SUPPORT TO BORDER SURVEILLANCE ARE BEING DEVELOPED BASED ON THE WORK OF PRECURSOR PROJECTS SUCH AS LIMES AND G-MOSAIC. NEW PROJECTS ADDRESSING THIS AREA ARE EXPECTED TO START IN EARLY 2013. THIS ARTICLE REPORTS ON A FEASIBILITY STUDY ON SPACE-BASED BORDER SURVEILLANCE CONDUCTED FOR THE EUROPEAN SPACE AGENCY.

The security of Europe's external borders is of prime importance to Europe's citizens as illegal immigration and cross border crime has a significant social and financial impact. In fact, the European Borders Agency, Frontex, believes that the shadow cross-border market is worth approximately 285 billion Euros a year, most of which manifests itself in loss of government revenue. This equates to about two percent of Europe's Gross Domestic Product (GDP).

The Greek-Albanian border is ideally suited for cross-border crime: it is rugged and remote, and consequently difficult to patrol. Furthermore, the

communication facilities are sparse, which makes the task of intercepting criminals involved in trafficking and smuggling extremely challenging. The region is characterised by a terrain consisting of rock-strewn mountains with densely-wooded and steep slopes. Additionally, the weather conditions in wintertime are harsh, with heavy snow covering the mountains. Illegal immigrants and smugglers often try to take advantage of the rugged characteristics of the terrain in order to avoid detection by the Border Guards. While the area is difficult to traverse, it is easy to hide in it.



The Greek-Albanian Border (Credits: Astrium GEO-Information Services).

Astrium and the Greek Institute for Security Studies, KeMeA, initiated a feasibility study supported by the European Space Agency to explore solutions to this problem. The study involved the Aliens Division of the Hellenic Police as the representative user and the proposal was based around determining the feasibility of six services; border mapping, border intelligence, Border Surveillance, communications, patrol management, and the provision of a

common operational picture. As a result of the user requirements, during the capture exercise conducted within the study, a seventh service was proposed, covering meteorological information.

What did the user require?

The user requirements were developed through discussions with the Greek Police and the KeMeA Institute. Based on an analysis of the regional situation, they have been checked and validated by the Greek Police. Amongst the requirements were: printed and digital maps in a variety of scales, terrain models, permeability mapping, change detection, and meteorological information.

In addition to the Earth Observation data, the user needed real-time track and trace capability, communications, and a common operational system, as well as a pre-frontier information picture based on data provided by liaison officers. To complement the information provided by the user, an analysis of user requirements previously generated by the Joint Research Centre in the GMOSS project was conducted. These user requirements closely matched those generated in this study.

“Border Control measures are ineffective unless supported by surveillance capabilities.”

What is the state of the art?

The management of land borders typically consists of control and surveillance capabilities. Control capabilities are those intending to restrict, prevent, or manage cross-border activities. Typical examples are: to monitor border crossing points, to patrol ground (or riverine) areas, and to build up physical barriers such as fences or walls.



Predator Unmanned Aerial Vehicle (UAV) used for Border Control (Credits: US Customs and Border Protection).

However, these measures are ineffective unless supported by surveillance capabilities since border crossing points can be circumvented, fences can be cut, and patrols can be avoided.

Surveillance capabilities have historically consisted of the observation carried out by patrolling personnel supplemented by static manned watchtowers. Conceptually, these two elements are still the bedrock of modern Border Surveillance systems, except that the sophistication of the sensors has changed, and now they typically consist of both mobile and static sensors using imagery techniques (radar, visual, infrared) or detectors of presence (magnetic, seismic, infra-red beam break, hydrophones).

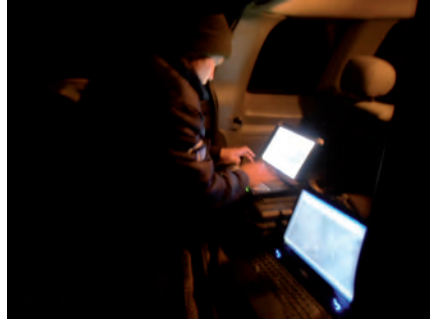
In recent times these capabilities have been supplemented by the use of the third dimension. Initially with manned aircraft and more recently with tethered balloons and Unmanned Aerial Vehicles, these systems provide additional surveillance capabilities along with an ability to look across the border for some distance into a neighbouring country. Whilst satellite observation has been used in the context of Border Surveillance, its use is still infrequent and often associated with a crisis situation or a military threat to the border. The routine use of satellite observation

Success Story

to support the control of a non-militarised border is almost unknown.

“The border intelligence component aims to locate vulnerable areas of the border line.”

From the analysis of the user requirements and the current state of the art, it was possible to determine which additional capabilities a future service should provide. The Earth Observation capabilities identified were border mapping, intelligence, and surveillance. Border mapping aims to provide accurate and up-to-date geographical reference data on the border area through multi-sensor observation, at a low frequency of re-observation, using variable scales and resolutions according to the type of landscape. The border intelligence component aims to locate vulnerable areas of the border line, essentially taking into account the distribution of population, the ease of walking or driving (which is determined by the relief and landscape type, the presence of roads or paths and ground suitability) the facility to hide (the presence of forests, canyons, and other suitable vegetation types), and the distance to ground surveillance infrastructure. Lastly, Border Surveillance monitors part of the border or pre-frontier areas. The vulnerable areas identified through border intelligence are monitored using regular satellite observation during specific periods. The monitoring operation is planned, allowing the mobilisation of in-field operatives. Illegal border crossing activity is sought through context-dependent strategies monitoring the presence of tracks directly crossing the border line, camps or other signs of human presence in the surrounding areas. The presence of vehicles under



Border Guard accessing Earth Observation data whilst on patrol (Credits: Astrium GEO-Information Services).

forest cover is detected using satellite radar and optical imagery over selected areas.

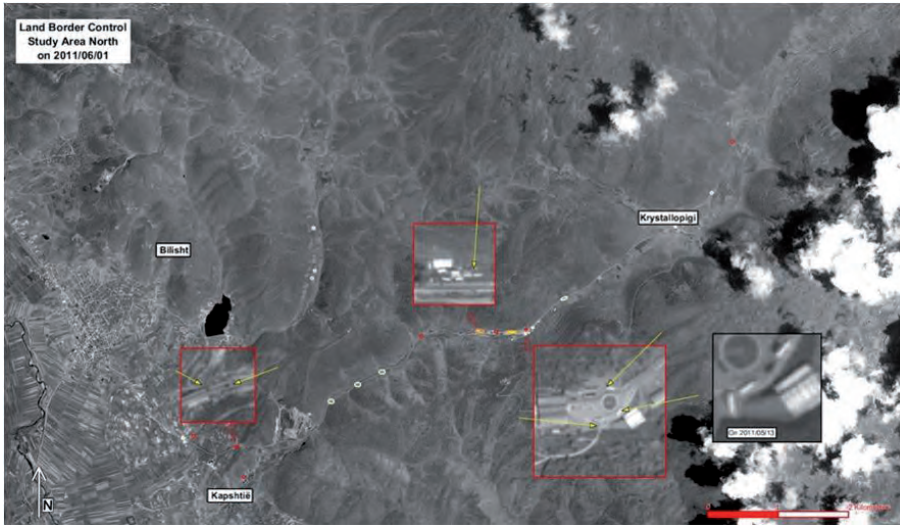
In addition to these Earth Observation capabilities, the proposed system included patrol management, communications, a common operational picture, and meteorological elements.

How were the capabilities tested?

A proof of concept exercise was conducted over a period of two weeks on the Greek-Albanian border. It was carried out with the support of the Greek border guards and involved a number of scenarios and demonstrations that sought to test and demonstrate to the user the full gamut of satellite Earth Observation support to Border Surveillance tasks.

While the preparation of the cartographic products and the analysis of the monitored areas were implemented just before the beginning of the exercise, the training, the deployable field experiments and the monitoring of the selected hot spot were ongoing during the two weeks of the exercise. Finally, the proposed solution for a common operational picture was presented to the end users.

The staff involved at the strategic level was trained for two days, whilst the local



Change Monitoring on the Greek Albanian Border (Credits: Astrium GEO-Information Services).

level staff, which included field units, was trained for three days. The field experiments lasted for six days. For the monitoring of the hot spot area, the acquisition of seven panchromatic FormoSat satellite visual images, with a two metre resolution was scheduled. The first, acquired on May the 13th, was used as a reference image of the area.

A new acquisition was planned for Monday the 30th of May, so that the staff in the headquarters could be trained in the relevant procedure. For the purposes of training at the Local Command Centre, the next image was scheduled for June the 1st. The rest of the images were acquired during four of the five days of the scenarios. The time of acquisition for each image was 08:45 GMT.

According to the user's requirements, the final deliverable after the acquisition of each FormoSat image was not only the image itself but also a jpeg file with all the changes detected between the reference image and the new one, as well as shapefiles of the changes.

In an attempt to consolidate requirements from the end users, it was also decided to provide them with two additional solutions.

In order to validate which image resolution better served the end user's requirements, a change detection process was conducted using two QuickBird satellite images at 60cm resolution, an archive visual image acquired in August 2006, and a new visual image acquired in May 2011.

In order to validate the utility of radar images for the end user, change detection using two TerraSAR-X radar images was also undertaken. The first radar image came from archives (acquired in February 2009) and the other was newly tasked and acquired in May 2011. The geometric resolution of the radar images was 3m. The purpose of this change detection procedure, rather than detecting features such as suspicious tracks, was to detect natural changes, such as seasonal vegetation conditions and crop rotation, as well as different water levels at rivers (or lakes), and varying soil moisture.

“The proof of concept exercise demonstrated what satellite technology is able to offer.”

What was the user's feedback?

For the people involved in this (local) level of command the proof of concept exercise demonstrated what satellite technology is able to offer in supporting their daily work. According to them: *“The above services can be important tools for more efficient and better quality work from the staff of the border guard centre in Krystallopigi. They add value at the operational level and assist in some degree the planning and the development of all activities of the department concerning the surveillance of land borders.”*

Is the proposed service viable?

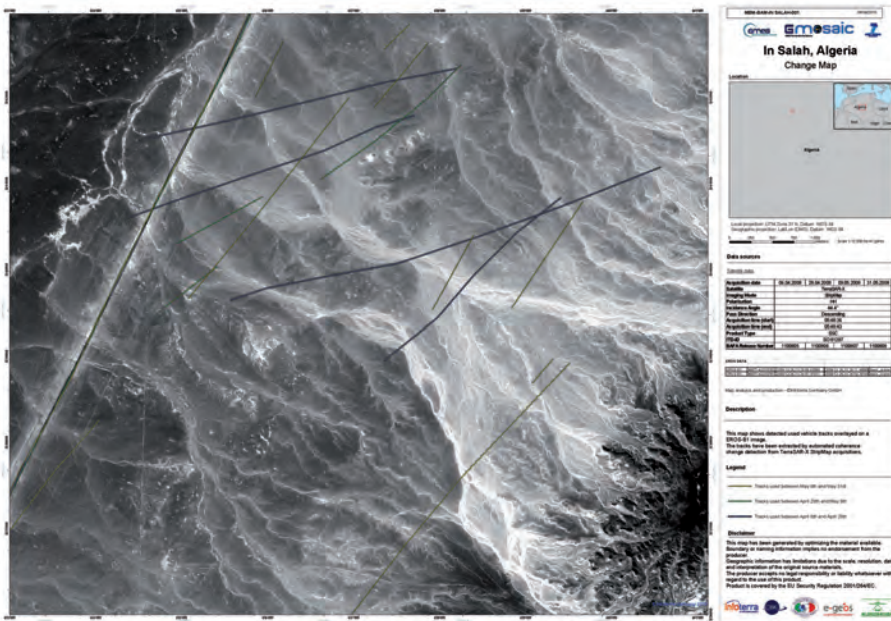
As well as the technical viability of the service, it was also necessary to determine its financial viability. To this end, a market and cost-benefit analysis was conducted. The market analysis was conducted separately for Europe and for the rest of the world, because of the existence of a free movement area within Europe. In the European case, the external border of the free movement area as a whole forms the border that requires securing, whilst each individual country within the area has a stake in the effectiveness of Border Control measures. Consequently, the provision of Border Control has a federating effect. In the rest of the world, such arrangements do not normally exist, although the South American Mercosur organisation intends, eventually, to reach such arrangements over the free movement of persons. The European Union and the Schengen Agreement define the limits of the European market. The organisations and systems put in place to support

the Schengen Agreement include: the European Union's borders agency, Frontex; the External Borders Fund; the nascent European border surveillance system, EUROSUR (see article on page 20); and importantly, future GMES services for Border Control, which would provide common surveillance tools for the EUROSUR system. In this respect the system proposed prefigures the national elements of the EUROSUR system and some of the European and Pre-Frontier elements.

“For the foreseeable future, Border Control will be an important issue for many countries.”

The rest of the world market is generally based around Border Control for individual countries. There are over half a million kilometres of borders worldwide, and in many parts of the world the Border Control infrastructure is basic, and therefore easily circumvented by migration and criminal activity. All trends point to an increase in migration and cross border criminal activity, which means that for the foreseeable future, Border Control will be an important issue for many countries. It was determined that the most likely candidates for the use of satellite systems for Border Surveillance were those countries that had long, remote or rugged borders, and which also had persistent issues with Border Control.

The primary benefit of the use of satellites for Border Surveillance is that the pre-frontier area can be imaged by satellites in a way that other means cannot. More specifically, it is the only means for imaging into the most distant pre-frontier areas. This capability is unique to satellite systems, and is not subject to competition from aircraft, Unmanned



Vehicle tracks in the Sahara desert, Algeria; a G-MOSAIC product in the field of monitoring borders, migration routes and settlements (Credits: Astrium GEO-Information Services).

Aerial Vehicles, or terrestrial means. The second major benefit is that the mapping of large areas at resolutions up to one metre is cheaper using satellites than aircraft. There are further small benefits to the use of satellites such as the lowering of tensions, in an area where the use of aircraft and unmanned aerial vehicles close to the border may be considered provocative. Overall, this feasibility study did not reveal any major obstacles with regard to the technical, commercial, or political viability of the proposed system.

What are the next steps?

It is clear that Earth Observation can provide support to the tasks of the border guards, although in Europe the proposed system has to integrate with the EUROSUR system and GMES surveillance tools. Therefore, a large-scale demonstration project in Greece has been proposed, which will provide pre-operational Earth Observation, and other services, over an extended period of six months. This is intended to integrate into the EUROSUR components as they come online.



Dave HALBERT is a project manager for Infoterra Ltd, part of Astrium's GEO-Information Services group, with a focus on Space-based solutions for Security issues. His work includes activities in crisis response, border management, maritime surveillance, humanitarian demining, and particularly within the GMES services for Security applications. Prior to joining Infoterra, he served in the United Kingdom's Armed Forces, primarily in the telecommunications and aviation domains.

Mapping ‘conflict minerals’: how G-MOSAIC supports the International Peace Information Service (IPIS)

by Elisabeth Schoepfer, Kristin Sproehnle and Filip Hilgert

EXPLOITATION OF NATURAL RESOURCES HAS, IN MOST CASES, A STRONG IMPACT ON THE ENVIRONMENT, OFTEN EVEN SPOILING NATURAL HABITATS AND AFFECTING PEOPLE’S WAY OF LIFE. THE EXPLOITATION AND TRADE OF MINERALS CAN ALSO FUEL ARMED CONFLICTS, AS IT IS THE CASE IN THE EAST OF THE DEMOCRATIC REPUBLIC OF THE CONGO (DRC). THE USE OF EARTH OBSERVATION TO SUPPORT THE MONITORING OF MINING ACTIVITIES WITHIN THE G-MOSAIC PROJECT AIMS AT AIDING POLITICAL DECISION-MAKING AND AT LINKING PEACE AND CONFLICT RESEARCH WITH THE GEO-SPATIAL ANALYSIS TECHNIQUES OF THE REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM (GIS) COMMUNITY. THIS ARTICLE, DESCRIBES A SPECIFIC CASE STUDY, IN WHICH THE GERMAN AEROSPACE CENTER (DLR) AND THE INTERNATIONAL PEACE INFORMATION SERVICE (IPIS) COOPERATED CLOSELY WITHIN THE G-MOSAIC PROJECT TO MONITOR AND DOCUMENT FORMAL AND INFORMAL MINING OPERATIONS IN THE DRC.

The Democratic Republic of the Congo is one of the richest countries in the world in terms of mineral resources; economically, however, it is one of the poorest. The DRC has been at the centre of what has been termed *Africa’s World War* (1998-2003). Despite the signing of peace accords in 2003, fighting continues in the East of the country, and the



A cassiterite and coltan (columbite-tantalite) mining site in the area of Mumba-Bibatama, North Kivu, Democratic Republic of the Congo (Credits: Laura Heaton, April 2011).

DRC continues to appear on top of the Failed State Index ranking published by the *Foreign Policy* magazine (the DRC was at the 4th place in 2011) and at the bottom of the United Nations Human Development Index ranking (it was at the 187th place in 2011). Among others, the main drivers of the Congo conflict are: poverty, weak State authority, exploitation of natural resources and widespread availability of weapons. Several studies have revealed that the DRC’s wealth in natural resources – in particular cassiterite (tin ore), coltan (tantalum ore), wolframite (tungsten ore), gold and timber – is fuelling, and thus perpetuating, the conflict.

“The use of remote sensing techniques has proven beneficial for the detection of widespread mining sites in the DRC.”

The lack of precise geographical information is a critical issue in the prevention of, and the response to, ongoing crisis relating to natural resource exploitation. Mining areas in Eastern DRC are often very difficult to access because they are widely dispersed, far away from roads or regarded as unsafe. In addition, conflict situations often prevent research teams from travelling freely. Field studies are fraught with difficulties and dangers, due to extremely bad road conditions and to the fact that researchers studying the area are exposed to attacks from rebel groups and militias. In this context, the use of remote sensing techniques has proven beneficial for the detection of widespread mining sites in the DRC, especially where the armed conflicts and the militarisation of the mining sector have made traditional field assessments almost impossible. Satellite monitoring thus provides a tool to augment field-based monitoring studies.

The service for the monitoring of “*Illegal Mining*” developed within *G-MOSAIC* provides conflict researchers with relevant information about mining areas and their surroundings. The objective is to contribute to prepare focused reactions during conflicts and to support the rapid identification of meaningful geo-spatial context information.

The study areas

The DRC is one of the most mineral-rich countries in the world. The exploitation of minerals plays a major role in sustaining the economy of the conflict-torn East of the country, in particular in the provinces of North and South Kivu. Nearly all mining activities in those provinces are done in an artisanal way, with very basic tools or even by hand. However, the militarisation of the mining sector fuelled the conflict and hindered all sustainable peacebuilding efforts.

The *G-MOSAIC* satellite monitoring activities focused on selected Areas of Interest (AOIs) within the Eastern provinces of the DRC. Three large areas at regional scale (spatial coverage: 2,500 km²) and several more focused areas at local scale (spatial coverage: 100 km²) were identified for the studies. The study sites differed in landscape and topography characteristics, in order to allow the development and testing of robust and transferable analysis approaches.

The analysis and monitoring products

Satellite-based Geographic Reference Maps provide basic geo-information such as road and river networks and settlements. They are generated at scales of 1:100,000 (for high resolution (HR) imagery) and 1:18,000 (for very high resolution (VHR) imagery). For areas such as the one of the DRC, reliable geo-spatial vector data sets, e.g. road and river networks or the demarcation of settlements, are scarce. Lack of these



Artisanal miners searching for columbite-tantalite, a tantalum ore better known as coltan, in the area of Mayi-Baridi, Katanga, Democratic Republic of the Congo. The country has one of the highest number of tantalum deposits in the world. Young men work in dangerous conditions to extract this mineral (Credits: IPIS, June 2010).

Success Story

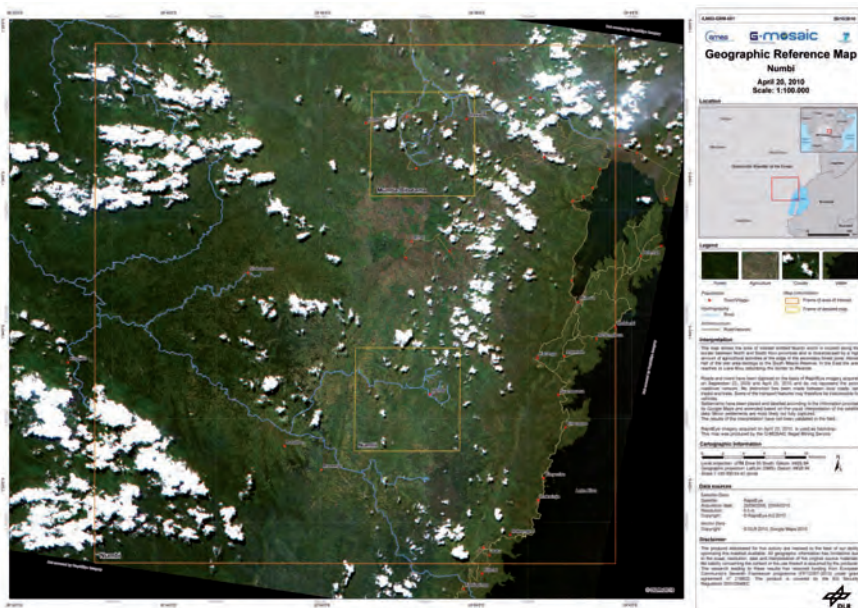
geo-data makes that most of the vector data has been derived from visual interpretation and manual digitisation of the satellite imagery, in order to support imagery analysis and mapping.

Potential Mining Maps highlight those areas where mining activities might be taking place. The method used for extracting potential mining sites is based on Object-Based Image Analysis (OBIA). The workflow is organised in two stages: (1) a transferable feature extraction scheme for the detection of bare soil areas, indicating potential mining sites, by using very high spatial resolution satellite imagery, and (2) further refinement after the initial classification, by using relevant ancillary¹ information (e.g. vector data such as roads, rivers and settlements) to reduce the number of false alarms. A

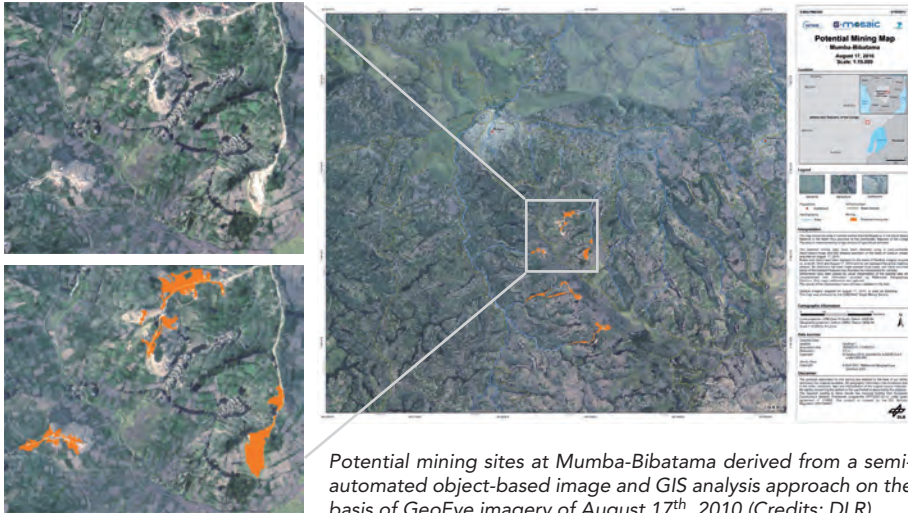
¹ 'In digital image processing, data from sources other than remote sensing, used to assist in analysis and classification or to populate meta-data' (source: ESRI.com).

special emphasis was placed on defining a classification rule set based on stable image characteristics, to ensure transferability to other natural environments and to different imagery sensor systems.

The satellite Change Detection Map is a product which shows the changes of certain geographic features, within a given area, at different points in time. The example (below) shows the opening of new surface patches at Bisie's 'Gécamines' mining site, derived through change detection analysis between two satellite images (*GeoEye* and *IKONOS*) taken six months apart. Within each satellite image, the mining area was identified through the same semi-automated object-based image and GIS analysis approach. The situation as observed on the *GeoEye* image (0.5 m resolution) of September 8th, 2010, three days before a mining ban was decreed, is displayed on the left zoom window in the map. The zoom window on the right shows the situation as of March 10th, 2011 (the



Geographic Reference Map of Numbi (DRC), providing information on infrastructure, hydrology and settlements; background image: RapidEye; scale 1:100,000 (Credits: DLR).



day the mining ban was lifted), based on an *IKONOS* satellite image scene (1 m resolution). *GeoEye* imagery acquired on September 8th, 2010 was used as the backdrop for the main map.

As an additional and in-depth analysis product, a so-called “information dossier” is provided. This describes the monitoring process, explains how to interpret the maps, and summarises the stages of the analysis and the major results. This information dossier is attached to the Geographic Reference Maps (GRM) and Potential Mining Maps (PMM) respectively. Together with the background information included in the information dossier, the maps give a comprehensive overview of the situation in eastern DRC and can be easily integrated into reports and policy recommendations by conflict researchers.

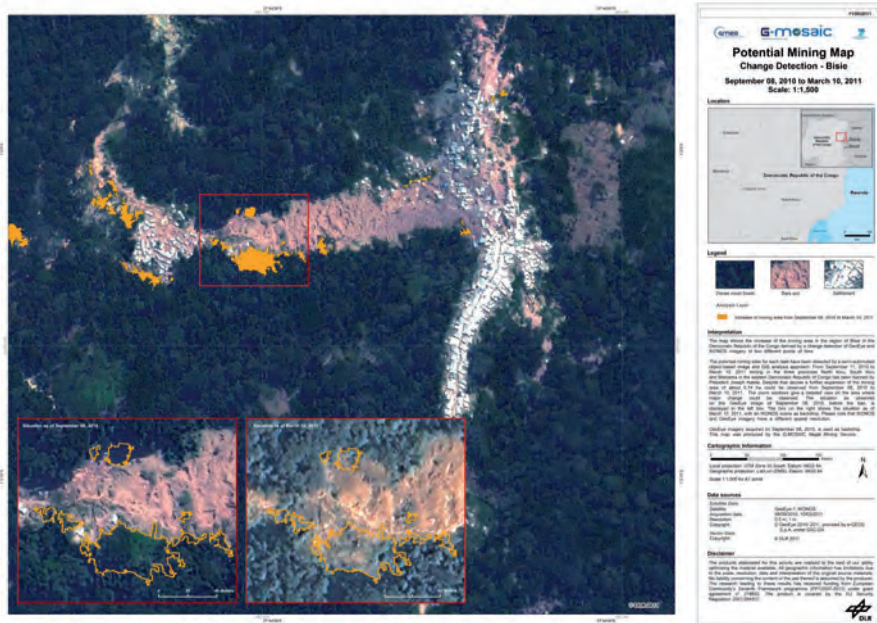
“Conflict minerals are used in essential components of common electronic devices.”

Using satellite imagery in conflict analysis and prevention in the DR Congo
 Although recent studies point out that the DRC’s mineral wealth is not the

primary cause of the armed conflict in the East of the country, its role in financing armed groups is indisputable. Various armed groups, as well as the Congolese Army, control and profit from the exploitation and trade of minerals in eastern DRC. These so-called ‘conflict minerals’, in particular tantalum (coltan), tin (cassiterite), tungsten (wolframite) and gold, are used in essential components of common electronic devices (mobile phones, laptop computers, mp3 players, game consoles, digital cameras, etc.) and in the automotive, aviation, aerospace and medical industries. Because of this situation, companies buying these ores (originated from the Great Lakes region), have been targeted by international Non-Governmental Organisations (NGOs), who are calling for the implementation of a thorough system of ‘due diligence’ (see box).

In light of this call for a stricter regulation of the sector, the listing of mining sites in eastern DRC is essential. Before systems of control, such as certification, can be designed and implemented, all mining activities in the East need to be identified and mapped. Besides its role as a monitoring mechanism, such a map

Success Story



Newly developed patches at Bisie's 'Gécamines' mining site (North Kivu, DRC), derived through change detection between satellite images of September 8th, 2010 (GeoEye) and March 10th, 2011 (IKONOS) (Credits: DLR).

can also serve as a tool for policy planning. In fact, it can be used to determine where an intervention is required - for example, in rethinking the deployment of mining agents or the opening or closing of markets. Moreover, it allows assessing the possible consequences of planned measures. For example, it can help to predict possible migrations of artisanal miners.

“Satellite images can detect and map otherwise nearly inaccessible mining sites over large areas.”

In 2009, the International Peace Information Service (IPIS), a Belgian research NGO, published an 'Interactive map of militarised mining areas in the Kivus', as a first systematic attempt to clarify the issue of profit made by armed groups from the extractive industry in the East of the DR Congo. This initiative

was followed in 2010 by the release of an overview of the mineral sector and the mapping of the mining areas in the regions surrounding the two Kivu provinces (the 'Kivu hinterlands').

During this research, it became clear that mapping mining sites in Eastern DRC is a very complex task. Many mining sites proved to be very difficult to access because they were too remote, too insecure or both.

In this respect, satellite imagery can be very useful in three different ways.

Firstly, satellite images can detect and map otherwise nearly inaccessible mining sites over large areas. Within the framework of the G-MOSAIC project, DLR in close cooperation with IPIS, developed a processing scheme for the semi-automatic identification of mining sites, based on bare soil areas combined with spectral elements (brightness) and texture (coarseness) generating Potential Mining Maps. Not only can sites be

'Conflict minerals' and the push for 'due diligence'

Concern over natural resources predation by armed groups in the DRC has been for many years minimal among the Developed countries. There have been a few periods of heightened attention, but few measures have been taken to tackle the issue. However, since the December 2008 report by the UN Group of Experts on the DRC, the matter has been high on the political agenda. In recent campaigns, NGOs such as GLOBAL WITNESS and the *ENOUGH PROJECT* are urging companies which use Congolese minerals to exert 'due diligence' on their supply chain. 'Due diligence' guidelines for responsible supply chains of minerals from the eastern DRC, and from conflict-affected and high risk areas in general, were drawn by the UN Group of Experts in 2010 and by the Organisation for Economic Co-operation and Development (OECD) in 2011, respectively. An important legislative initiative is the 'Dodd-Frank Wall Street Reform and Consumer Protection Act', passed by the United States government in July 2010, which, in Section 1502, imposes legal obligations with regard to 'due diligence' measures by companies that trade on US Exchanges and that are implicated in the supply chains of tin, tantalum, tungsten and gold (the four main metals extracted from the Eastern DRC ores). The same section states that a map of the mineral-rich zones, trade routes, and areas under the control of armed groups in the DRC and in neighboring countries should be published. In the meantime, other initiatives for the traceability and certification of Eastern DRC minerals have been set up by, among others, the tin industry (ITRI) and the International Conference on the Great Lakes Region (ICGLR).

detected, but it also gives an idea of the relevance of the detected sites in terms of mineral production on the basis of the extent of the mining area.

Secondly, known mines can be monitored with regard to the change of their mining area (Change Detection Maps). A good example of this second application is the Change Detection Map, produced by the DLR, of the most important tin

ore mine of the DRC: Bisie in North Kivu province (see previous map). This mine was first discovered almost ten years ago and it has been illegally controlled by the Congolese Army. The Change Detection Map, supplemented by field research, shows that the army continued to exploit mining sites even during the presidential suspension of mining activities from September 2010 to March

Difficulties and challenges of mapping mining sites in eastern DRC

The most important challenges of mapping mining sites are the following:

- There are many mining sites and they are widely dispersed;
- Artisanal miners often work in remote areas only accessible by foot and requiring several days of travel;
- Mining activity can easily shift from one area to another. Frequently, new sites are discovered, forgotten mines are rediscovered and existing mines are abandoned;
- Mapping mining sites in the East of the country is further hampered by the persistent insecurity in this area. The conflict situation prevents research teams from travelling freely. Moreover it has weakened the capacity of state institutions to monitor the sector, limiting their usefulness as a source of information.

Success Story

2011. This ban had the explicit aim of “cleaning up” mineral exploitation and trade from military (and civil) “mafia” networks. However, in contradiction with its initial aims, it evidently allowed units of the army to consolidate and even extend their control over several important mining areas. The images clearly show that the mining area of “Gécamines”, the larger of the two working sites at Bisie, changed during this “ban” period, as the two satellite images were taken on September 8th, 2010, just before the ban was imposed, and on the day the ban was lifted, March 10th, 2011.

Thirdly, satellite images can dramatically increase the amount of accurate geographical information on the DRC, by extracting relevant information on villages, roads and rivers from the satellite data and integrating them into Geographic Reference Maps.

In summary, the activities within the G-MOSAIC project on monitoring natural resources have demonstrated the applicability and usability of Earth Observation techniques for supporting the monitoring and documentation of informal mining activities in the context of studies of conflict minerals in the DRC.



Elisabeth SCHOEPPER received a degree in Geography and Geoinformatics at the University of Salzburg in 2001 and her PhD in 2005. Since March 2009, she has been working with the German Remote Sensing Data Center (DFD) of the German Aerospace Center (DLR) as member of the research team on “Civil Crisis Information and GeoRisks” after several years of experience in remote sensing working at the Centre for Geoinformatics (University of Salzburg) and at the European Space Agency (ESA). Her main application field is on Security issues (*GMOSS*, *LIMES*, *G-MOSAIC*) in which she has gained a significant scientific and technical expertise related to humanitarian crisis monitoring.



Kristin SPROEHNLE received a degree in Geography at the Otto-Friedrich University Bamberg in 2010. She wrote her academic thesis about the environmental impact in the surroundings of refugee camps in Darfur on the basis of SPOT-4, IKONOS and QuickBird data. In October 2010, she joined DLR-DFD and is currently involved in operational and method development activities at the Center for Satellite Based Crisis Information (ZKI). Her main research activity is in the area of IDP (Internally Displaced Persons) camp monitoring and natural resources in conflict.



Filip HILGERT holds degrees in Classical Philology, Archaeology and Italian Studies. He was a researcher and lecturer at K.U. Leuven University, where he concentrated on archaeological topographic survey in Southern Italy. In 2007, he joined the Belgian research NGO International Peace Information Service (IPIS) as a researcher and GIS expert in the project ‘Mapping Conflict Motives in War Areas’. His main focus is on armed conflict and natural resources in Central Africa and the Democratic Republic of the Congo in particular.

GMES support to EU External Action: the institutional framework

by Sandra Mezzadri *

AT THE TIME OF THE ADOPTION OF THE "BAVENO MANIFESTO" IN 1998, WHICH LAUNCHED THE GMES INITIATIVE, THE ABBREVIATION STOOD FOR "GLOBAL MONITORING FOR ENVIRONMENTAL SECURITY" AND THE INITIATIVE WAS EXCLUSIVELY DESIGNED TO MONITOR THE ENVIRONMENT. IT WAS SUBSEQUENTLY MODIFIED INTO "GLOBAL MONITORING FOR ENVIRONMENT AND SECURITY", WIDENING THE SCOPE OF THE INITIATIVE TO INCLUDE A SECURITY DIMENSION. AFTER MORE THAN 10 YEARS OF EU FUNDING TO SUPPORT THE IMPLEMENTATION OF THE INFRASTRUCTURE AND SERVICES OF WHAT HAS NOW BECOME A 'PROGRAMME', GMES IS EXPECTED TO BECOME FULLY OPERATIONAL BY 2014.

However, contrary to the "Environmental" and "Emergency Response" applications of the programme, "Security" remains far less developed due to its complexity and sensitivity. The fragmentation of the EU Security market as well as the limited EU competence in the internal Security dimension (what could be compared to 'Homeland' Security) and its difficulties in acting as a global actor outside the EU (crisis management) represent natural challenges for GMES Security applications. Despite these constraints, the Security scope of GMES applications has been gradually defined. On the one hand, the Emergency and Environment services becoming operational will contribute to some Security applications. On the other hand, the EU Research and Development funded projects (in particular *G-MOSAIC*, *LIMES*, *GMOSS*, ...) have also participated to the definition of an additional set of Security applications at least for three main areas: Border Surveillance, Maritime Surveillance and support to External Action. Concerning the third domain, GMES Security

applications are in need of better coherence and coordination, especially after the Lisbon Treaty provided the EU with new instruments and institutions to develop its action abroad.

A new context for GMES: the Security dimension of EU external policies

The threats Europe is facing are complex and asymmetric by nature as expressed in the EU Security Strategy (adopted by the European Council in 2003 and updated in 2008). They include terrorism, regional conflicts, proliferation of Weapons of Mass Destruction, organised crime and climate change. In addition, other global challenges are increasingly impacting the External Action of the EU, in particular: natural disasters, poverty, energy dependence and competition for key natural resources, as well as management of migration flows. In this new and wider strategic environment, the traditional divide between external and internal Security actors as well as military and civil responsibilities are becoming less and less relevant. As a consequence,

* The author kindly acknowledges the contribution of Anna Veclani, from *Istituto Affari Internazionali* (Rome), to the preparation of this article.

Opinions on GMES

the EU is increasingly facing the need to act in a coordinated and comprehensive way by enhancing synergies between the various tools at its disposal, in terms of institutional management and responsibilities (coordination between the various EU institutions) and with regards to the combined use of civil and military assets. The Lisbon Treaty signed in 2007 has affected the External Action of the EU in various ways. In particular, with regards to the new Common Foreign and Security Policy (CFSP) and Common Security and Defence Policy (CSDP) institutional framework, considerable progress has been achieved in the comprehensive approach implemented by the EU. The EU legal personality has made it possible to establish a High Representative for EU Foreign Policy (HR) with a dual mandate, which brings more coherence among all EU external policies. The HR is indeed responsible for conducting the EU Foreign Policy (supported by the European External Action Service/EEAS and a network of 136 Delegations around the world) and as Vice-President of the Commission is also responsible for external relations (coordinating the four DGs involved: ECHO, DEVCHO, TRADE, ELARG). This "double hat" allows to better coordinate the EU External Action as well as those EU external policies having a Security dimension.

The most relevant examples of the Security dimension of the EU External Action are certainly the civil missions and military operations managed by the EEAS under the so-called "CSDP umbrella", with improved operational and planning systems which allow the EU to conduct operations under its own flag¹.

¹ The Political and Security Committee (PSC) is responsible to prepare the EU crisis response and to control the political and strategic direction of the CFSP/CSDP, supported by the European Union Military Committee (EUMC)

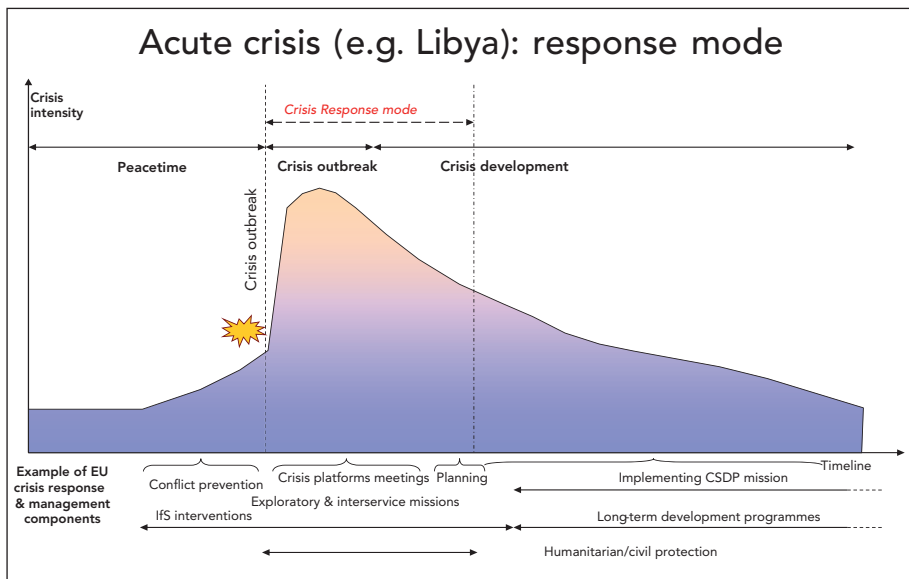
GMES applications (consisting mainly of satellite-based remote sensing) are key for CSDP missions and operations since they provide situational awareness and intelligence support in crisis management situations. The importance of Space-based capabilities in support of external operations had already become clear among European countries during the Balkans conflicts in the 90s and, more recently, during the Libya intervention. The Lisbon Treaty has strengthened the political relevance of Space matters in Europe, notably through the development of Space infrastructures as an effective support to Security. With Earth Observation (EO) becoming increasingly significant for Security-related applications, two dedicated European programmes have been developed in both the civil (with GMES) and defence (with the MUSIS military satellite programme) spheres. Intelligence and monitoring, strategic and tactical planning, conduct of the operations (strike planning, navigation...), and post-conflict damage assessment are only a few examples of activities which can benefit from the development of independent European Earth Observation assets. So far, the EEAS crisis management structures make use of tools provided either by Member States or directly by the EU Satellite Centre (SatCen).

when military issues are at stake and by the Committee for Civilian Aspects of Crisis Management (CIVCOM) when the civil side is involved. The European Union Military Staff (EUMS) coordinates military actions, under the direction of the EUMC and the direct authority of the HR. In addition to these operational structures, the EEAS has also strategic planning structures with the Crisis Management Planning Directorate/CMPD (responsible for planning the use of civil and military means at a strategic level) and the Civilian Planning and Conduct Capability/CPCC (in charge of conducting civil CSDP missions).

In recent years, it has become more and more difficult to clearly distinguish between civil, military and Civil Protection activities, since crises are increasingly of a complex nature and require the deployment of a full range of tools, from humanitarian aid to Civil Protection, rule of law and military support. Indeed, amongst the 25 CSDP missions which have been deployed so far, the majority was of a civil nature² and many implied the deployment of Civil Protection means. This was especially the case for the Haiti earthquake in 2010, for Libya in 2011 and more recently for Syria. All these situations required the deployment of the set of EU crisis management assets, as shown in the table below. This demonstrated the need to adapt the EU crisis management system to enable it to respond to complex crises and, most importantly, the necessity to enhance the

coordination between the EEAS crisis structures and tools and the Commission Civil Protection structures and tools (the Civil Protection Mechanism managed by the Commission [DG ECHO] based on Civil Protection modules provided by Member States). Since 2010 considerable developments have taken place. A Managing Director for Crisis Response and Operational Cooperation has been appointed within the EEAS and new structures established, in particular a Crisis Management Board, a Crisis Platform and an EU Situation Room. The Crisis Platform should ensure the coordination between all crisis structures and instruments of the EU (Emergency and Security especially) by bringing together all the EU stakeholders involved (see scheme on page 92). The EU Situation Room, with its civilian and military experts, provides 24/7 situation monitoring, alerting/warning and situational awareness. EU delegations will also become increasingly involved during a crisis situation.

² <http://www.consilium.europa.eu/eeas/security-defence/eu-operations.aspx?lang=en>



The EU crisis management response cycle using as example the crisis in Libya (2011) (Credits: EEAS).

Opinions on GMES

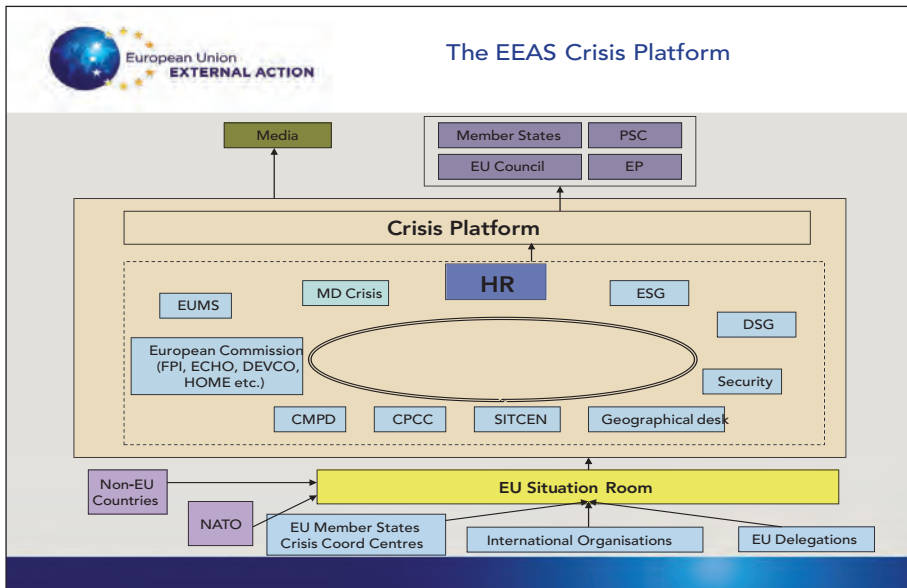
This demonstrates how complex the crisis management system at EU level is, and the challenges GMES will face since Security applications in support of External Action will need to complement existing tools (Member States assets and SatCen) and be managed under a governance scheme yet to be defined.

What can GMES do in support of EU External Action?

Space-based applications in support of EU Security and crisis management have been repeatedly identified as an important asset for Europe. The three components of GMES (i.e. "Environment", "Emergency" and "Security" services) undoubtedly have a strong potential to provide effective support to EU External Action, and especially to meet the challenges the EU is facing in implementing its CFSP/CSDP. The Security dimension of CFSP (CSDP) is an area in which Earth Observation

(EO) applications are naturally needed and where GMES services for Security applications could indeed have an obvious added value in support of the wide range of missions, as recalled above: humanitarian relief and rescue, peace-keeping, crisis management, border control, support to third countries in fighting terrorism, Security Sector Reform (SSR), Disarmament, Demobilisation and Reintegration (DDR)³. In fact, the EU and the national bodies in charge of the planning and conduct of such missions need to rely on accurate and timely information to support early warning, situation analysis and assessment (in particular capabilities for wide area surveillance/observation); for detailed detection, reconnaissance and identification; for the collection of information in other bands

³ These tasks have been added by the "Headline Goal" 2010, as approved during the Brussels European Council of 2004.



The EU crisis response system is subject to different institutional and decision-making processes. Effective coordination of the entire range of crisis management instruments (civil and military) remains a very important challenge during all phases of the crisis response cycle (Credits: EEAS).

of the electro-magnetic spectrum; and, finally, for frequent, all-weather conditions and day/night information or imagery gathering. These capabilities are also useful for conflict prevention and for international treaties monitoring within CFSP. Specific indicators need to be constantly kept under control/observation in critical areas: drug cultivation and trafficking, natural resources access and management as well as environmental degradation, massive population flows, clandestine immigration and human trafficking, proliferation activities.

Experience has already proved that GMES services can effectively support the Security dimension of CFSP by complementing existing tools and, most importantly, by providing synergies between Security needs on the one hand and Emergency and Environmental needs on the other hand. To begin with, the SatCen (see above), could effectively benefit from complementary data supplied by GMES, when needed, so as to enrich its services and products. Furthermore, possible synergies in the field of Earth Observation should be examined, in order to make the best use of resources, to lower costs and to avoid duplication. In particular, the development of an interface between Emergency and Security has been placed on the agenda since the early days of GMES. Emergency Management Services (EMS) were even considered by some stakeholders as an integral part of the GMES Security dimension. It is clearly evident that EMS (covering in particular floods, forest fires, landslides, earthquakes and volcanic eruptions, humanitarian crises) is of great interest for the CSDP and that synergies can be created between these two domains.

This has been clearly demonstrated by some of the activations of *G-MOSAIC*, i.e. the GMES R&D project dedicated to

the development of geo-spatial information products (intelligence and early warning) in support of CFSP Security-related activities.

A particularly good example of a complex crisis outside the EU, requiring both Emergency and Security applications, is the Libyan crisis of February 2011, during which *G-MOSAIC* and *SAFER*⁴ were simultaneously activated. In addition, as environmental issues have been clearly identified as having potential Security implications, the civilian and military users of GMES services for Security applications should also have an interest in exploiting synergies with the environmental part of the programme. This includes intelligence and early warning applications related to land, ocean, and atmosphere. In that respect, *G-MOSAIC* confirmed environmental factors as a trigger or an accelerator of crises. Indeed, the lack of vital goods (water, food...), the availability of valuable goods (rare minerals, gold, diamond...), and the climatic constraints (climate refugees, shortage of arable land, land degradation...) are major causes of conflicts. A concrete example of the added value brought by synergies between services pertaining respectively to the "E" and the "S" of GMES was the activation of *G-MOSAIC* services to examine the potential interlinkages between land degradation, land use changes and conflicts in Zimbabwe⁵. By producing multi-temporal analyses of Earth Observation data combined with *in situ* data, the activation

⁴ *SAFER* was the GMES Emergency Management R&D project financed under FP7. It paved the way for the fully operational EU-funded *Emergency Management Service-Mapping* which started operations in April 2012.

⁵ The *G-MOSAIC* Land Degradation service was based on the multi-temporal analysis of land use maps of Zimbabwe.
http://www.gmes-gmosaic.eu/sites/gmes-gmosaic.eu/files/brochure_LD_v3_June2011_A4_web_0.pdf

of G-MOSAIC identified potential crises which could develop in the country.

The challenge ahead

There is still a number of critical questions to be addressed in order for GMES to become an effective tool in support of the EU External Action: how will GMES be integrated into the new EU system for crisis management? How will it be coordinated with the existing EO capabilities (Member States assets and SatCen)? Will GMES applications be able to respond to the technical constraints specific to the Security area (e.g. protection of information and data exchange)? How will the governance be managed?

In the coming two years, the challenge lies in coordinating the full set of GMES Security applications and especially bringing more coherence in the "support to External Action" dimension. Although Space is gaining importance on the EU agenda, and existing or planned EO systems are to be used in support of crisis management and Security, the interface between GMES and the EU External Action is still lacking coherence, ambition and cost-effectiveness. In order to address such shortcomings, and to facilitate the incorporation of Space products in users' crisis management activities, efforts have to be made in the following areas:

- the definition of a sustainable governance framework, leading to dedicated and clarified EU Space capabilities for Security and crisis management. As the GMES services for Security applications are coming to operational maturity, a clear and defined overall governance needs to be developed and implemented. Considering the heterogeneity of the users and the numerous areas of application, the governance model will have to be new and specific, in order to ensure an effective link between civil and military objectives, as well as between intergovernmental actors and Commission services. This will be the main challenge of the *BRIDGES* project, launched on January 1st, 2012 and coordinated by the SatCen;
- improvement of the cooperation between the relevant DGs and Services of the Commission, the General Secretariat of the Council, the EEAS, the SatCen, the European Defence Agency and the European Space Agency, in order to achieve a better coordinated management of Space applications in general and GMES in particular;
- enhancing the efficiency and performance of existing GMES Services, in terms of responsiveness, autonomy, flexibility and integration.



Sandra MEZZADRI received a degree in Political Science from the University of Pisa (Italy) and holds a Master Degree in European Administration from the College of Europe (Bruges-Belgium). She has worked at the European Commission (DG ENTR) and at the European Defence Agency, where her focus has been on the development of the European Defence market. Since 2010 she works as a consultant, expert on Security and defence issues, and she is Senior Advisor at SpaceTec Partners.

G-MOSAIC Project Partners

- ■ ■ e-GEOS - Project Coordinator, Italy
Service chain leader: Contingency Plan Preparation.
- Adelphi Research, Germany
- Astrium Satellites, France
- Consiglio Nazionale delle Ricerche, Italy
- DLR (Deutsches Zentrum für Luft und Raumfahrt), Germany
Service chain leader: Illegal Mining; Illegal Timber Logging; Damage Assessment for Post-Conflict Situations; Support Reconstruction Missions after Conflicts.
- European Union Satellite Centre, Spain
Service chain leader: Rapid Geo-spatial Reporting.
- Eurosense, Belgium
- Fondation pour la Recherche Strategique, France
- GISAT, Czech Republic
- GMV Aerospace and Defence S.A., Spain
Service chain leader: Critical Assets Monitoring; Critical Assets Event Assessment.
- GMVIS SKYSOFT S.A., Portugal
- Indra Sistemas S.A., Spain
Service chain leader: Monitoring of Nuclear Decommissioning Sites; Continuous Surveillance of Nuclear Facilities; Illicit Crops.
- Infoterra GmbH (Astrium GEO-Information Services), Germany
Service chain leader: Border Area Monitoring; Monitoring Migration Routes and Settlements.
- Infoterra UK Ltd (Astrium GEO-Information Services), United Kingdom
- Instituto Superior Técnico (Lisbon Technical University), Portugal
- Istituto Affari Internazionali, Italy
- Joanneum Research, Austria
- Joint Research Centre of the European Commission
Service chain leader: Exploitation of Natural Resources, Population Pressure, Land Degradation.
- King's College London, United Kingdom
- LUISS Business School (Luiss Guido Carli University), Italy
- TNO (Organisation for Applied Scientific Research), The Netherlands
- Planetek Italia, Italy
- San Marco Project Research Centre (University of Rome "La Sapienza"), Italy
- Satelitarne Centrum Operacij Regionalnych, Poland
- Satellite data Analysis Laboratory (Universita Degli Studi Della Basilicata), Italy
- Sistematica S.p.A., Italy
- Space Research Centre of the Polish Academy of Sciences, Poland
- SpaceTec Partners, Belgium
- Spot Image (Astrium GEO-Information Services), France
- Swisspace, Switzerland
- SYNESIS, France
- Thales Alenia Space France, France
- Thales Alenia Space Italia, Italy
- Thales Communications France, France
- Technische Universität Bergakademie Freiberg, Germany
- Z_Gis, Centre for Geoinformatics (Paris-Lodron University, Salzburg), Austria

■ ■ ■ **Publisher** ■ ■ ■

Stéphane Ourevitch, G-MOSAIC Communications Manager
ourevitch@spaceteccpartners.eu

■ ■ ■ **Editorial Director** ■ ■ ■

Dimitrios Papadakis
papadakis@spaceteccpartners.eu

■ ■ ■ **Graphic Design** ■ ■ ■

M'hamed Belahouel (Paris)

■ ■ ■ **Layout** ■ ■ ■

SEFF & Art Mature (Brussels) – seff.fd@skynet.be

■ ■ ■ **Editorial Committee** ■ ■ ■

Sergio Proietti, G-MOSAIC Project Coordinator, e-GEOS
Denis Bruckert, BRIDGES Project Coordinator, SatCen
Paola Nicolosi, DOLPHIN Project Coordinator, e-GEOS
Stéphane Ourevitch, Isabella Pirolo and Sandra Mezzadri, SpaceTec Partners

This review is published by the G-MOSAIC consortium and co-funded by the European Commission's Research Executive Agency. It is distributed free of charge to a panel of selected recipients.

The G-MOSAIC project is a Collaborative Project co-funded by the European Commission's Research Executive Agency within the 7th Framework Programme, the EU funding instrument for Research and Technological Development (Grant Agreement n°218822).

Printing run: 1500 copies (English).

Window on GMES is also available in electronic format (PDF) on the website of the project consortium: <http://www.gmes-gmosaic.eu>

Legal registration number: ISSN 2030-5419

Responsibility for the views expressed in this publication lies exclusively with the authors of the articles. These views do not represent those of consortium or of its partners nor those of the European Commission or of the European Space Agency.

Reproduction of texts is authorised with the prior written permission of the G-MOSAIC consortium.

Please send an e-mail to Window_On_GMES@spaceteccpartners.eu if you wish to request additional copies of this publication for yourself, your colleagues or other parties.

The *Window on GMES* publication has been created in the framework of the BOSS4GMES project under the coordination of Astrium GEO-Information Services. This special issue is published with the kind permission of Astrium GEO-Information Services and Arsenale Novissimo.

CONTACT

Window on GMES
c/o SpaceTec Partners s.p.r.l.
Avenue Louise 66 - B-1050 Bruxelles
Tel: +32 2 642 23 43 – Fax: +32 2 642 23 49
Window_On_GMES@spaceteccpartners.eu

Printing E3 Expansion (Paris)
Printed in the EU