



# GMES: WHAT'S IT ALL ABOUT?

IN THE FIRST OF A TWO-PART ARTICLE, DR. CLIVE FARQUHAR OUTLINES THE SCOPE OF ONE OF THE MOST AMBITIOUS EARTH OBSERVATION PROGRAMMES EVER CONTEMPLATED... ONE THAT WILL HELP SHAPE THE FUTURE OF OUR PLANET FOR GENERATIONS TO COME

A key step in the maturing of remote sensing as a technology is its use as an operational resource. Within Europe, imagery is used to ensure agricultural subsidy compliance and to provide data useful in issues including climate change and citizen security. The most significant European initiative that uses Earth Observation (EO) imagery is the Global Monitoring of Environment and Security (GMES) project.

GMES is the most important European Commission flagship initiative after the Galileo global navigation satellite system and is one of the most ambitious EO programmes ever undertaken. Its objective is to collect and process multi-source data for information services that support policies related to the environment and security at the European level, but with the broader objective of providing such services on a global scale.

## What is GMES?

GMES is a joint initiative between the European Commission (EC), European Space Agency (ESA) and the European Environment Agency (EEA) that aims to achieve an autonomous and operational EO capacity. Each partner processes different parts of the infrastructure, with the European Union funding and managing the services, ESA managing the space component, and the EEA along with the member states being responsible for the *in-situ* and airborne data.

GMES operational services will be ensured through public funding from EU, intergovernmental agencies and member states. As 'public goods' GMES services will be fully accessible and freely open to any organisation or citizen. Principal GMES users will be various policymakers and public authorities, who use the information to prepare national, European and international legislation on

environmental matters (including climate change) and to monitor its implementation.

GMES's security component will be used to support time-critical decision making during emergencies, such as natural catastrophes and humanitarian crises. GMES is currently at the end of its pre-operational phase, which began in 2008, and it is expected these services will enter initial operation this year and be fully operative by 2014.

### Themes

GMES will provide users with highly useful geospatial information through services dedicated to a systematic monitoring and forecasting of the state of the Earth's subsystems.

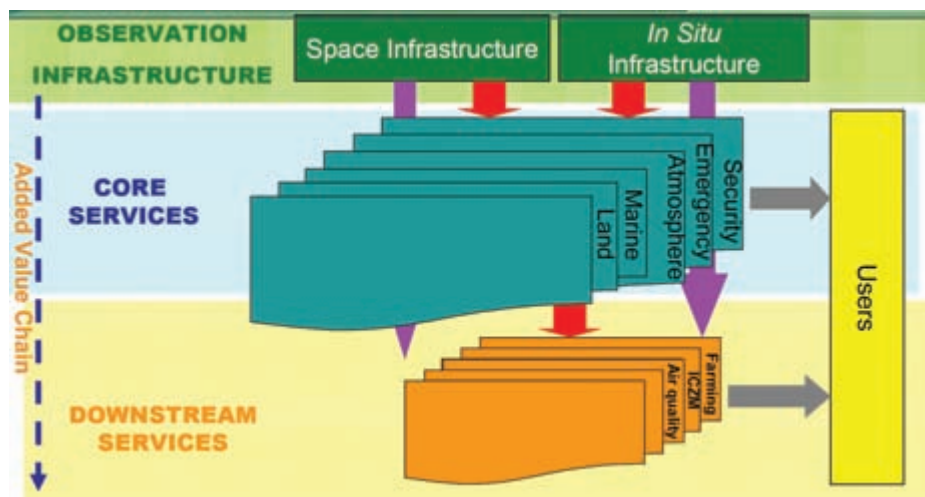
These information services can be grouped into six main interacting themes: *land, ocean, emergency response, atmosphere, security and climate change*. The land, marine and atmospheric services also contribute directly to climate change monitoring and assessing mitigation and adaptation policies. All GMES services are designed to meet common data and information requirements and have a global dimension.

### Technical components

In practice, GMES consists of a complex set of systems that collect and process data from multiple sources and provide users with reliable and current information through one of the six services. As such, GMES can be divided into four components;



Artist's impressions of the first four GMES satellites: Sentinel-1 (bottom), Sentinel-2 (centre right), Sentinel-3 (centre left) and Sentinel-4 (top) (Source: Montage compiled from original ESA imagery)



GMES Architecture

the *space component* (observation satellites and associated ground segment with missions observing land, atmospheric and oceanographic parameters); *in-situ measurements* (ground-based and airborne data gathering networks providing information on oceans, continental surfaces and atmosphere); *data harmonization and standardization*, and *services to users*. The overall GMES architecture is illustrated in the diagram above.

At its core, GMES aims to fully utilise the potential advantages of using EO imagery to regularly collect synoptic overviews on a continental or global scale. Over the last decades, Earth Observation has matured as a science with improving technological capabilities and increasing numbers of satellite-based sensors, making it now possible to acquire imagery on an almost hourly basis.

In parallel, software advances such as the automated image processing and analysis workflows found in software packages such as ENVI have made imagery and derived information products more accessible to a wide range of geoinformation professionals.

A primary goal of GMES is to collate such capabilities into a sustainable and reliable EO system. To achieve this, ESA is developing five space-borne Sentinel missions, the first of which is scheduled for launch in 2013. Each mission has complementary capabilities including RADAR, high resolution optical sensors, global oceanographic and land sensors, atmospheric compositions and meteorological monitoring capabilities. A key point to note is that Sentinel data will be free.

The other data source for GMES is the *in-situ* data, which include ground-based, airborne and ship or buoy-based observations and measurements. Such data are essential as they can be used in forecasting models, calibrating and validating space-based information, and contributing to analysis or filling information gaps.

### Key GMES Projects

Since GMES covers a wide range of themes, a diverse number of projects are required to fulfil its criteria. A number of key pre-operational projects commenced in 2009 and are focused on land, marine, emergency, atmospheric and security components.

**Geoland2** ([www.gmes-geoland.info](http://www.gmes-geoland.info)) is the primary land component project and deals with a wide range of topics including land use, land cover change, water quality, spatial planning, forest management and carbon storage.

The primary pre-operational marine project, **MyOcean** ([www.myocean.eu.org](http://www.myocean.eu.org)) provides global oceanographic information such as temperature, salinity and sea levels, which can be used in marine resource management, forecasting and climate change studies.

**SAFER** (<http://safer.emergencyresponse.eu>) is the pre-operational emergency response project, and reinforces the European capacity to respond to emergency situations such as fire, floods and earthquakes. During the response phase SAFER will provide mapping (reference maps and assessment maps) that can also be used in the early warning and the reconstruction phases.

**G-Mosaic** ([www.gmes-gmosaic.eu](http://www.gmes-gmosaic.eu)) is the pre-operational security component project and provides highly useful, time-critical geospatial intelligence before, during and after a crisis. It also supports EU intervention activities in the form of preparedness, crisis management, damage assessment, reconstruction and resilience.

**MACC** ([www.gmes-atmosphere.eu](http://www.gmes-atmosphere.eu)) deals with GMES's atmospheric component by monitoring global distribution of greenhouse gases such as CO<sub>2</sub> and methane to provide maps and data that can be used for air quality assessments and identifying pollution sources.

With the deployment of the Sentinel satellites over the next few years, GMES is expected to become fully operational around 2014 and the existing pre-operational projects will mature into operational ones.

## Value-added services

In addition to the core GMES services, many other value-added services tailored to more specific public or commercial needs (e.g., forecasting services with a local scope, services including socio-economic data, etc.) will certainly be developed, possibly for markets that are not currently utilising EO imagery. This will be aided by easy-to-use image processing and analysis software such as ENVI with which non-experts can create high-quality image products. This will stimulate the downstream sector as the levels of information derived from GMES services increase, particularly those derived from free-of-charge Sentinel data.

GMES provides a unified system through which vast amounts of data, acquired from space and a multitude of in-situ sensors are fed into a range of thematic information services designed to benefit the environment, the way we live, humanitarian needs and support effective policy-making for a more sustainable future.

The viability of GMES is due to improving sensor technology, such as the development of the Sentinel satellite missions and also advances in image processing and analysis, which enable more and more of the information contained in an image to be automatically extracted.

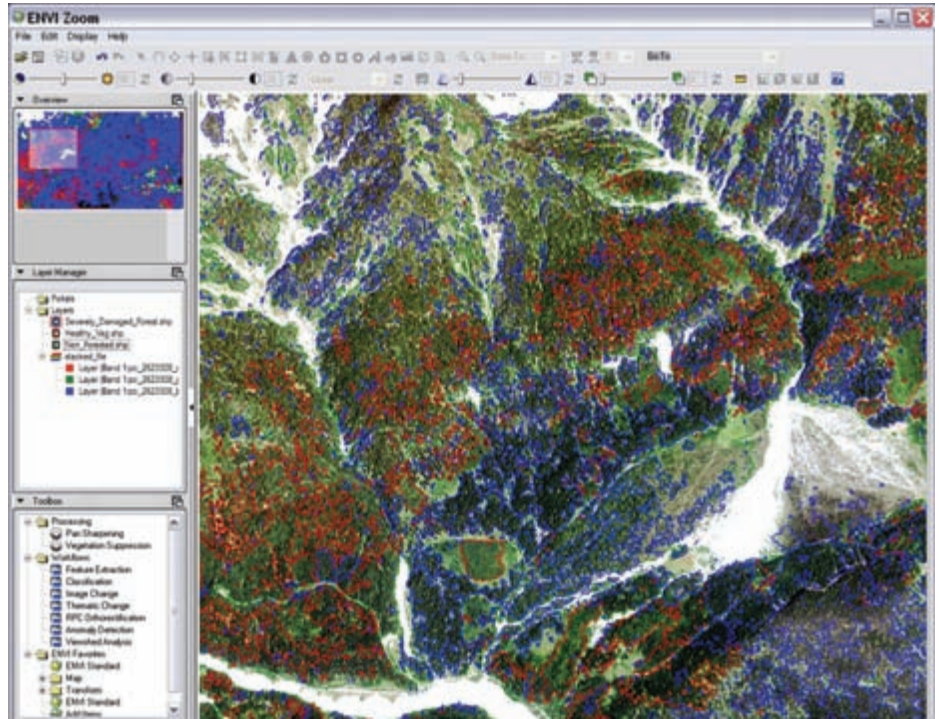
In essence, GMES will help shape the future of our planet for the benefit of all by ensuring an information infrastructure for the guaranteed production of various types of information. It will allow various organisations and individuals to take action, make appropriate policy decisions, and decide on necessary investments. This is of particular interest for those within the geoinformation sector, where open access to high quality geospatial information is critical.

In the second part of this article, to be published in the October issue, we explore specific applications of GMES geospatial imagery.

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*'The GMES programme is a powerful tool at the Union's disposal in the fight against climate change. Space observation, along with observation from other sources, provides us with information to improve our understanding of how the climate is evolving and enables us to draw up policy to adapt to that development'*

– 2011 Communication from the European Commission to The Council, the European Parliament, the European Economic & Social Committee and the Committee of the Regions on 'Towards a Space Strategy for the European Union that benefits its citizens'



Automated image processing and analysis software such as ENVI (pictured here analysing forest cover from satellite imagery) will be key tools in stimulating the downstream added-value products sector



Jean-Jacques Dordain (left), Director General of ESA, and Heinz Zourek, Director General of the European Commission's DG Enterprise and Industry, met in Paris in June to confirm the transfer of funds to ESA for initial operation of the space component for the GMES programme. (Photo: ESA-S.Covaja)

## USEFUL LINKS

- <http://ec.europa.eu/enterprise/policies/space/gmes/> – European Commission Enterprise & Industry GMES website
- [www.gmes.info](http://www.gmes.info) – website dedicated to EU-funded R&D activities that support implementation of the GMES programme.
- [www.land.eu/portal](http://www.land.eu/portal) – GMES land monitoring demonstration portal
- <http://gisc.ew.eea.europa.eu/> – web forum supporting the European Environment Agency in its coordination role for in-situ component of GMES services.
- [www.esa.int/esaLP/LPgmes.html](http://www.esa.int/esaLP/LPgmes.html) – European Space Agency website devoted to GMES space component, ground segment and contributing missions
- [www.gmes-masters.com](http://www.gmes-masters.com) – GMES Masters 2011 Competition website sponsored by ESA, the Bavarian Ministry of Economic Affairs, the German Aerospace Center (DLR), and T-Systems. The competition encourages students, researchers, entrepreneurs, start-up companies and SMEs to develop market-focused applications



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