Executive Summary:

With the ongoing climate change, the pressure on nature, biodiversity and our own living conditions increases steadily. To mitigate these threats by effective adaptation strategies and counter measures a frequent and area-wide monitoring of the environment is crucial to provide decision makers with accurate, up-to-date and reliable information on the changing conditions of our natural resources.

Benefiting from Earth observation satellite data, the GMES Land Services provides such cross-border harmonised geo-information at global to local scales in a time- and cost-effective manner. These monitoring services have been defined, developed and implemented within a series of projects funded by the European Commission (geoland, BOSS4GMES) and the European Space Agency (GSE Land / GSE Forest Monitoring).

Building upon their results, geoland2 is the last brick towards the implementation of fully mature GMES Land Services, consisting of Core Mapping Services and Core Information Services. The project aims to
organise a qualified production network, to build, validate and demonstrate operational processing lines and to set-up a user driven product quality assurance process, to guarantee that the products meet the actual user requirements.

The Core Mapping Services produce basic geo-information on land cover and land use and its annual and seasonal changes as well as a variety of additional biophysical parameters describing the continental vegetation state, the radiation budget at the surface and the water cycle on the basis of satellite Earth observation data. The mapping products are of broad generic use: besides being a valuable information source in their basic form, they are the basis for more specialised geo-information services, focusing on a broad variety of thematic fields, like water quality, forest managing, spatial planning, agri-environmental issues, the carbon cycle, food security, etc.

The Core Information Services offer specific information for European Environmental Policies and international treaties on Climate Change, food security and the sustainable development of Africa. geoland2 gathers more than 50 European Service Provider partners and over 80 major international user organisations and is financed by the European Commission within its 7th Framework Programme. geoland2 project activities started in September 2008 and the project duration is 4 years.

Project Context and Objectives:
A comprehensive set of EC, ESA and national projects have developed COPERNICUS Land Information Services and have demonstrated their added value in supporting the implementation of European Directives and International Policies in close collaboration with international, European, national and regional / local end-user organisations.
From this “bottom-up” consolidation of geo-information services, a set of common geo-information parameters has been identified to support a broad range of down-stream services. These will be established as the COPERNICUS Land Monitoring Core Service (LMCS).

The purpose of the project is to further elaborate the LMCS specifications and validation approach, and to set-up a pre-operational prototype of a production system to validate its performance.
The LMCS has evolved from core “mapping” parameters (such as land cover, land use or bio-physical vegetation information) to core “information” relevant on a pan-European scale (such as water quality information or sustainable development parameters) that will allow policy impact assessment, harmonisation back-drop to national / local reporting or common reference for sector-specific analysis).
A range of downstream service applications derived from the developed LMCS in geoland2 that use local in-situ data and/or local models, and that support national and regional-level reporting have been consolidated and demonstrated by FP6 and GSE projects. Primary focus of the downstream services is to serve legally mandated organisations (agencies) in implementing their daily duties. Further down-stream applications are expected to address commercial and/or export spin-off use of COPERNICUS skills and data.

A core service that serves multiple purposes is expected to substantially stimulate the downstream services market and to offer excellent opportunities for growth in particular for established SMEs serving regional / local markets or specific down-stream market sectors.

The current operational implementation GMES Initial Operations relies on competitive market rules. The LMCS will be procured on European level, while downstream services will follow the subsidiarity rule and be delivered on national / local levels.
rly on national / regional / local public customers. Commercial and export opportunities to exploit European COPERNICUS skills are expected to happen beyond the current scope and timing. To build a trusted market offer, sound and accepted validation approaches, transparent and commonly agreed service standards need to be established.

The objectives of the project are

• on one hand, to provide all the elements necessary for the development of an operational system implementing the COPERNICUS Land Monitoring Core Service (LMCS). This objective will materialise in the set-up of technical specifications, validation methodologies, organisational and operational procedures that are expected to be adopted by the entity or entities that will lead the LMCS in the future. It is expected that they will be made applicable to the internal or external developers/operators of the LMCS. All these elements will be sufficiently open and standardised to allow a fair competition between future providers of the LMCS elements. However, COPERNICUS implementation and market rules need to ensure a fair opportunity for return-on-investment for those players that continue to engage in the shared-cost COPERNICUS projects.

• On the other hand, the second main objective is to demonstrate that a system implementing the above specifications/methodologies will provide the results (functionalities, performances) that are expected by the users to improve their operational activities, so that COPERNICUS brings added value.

For this, the concept is to envisage a harmonized workflow for the service provision that can run on different platforms and to work as much as possible with existing software tools which could be customized. Development of new software products will pursued only to close gaps, e.g. to establish cross-platform management of the system or to bring proven algorithms into a user-friendly environment. The effort will be put on the production of certified methods and of standardised workflows.

Project Results:

The three components of the geoland2 Core Mapping Services (EUROLAND, BioPar, and SATChMo) produced ‘basic’ products which are of broad generic use and can be directly used for deriving more elaborated downstream products. A further evolution step of the Land FTS geoland2 foresees a set of thematic elements from local to global level – the geoland2 Core Information Services. They produce ‘elaborated’ products of general interest which will address specific European policies (e.g. agro-environmental indicators, information bulletins on resource management, maps of pollution, etc). They will be mainly based on the assimilation of CMS products into user models or indicator systems. The CMS service providers are in direct contact with institutional end-users in charge of European policies and Member State policies which have a generic pan-European character. In geoland2 their task is twofold: (1) to estimate the added value of the CMS in comparison to existing approaches, such as CORINE Land Cover and (2) to carry out a utility assessment of selected end-to-end service demonstrations.

• EUROLAND, concerned with the support of production of an Urban Atlas based of European Cities on VHR data, and with the demonstration of 5 quantitative high resolution (HR) Land Cover and Land Cover Change layers and intermediate products based on HR EO data; the time frequency of product update is in the order of 3 - 5 years.

• BioPar, concerned with the production in near real time and off-line of a series of biogeophysical parameters derived mostly with MR and LR data, at a global or continental scale; the time frequency of product update is on the order of 1 - 30 days.

• SATChMo, concerned with the off-line production over Europe and Africa of seasonal and annual
indicators (land use update, land cover change, using an Area Frame Sampling (AFS) strategy, and MH and HR EO data; the time frequency of the product update is on the order of 3 - 12 months.

The Core Information Services addressing important sectoral policies representing demonstrators of COPERNICUS end-to-end services, with the following missions:

• Spatial Planning: Describe, explain and forecast urban land use change.
• Water: Integrate EO derived LC/LU data in water and water quality models that can contribute to water management in Europe in a flexible, sustainable and cost-efficient way.
• Agri-Environment: Evaluate the utility of the CMS for the supply of EO-based indicators assessing the impact of agriculture on the environment and the effectiveness of agri-environmental measures.
• Forest: Address specific user requirements from the European Environment Agency (EEA), DG JRC and DG AGRI for improved forest class and biodiversity indicator information required for the LMCS and policy reporting requirements at a Pan European level.
• Land Carbon: Understand and assess the impact of weather and climate variability on terrestrial biospheric carbon fluxes, in the context of international conventions.
• Natural Resource Monitoring in Africa (NARMA): Develop an environmental monitoring capacity over African countries for the needs of the EC services and for regional and continental EC partners in African countries.
• Global Crop Monitoring (GCM): Provide objective, real-time crop assessment and Yield forecasts in support to EC Policies in the field Agriculture (Common Agriculture Policy) and Food Security.

Overall project achievements are:

• Service specifications and commonly agreed validation rules, including service evolution in terms of evolving thematic content for both core mapping and core information service elements,
• operations requirements, specifying service performance, meeting the requirements on production efficiency, increased throughput,
• production system prototype, including both an integrated software / hardware environment and an adequate organisational layout taking benefit from existing skills and capacities across Europe. The production system shall be based on open standards and rules that allow market competition and qualification of new suppliers,
• organisational layout for operating such a prototype system, meeting the anticipated future operational specifications,
• demonstration to validate the performance of the end-to-end production system prototype, incl. the performance of external interfaces, both “up-stream” (EO data, in-situ information), and “down-stream” data assimilation vs. the operations requirements and service specifications.
• stakeholder platforms as a tool to consensus building, strengthening the existing COPERNICUS Land User Platform supported since several years by GSE SAGE, GSE Land, geoland, and B4G – extending them to geoland2 / GSE Forest Monitoring, and the SSA GNU, adding a service provider network (to facilitate agreement on producer side rules and working principles) and to benefit from a science network to support the definition of validation principles and conduct independent validation and reviews. The stakeholder platforms also need to translate their findings and trust into the jointly developed services into a broad European acceptance and dissemination of the LMCS results.
• Limited set of technical service evolution activities for elements of lower maturity; e.g. by introducing new sensors (TerraSAR, Cosmo SkyMed, RapidEye), by emphasizing land cover change and seasonal dynamics to enable optimised response to global change impacts and to monitor policy impacts, or by...
integration additional thematic layers requiring the integration of multi-sensor approaches.

European Land Monitoring – The continental Component

The European Land Monitoring Service addresses the continental LMCS component (i.e. high spatial resolution, wall-to-wall land cover parameters and land cover change), of the Land Monitoring Core Service (LMCS). High spatial resolution land surface parameters are available with a minimum mapping unit of 1 ha derived from calibrated EO data with a spatial resolution around 20 m. These High Resolution (HR) Layers build on a set of common layers (e.g. biophysical parameters, indices, and texture features). At present they offer the following thematic content: degree of imperviousness, forest (cover, type, density), grassland intensity, wetland with water level fluctuation and small water bodies. For all the layers the monitoring aspect, i.e. changes over time, is more important than single time point mapping activities. Demonstration products, freely available, comprise Image2006 and Image2009 cloud masks, and calibrated indices for the whole of Europe. A major service which is already pre-operational is the wall-to-wall update of the imperviousness layer (previously called “European sealing layer”). Other deliverables offer a HR Scandinavian Land Cover dataset and HR and medium resolution (MR) biophysical variables from various European sites, including fraction vegetation cover and canopy shade fraction.

As with all COPERNICUS Core Services, once implemented in a sustainable wall-to-wall monitoring scheme over the European continent, the benefits resulting from the local and continental LMCS will be on different levels, and will differ according to the needs of the various users interested in land cover information and its change over time.

- As stated frequently, not only from international organisations and user DGs, but also from scientists, trans-boundary coherent information on land cover and land use is most important. It not only provides measures to assess the impact of European policies and Directives but also can support new reporting obligations (e.g. coming from UNFCCC, UNEP ...), as well.
- For member states (MS) the 5 HR layers can support their reporting obligations by reducing the overall costs, as shown in Germany where the sealing layer was successfully used for CLC production. In addition, they allow the upgrade of national databases; e.g. again in Germany where the sealing layer for the national topographic landscape model (DLM-DE) was deployed. The availability of the other HR layers would have improved both approaches even more.
- It is expected that the wall-to-wall image products together with the 5 HR currently under production will motivate member states to invoke national programs to take full benefit from the new data sources.
- At the European as well as national and regional levels, the high resolution Layers will permit the retrieval and/or to regular updates of European and national land cover databases, downstream services, environmental indicators and cross-border planning.

The possibility to connect in-situ monitoring with spatially explicit information facilitates improved exploitation of the remote sensing-based information by calibration of models, leading into better environmental indicators and improved statistics, as was demonstrated by the Core Information Service Spatial Planning.

Of critical importance for all governmental and regional users is the long-term sustainability of the local and continental LMCS services. Only by reliable and repetitive time series can the monitoring of urban and regional developments create the fullest benefits and lead-in investments required by national and regional agencies to become economically sustainable.
According to the overall specification of geoland2, the emphasis was more on the development and consolidation of operational production capacities rather than on basic research. Hence, some R&D issues which were known even before, or were identified during the project, were not fully solved during the project’s lifetime. Perhaps the most important issue here relates to possible improvements of the current HR layers with respect to accuracy, thematic content and their integration with European and/or national LC/LU databases (e.g. the appropriate upgrade of CLC polygons or existing national data bases with HR thematic content). Especially for the latter national programs are required to prepare the MS on the optimal use of the HR layers and the Sentinel data (from 2013/14 onwards). Only the effort of the EEA, as part on the GIO program, does not seem to be sufficient in this regard. This requires measures to incorporate directly the new high quality satellite data and the improved HR layers, based on more reliable coverages. However, for an optimal exploitation of the new resources it will be mandatory to link the COPERNICUS satellite data base of ESA with national data archives and third party mission data providers. Investigations are required relating to the data volumes to be expected, data handling and their integration into large area processing chains. All of the above goes hand in hand with the demand for a higher degree of automation, as increasing data volumes will require more data analysis work. It also demands new multi-sensor approaches and integrated monitoring concepts taking advantage of the Sentinel satellites and other third party missions.

BioPar: Time Series of Global Biophysical Variables - Core Mapping Service
The Core Mapping Service BioPar aims at establishing a validated pre-operational infrastructure able to provide bio-geophysical products describing the state and disturbances of continental vegetation, the energy budget at the surface, and some components of the water cycle. It addresses a range of applications such as global crop monitoring for food security or early warning, natural resources management, including water and forest, and the assessment of global terrestrial carbon fluxes in the context of international conventions.

Today, many processing lines are running in near real time to generate a number of variables at various temporal and spatial resolutions depending on the properties of the input sensor and on the retrieval methodology (Table 1). The same processing chains are also operated off-line to generate the same variables over historic sensor data to create coherent time series over a long a period as possible. Accordingly, the available global land products include:

• The Leaf Area Index (LAI) (Figure 2), the fraction of photosynthetically active radiation absorbed by the vegetation (FAPAR), the fraction of green vegetation cover (FCover) and the normalized Difference Vegetation Index (NDVI), derived from SPOT/VGT data, are produced at VITO using a processing line developed by CNES, and a methodology defined by INRA. A global new product is available every 10 days less than 3 days after the acquisition of the last image of the compositing period. The SPOT/VGT archive has also been processed to obtain a 14-year long time series. These LAI, FAPAR, and FCover time series have been extended in the past from 1981 to 2000: CNES has processed the 20 years of the NOAA/AVHRR Long Term Data Record (LTDR, http://ltdr.nascom.nasa.gov) data set with a processing line implementing an algorithm elaborated by INRA, and compatible with the SPOT/VGT approach. The resulting 32 years consistent time series provides a unique tool to detect changes and analyze the trends in the evolution of continental ecosystems over the last three decades.
• The Dry Matter Productivity, generated by VITO, is the product generated from SPOT/VGT data for the MARSOP (http://marsop.senecon.international) initiative.
MAHSOP project (http://www.marsop.info). It is dedicated more specifically to crop monitoring applications.

- The Burnt Areas product is produced by VITO, based upon a methodology elaborated by the University of Leicester. The detection is undertaken with daily SPOT/VGT observations from 1999, and the products are delivered every 10 days. These products contain also unique information about the fire seasonality (start, length and end of the fire season).

- The Albedo product derived from SPOT/VGT data is generated by VITO using a processing line developed by CNES based upon an approach defined in the framework of the previous FP5/Cyclopes project. It contains the spectral and broadband black-sky (directional hemispherical reflectance) and white-sky (bi-hemispherical reflectances) albedo variables. It covers the period from 1999 to the present, with a new product every 10 days.

- The Albedo product derived by merging geostationary sensors (GOES-E, MSG/SEVIRI, MTSAT) data has been developed and is generated by the Institute of Meteorology of Portugal (IPMA). It contains the same broadband black-sky and white-sky variables as the SPOT/VGT albedo.

- The Downwelling Shortwave and Longwave Surface fluxes (DSSF & DSLF) and the Land Surface Temperature (LST) (Figure 3) are also derived by merging geostationary sensors (GOES-E, MSG/SEVIRI, MTSAT) data. They have been developed and are currently generated by the Institute of Meteorology of Portugal (IPMA). They benefit from the high temporal resolution of the geostationary sensors: a new product is available every hour. This permits description in detail of the daily cycle of the radiation fluxes and of the surface temperature.

- Two different Water Bodies products are included in the BioPar portfolio. The first one is derived from SPOT/VGT data at 1km resolution, the second one is derived from TERRA & AQUA/MODIS data at 250m resolution. Both are produced by VITO using an approach developed by the Université Catholique de Louvain. Both cover only Africa for the whole availability period of the input data. They contain also information about the seasonality of the ponds i.e. when they are dry and when they are full.

- The Soil Water Index (SWI) (Figure 4) is generated by IPMA using a processing chain developed by CNES based upon a methodology set-up by the Technical University of Vienna. The SWI is derived from daily Metop/ASCAT observation acquired since 2007.

Besides these global products, the BioPar portfolio also contains a set of variables (Table 1) produced by Astrium Geo-information Services from Envisat/MERIS data over Europe (EU + Switzerland) at 300m resolution (Figure 5), and over some high risk areas at 10m resolution using SPOT/HRV and RapidEye data, primarily.

Quality assessment of the BioPar products is undertaken following the guidelines of the thematic focus areas of the Land Product Validation sub-group of CEOS (http://lpvs.gsfc.nasa.gov) when they exist. As much as possible, the validation exercises are performed by independent teams (EOLAB for LAI, FAPAR, FCover, Albedo, DSSF and DSLF; Meteo-France and ECMWF for SWI), not involved in the retrieval process.

The BioPar products are provided in hdf5 format, except the Water Bodies, the MERIS and the HR datasets which are disseminated in GeoTiff format. In all cases, the metadata are INSPIRE-compliant. They are all accessible freely through the geoland2 web portal (http://www.geoland2.eu) after registration. It is also possible to subscribe to receive the near real time products as soon as they are generated. A complete documentation including the Algorithmic Theoretical Basis Documents, the Product User Manuals and the Validation Reports can also be downloaded on the portal.

Following the completion of the geoland2 project, the production and the dissemination of some global bio-
geophysical products should continue in the framework of the Global Land component of the COPERNICUS Initial Operations that should commence in January 2013, under the technical coordination of the EU Joint Research Centre.

SATChMo Core Mapping Service: Area Frame Sampling Europe

A means of providing detailed mapping of selected sites ('hot spots') is an important component of the Land Monitoring Core Service (LMCS), as outlined in the COPERNICUS: Next Steps (GAC-13-02) document. Planning for the COPERNICUS Initial Operations (GIO) local component is currently under way with a focus on biodiversity and riparian zones building on a very high spatial resolution (VHR, 1 – 5 m) image coverage in the Data Warehouse.

The Area Frame Sampling (AFS) Europe (AFS-E) component of SATChMo has been established to support these developments to monitor landscape features of interest at a set of specific sites rather than over the ‘whole territory’, which would be too expensive and challenging. The AFS increases representivity, improves the quality of the estimates derived from the sample sites, and permits understanding of the uncertainties present. The European AFS therefore provides a biogeographically and politically relevant set of sites covering 8 biogeographic regions, 19 Member States, coastal zones, urban areas and land above 1200m. At each sample site land cover, land cover change and indicators for features with fine spatial detail (0.25 ha) are derived from VHR EO data.

The AFS-E portfolio is therefore made up of a number of products from the sampling design itself, through collections of pre-processed VHR images (including multi-date composites) to information products such as land cover maps. The main information products are generic land cover maps delivering 10 basic classes aligned with the nomenclature recorded by LUCAS. Using these basic building blocks, indicator and change detection products are also produced.

Likely applications of AFS-E products:

• Targeted mapping and monitoring of semi-natural sites associated with Natura 2000, riparian zones or other hot spots. A combination of the generic land cover map, change and indicator information can identify key condition and process features.

• Validate the High Resolution Layer (HRL) Urban Atlas (UA) products where the AFS-E could provide both VHR imagery and tailored information masks to support validation activities.

• The AFS-E was aligned closely with the LUCAS requirements to support its activities in a number of ways. The sample sites were selected to address specific deficiencies in the LUCAS scheme, by including certain islands not visited by LUCAS surveyors, and land above 1200 m where EO derived products could provide additional information. The land cover products use a nomenclature aligned to LUCAS, to provide added value to LUCAS results, to calibrate LUCAS results against other products, and to validate LUCAS results against an independent dataset. Further added value could be provided by the EO-derived products through the provision of information which it is not possible to record in the LUCAS approach, such as landscape pattern and habitat connectivity, and the conversion of mapping to other nomenclatures.

• The AFS-E will also demonstrate the capabilities of VHR EO data for monitoring a number of “hot spots” on a regular basis. The AFS sample sites were selected to cover NATURA 2000 sites (74 sample sites have one or more N2000 sites present), areas of high nature value (HNV) farmland and wetlands. The information products will provide generic and enhanced land cover, indicator and change detection data to support monitoring of these sites.

• The AFS-E can be easily extended to cover other “hot spot” situations, with the existing sites providing
long term background or control information. For instance, the site of the Hungarian toxic waste release in 2010 could have been set up as an additional sample site for future monitoring. The impact of the release and subsequent clean-up / recovery could then have been compared to unaffected sample sites in the region or with similar biogeographical situations.

In summary, the SATChMo AFS-E within Geoland-2 is an important and effective demonstrator for what will be possible, given sufficient EO data within GIO local component core service and downstream services which exploit VHR data. The European AFS bridges the gaps between more conventional in-situ / site-based monitoring and full territorial EO-based products with limited spatial detail. Each of the sample sites contributes to a localised framework for integrating ancillary information and regional statistics in a realistic landscape structure, allowing the extraction of robust results, indicators of condition, measures of uncertainty and evidence for causal relationships between policy, processes and outcomes.

Besides AFS-Europe, SATChMo also focuses on AFS- Africa and vegetation/agriculture products. These two are providing mapping services directly ingested by Core Information Services (CIS). Therefore, services about these product/services are addressed directly in the CIS related.

Spatial Planning Core Information Service

The Spatial Planning Core Information Service (CIS-SP) provides harmonized Earth Observation (EO) based information products and tools to describe, explain and forecast urban land use changes. The portfolio comprises land take trend indicators and urban growth scenarios with an improved spatial resolution and thematic scope, supporting spatial planning authorities from regional to European scale. The service responds to information requirements and priority aspects derived from current European Community policies targeting reduction of territorial disparities and promotion of greater economic, social and territorial cohesion. Other key topics centre on population development and urban growth, the impact of Trans-European Networks (TENs), strategic environmental assessments (SEA) and adaptation to climate change.

At national and sub-national levels user needs are defined by regular reporting obligations as well as the definition, implementation and monitoring of regional spatial planning instruments.

The users of the service are spatial planning departments within regional governments as well as national ministries and Federal Environment Agencies. In addition, the service caters for the specific information needs of various EU bodies (European Environment Agency, DG Regio, Eurostat, etc.). The service supports spatial planning authorities in their efforts to fulfil a broad range of monitoring and reporting obligations arising from regional, national and European Directives and policies.

The Spatial Planning service builds upon the application of high resolution land cover / land use (LC / LU) mapping data from the COPERNICUS Land Monitoring Core Service (e.g. Imperviousness layers, CORINE LC) as well as from national providers. The LC / LU maps depict with great accuracy the extent, development and density of urban areas and their surrounding peri-urban environments.

Subsequently, the maps are integrated with ancillary geospatial and statistical data into geographical information procedures, toolsets and models. These derived information products open the way for the analysis of demographic developments and urban land take trends, and for describing the state of land consumption and its impact on the environment.

The portfolio comprises GIS-ready information products and toolsets to better describe, explain and forecast urban land use changes:

Information products: The product portfolio consists of land take trend indicators (= describe and explain) as well as urban growth scenarios (= forecast) to illustrate the benefit of systematic and geospatially
explicit territorial analysis for spatial planning, and therefore supporting responsible authorities from regional to European level.

In the frame of geoland2, the Spatial Planning Service has been made additionally operational to support the utilisation of innovative EO derived products for spatial planning at national and regional scales. A core set of policy-relevant indicators and urban growth scenarios were rolled out to larger European implementation sites, addressing current and potential future trends and impacts of land take for urban development and infrastructure investments, such as Trans European Networks (TENs).

The service resolves two of the major constraints with regard to the utilisation of spatial planning information: first the service provides spatially explicit information depicting real-world trends instead of lump statistics on aggregated administrative units, and second it builds upon homogeneous LC/LU mapping products following high thematic and geometric standards, thus allowing for comparable analyses across administrative boundaries.

Key service benefits of the Spatial Planning Service comprise:

- Enriching lump statistics with geospatial information in a grid-based, object-oriented framework;
- Guaranteeing European consistency and comparability across administrative boundaries;
- Moving from observing and monitoring to the evaluation of policy options;
- Improving decision-making through better planning information.

The interest of users is to obtain reliable information about current land take trends, and to move from ex-post observations to continuous monitoring, as well as the evaluation of policy options under different scenarios.

Agri-Environmental Core Information Service

AgriEnv objectives were to fulfil the needs of (i) European users who are involved in the definition of European Directives (e.g. Water Framework Directive and Nitrate Directive), strategies (e.g. Soil Thematic Strategy) and of the Common Agricultural Policy (CAP): DG Agri, DG Env and EEA, (ii) users responsible for their implementation: agriculture and environment ministries, national and regional environmental agencies, regional water agencies. After a detailed review of these users and their policies, AgriEnv has specified services relevant to their needs mainly focused on: (i) better timely monitoring of the agricultural land use state and changes and (ii) an analysis of impacts on the environment at national and regional levels.

The indicators are generated simultaneously on selected demonstration sites (catchment and hot-spot scales) divided between 4 different countries:

- EU-08 Rhine River catchment (The Netherlands) with a hot spot site located in the Groene Woud region (3800 km²)
- EU-09 Seine-Normandie River catchment (95.000 km², France) with a hot spot site located in Seine-Maritime department (6200 km²),
- EU-10 Guadalquivir River catchment (58.000 km², Spain) with two hot spot sites around Sevilla (3400 km²) and Grenada (3400 km²),
- EU-15 Strymonas Struma (12500 km², Greece/Bulgaria) with two hot spot sites respectively in Greece (150 km²) and in Bulgaria (150 km²)

These AgriEnv indicators rely on a large amounts of High Resolution (HR) Earth Observation (EO) data acquired generally 3 or 4 times throughout the year or Medium Resolution (MR) EO at higher temporal frequency and derived indicators generated within CMS BioPar (BP) and SATChMo (SM).

Main users of AgriEnv products are end users at regional or national scales involved in the application of
European and national policies and reporting to higher authorities (local to national, national to European).
In detail, each site has associated end users who provide a user assessment report on AgriEnv products. In France, AESN (Seine-Normandie Water Agency); In Spain, CHG (Confederación Hidrográfica del Guadalquivir); In Greece/Bulgaria, NAGREF (Soil Science Institute and Forest Research Institute), N. Poushkarov (Institute of Soil Science), SAITC (State Agency for Information Technology and Communication); In the Netherlands, LNV (Ministry of Agriculture), VROM (Ministry of Public Housing).
AgriEnv CIS provides 6 services aiming at the evaluation of the utility of the (CMS) products for the supply of 13 EO-based indicators assessing the impact of agriculture on the environment and the effectiveness of Agri-Environmental Measures (AEM) (see http://www.Copernicus-geoland.info/service-portfolio/agrienvironmental-service-products.html). These services are related to: (i) the agriculture state and trends, (ii) the farming pressure on water and soil resources, (iii) the contribution of agricultural land use changes to sustainability in terms of impacts on biodiversity and landscapes.
Within the service category ‘Agricultural State’, the indicators ‘Cropping Pattern’ and ‘Crop Rotation Pattern’, ‘Intermediate Crop Coverage’ represent probably the most generic type of assessment, though it is focused on land cover types related to agriculture. These indicators provide insights into environmentally important trends by assessing in detail the proportion of arable land vs. grassland in the case of ‘Cropping Pattern’ at local and regional scales, or by identifying clearly what are the ‘Crop Rotation Patterns’ applied by farmers in river catchments. These indicators rely on SM-03 HR Agricultural Land Cover products at local scale, and SM-15 Arable Acreages products at regional scale.
Within the service category ‘Agricultural Trends’, the indicator methodologies for ‘Extensification’ and ‘Land Abandonment’ are clearly relying more on the use of ancillary data. The examples presented for land abandonment point at more complex processes that is not always easy to detect. European assessments rely heavily on farm statistical data such as FADN. The indicator ‘Agri-environmental measures effectiveness’ is quite challenging since up-to-date assessments are strongly dependent on expert information rather than geo-data.
For the indicator on ‘Soil Erosion’ it is proposed to rely on the Universal Soil Loss Equation (USLE) and hence on the use of a wide range of ancillary data in combination with BioPar fSoil (BP-10 and BP-11) products.
In the service category on ‘Agricultural land use changes as driving forces for sustainability – Biodiversity’, the assessments of two High Nature Farmland indicators (percentage and land use change) it is proposed to use the BP-11 fCover and/or the Normalised Difference Vegetation Index (NDVI) to measure and monitor plant growth and vegetation. The indicator ‘Landscape Coherence’ is being developed to assess migration corridors between intensively used lands for specific target species, making use of data on the Natura 2000 network as well as national data.
The last service on Landscapes comprises the indicator ‘Openness/Closeness’ and ‘Landscape Diversity’. For both landscape indicators, LANAMP2 serves as a basic spatial reference in combination with land use change data deriving from SM-03 in combination with expert advice. During recent years, the exploration of landscape indicators as a key to measurement of socio-economic transitions that affect the direct perception and sense of regional identity of people have received increasing attention. With the signing of the European Landscape Convention by most EU Member States, a new commitment towards landscape related objectives have become more firmly established.
Mobilizing end users who are responsible for the monitoring and implementation of European and national/regional policies was difficult to achieve, probably because these end users often have their own ways of working, and have existing monitoring tools at their disposition. Another aspect to consider
concerns political change in different organisations that may lead to the shifting of priorities, and the postponement of certain tasks. The AgriEnv initial purpose of a product/data flow between EO acquisitions and final products delivery, has demonstrated some positive results (capacity to deliver qualified and validated products, whatever the sensor acquiring images, over demonstration sites can be considered as excellent) but also some weakness (too few EO acquisitions from the Data Access Portfolio (DAP) leading to insufficiently accurate HR Agricultural Land Cover maps, long temporal windows as the acquisitions had too low a priority). Some products were cancelled because the EO data proposed by the DAP was not suitable for the targeted purpose (e.g. AE-01 ‘Land use change’) (trade-off between spatial coverage and resolution), sometimes because of lack of auxiliary data (AE-06 ‘Heritage Functions’). Nevertheless, a large number of products from the AgriEnv portfolio have been generated for different years, qualified and validated when in-situ data were available, and sent to AgriEnv users for assessment. In addition, numerous meetings with end users have taken place to collect feedback, to promote other Geoland 2 products, and to train end users to use the products in their daily work. Operationality of AgriEnv services is not yet accomplished as barriers to operationality are not fully overcome (in time and in space), but nonetheless the demonstration exercises have led to clear success (e.g. AE-04 ‘Soil Erosion’ or AE-01 ‘Crop Rotation Pattern’).

Water Core Information Service: E-HYPE: Homogenous Hydrological and Nutrient Model for Water Assessment across Europe

Water information is essential for sustainable development and protection of nature and civilians. Increasing challenges include changes in flood frequency, drought periods, sediment production, water quality, groundwater levels, and drinking water or energy supply. Most engineering constructions are dependent on calculations of water amounts, fluxes and extremes, which may change under changing conditions.

Three European framework Directives have been adopted during recent years:
• The Water Framework Directive commits the European Union member states to meet minimum thresholds (both qualitative and quantitative indicators) for all inland and coastal waters.
• The Flood Directive requires the member states to draw up a Preliminary Flood Risk Assessment.
• The Marine Strategy Directive aims to achieve good environmental status for the EU’s marine waters and establish environmental targets and monitoring programmes.

These Directives require assessments of status and effects of measures for effective water management in Europe. The challenge for the hydrological scientific and operational communities is to provide detailed water information for large regions.

E-HYPE - Core Information Service for Water

Within geoland2 the Water E-HYPE (pan-European Hydrological Predictions for the Environment) core service has been developed and put into operation. The E-HYPE tool contributes with uniform and homogenous estimates of several hydrological variables. These may be used in assessments at different scales and across borders, and may reduce the costs of extensive field monitoring. The E-HYPE model calculates daily water balance, hydrological and nutrient fluxes and discharge to the sea for small streams and entire river basins. The model system can be used for simulating long term past conditions, forecast and future predictions. The predictions may be used for e.g. early warning services, hydropower regulation, water allocation, infrastructure planning, agricultural practices, shipping guidance, environmental control or climate change adaption. E-HYPE is operational in the SMHI production system.
and data can be downloaded for free at [www.smhi.se/e-hype](http://www.smhi.se/e-hype). Data is also distributed directly to marine institutes for input to operational oceanographic forecast models. Earth observations are one of many data sources needed for the E-HYPE modelling system. Some products used that are based on satellite data include topography, land use, soil sealing, phenology, snow coverage, and lake ice. Looking at future changes the satellite based information may be even more crucial for assessments using the E-HYPE system.

Prospects for E-HYPE

Traditionally, hydrological model systems have been site specific for water bodies, rivers or catchments. E-HYPE contributes with a harmonized system that can be used both for practical decision making and scientific hypothesis testing in trans-boundary basins, at national and international levels. The system is managed by SMHI and will be continuously improved and released in new versions, and updated earth observations and in situ measurements will be incorporated. SMHI look forward to assisting in the customisation of products based on model outputs from the E-HYPE system. Such products could, for instance, include flood frequency which is important for flood risk evaluation and planning of infrastructure development. Furthermore, the number of days with agricultural drought is important for farmland planning, use of fertilizers and irrigation needs. Snow water equivalents are important for planning new power plants, and renovation of existing ones as well as daily energy pricing. E-HYPE is open for international collaboration and the HYPE source code will be further developed in the recently launched open source community ([http://hype.sf.net](http://hype.sf.net)).

Forest Core Information Service

The geoland2 Forest products as addressed by the Core Mapping Service Euroland, and the Core Information Service Forest, have developed and demonstrated innovative, quality-assured forest products to support European users in their reporting obligations concerning national and international policies such as:

- The UN Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol;
- The UN Convention on Biological Diversity (UNCBD);
- FOREST EUROPE (The Ministerial Conference on the Protection of Forests in Europe); and
- The EU Biodiversity Strategy to 2020.

The services provide highly accurate and spatially detailed information on the state and development of forests, whilst accommodating different definitions of forest.

Service Description

The Core Mapping Service has demonstrated High Resolution Layer (HRL) Forest products ready for production at a pan-European scale, serving European users (such as EEA and EC DGs), and various national applications with harmonised and validated basic forest information. Within the frame of the geoland2 project, the HRL Forest products have been produced for 15 test sites in 23 European countries.

The HRL Forest products with a 0.5 ha Minimum Mapping Unit (for forest cover) are mapped by applying standardised high-capacity processing chains to Earth Observation data, using in-situ data as reference information. The products comprise information on the continuous proportion of Forest Crown Cover Density, as well as the continuous Forest Type mixing ratio (Broadleaved vs. Coniferous Forest) for every 20m size pixel. By enabling flexible application of different thresholds for crown cover density, the innovative Forest Crown Cover Density product allows differences between definitions of forest applied at
an international level, and definitions applied by countries at a national level to be bridged, thus supporting
an unprecedented and harmonised quantification and investigation of the European forest area.
The Core Information Service (CIS) Forest products make use of the HRL Forest products as inputs, and
are mainly applied to derive biodiversity-relevant information concerning the spatial characteristics of the
forest landscape at a 100m×100m or 1000m×1000m grid resolution.
All geoland2 Forest products can be accessed directly via the geoland2 SDI expert portal
http://www.geoland2.eu/ for the High-Resolution Forest Layer, see Land Cover and Land Use Monitoring
Products; for CIS Forest, see Forest Service Products.

Users
The Forest services mainly address European-level users, i.e. international authorities like the European
Environment Agency (EEA) and EC DGs and their intermediaries on the science-policy interface.
However, national ministries and authorities in charge of implementing forest and environmental
legislation, monitoring, management and protection, may also benefit. Furthermore, the COPERNICUS
Downstream sector is explicitly addressed as an integral part of the forest service user base.

Benefits
Users of the Forest Services will especially benefit from:
• Consistent and up-to-date European forest products for multiple applications in the forest and
environmental domain;
• Maximum flexibility to suit various definitions of forest;
• Strong focus on user requirements in support of policy making, decision taking and sustainable forest
management;
• Fit-for-purpose products meeting the high verification and thematic accuracy requirements for policy
reporting and downstream service integration.

Outlook
The focus within the Forest tasks of geoland2 has been to lay the foundations for pan-European
operational mapping of harmonised and consistent core forest products within the COPERNICUS Initial
Operations (2011-2014). The production and regular update of such services is expected to give an
enormous boost to various downstream applications in the near future. The new Tree Cover Density
product will help to overcome the currently existing incompatibilities between European and national-level
forest assessments.

Land Carbon Core Information Service: Monitoring Soil and Vegetation fluxes of Carbon and Water at the
Global Scale
This activity of geoland2 aimed to establish pre-operational infrastructures providing regional and global
variables related to the terrestrial carbon cycle, in near real time. In particular, the continental vegetation
state (LAI), the surface fluxes (carbon and water), and the associated soil moisture were considered.

These variables are now produced daily by land surface models (LSM) able to assimilate satellite data, at
the global scale (16km x 16km), and at the regional scale (8km x 8km) over European test countries.
Methodologies to integrate remotely sensed biophysical variables into LSM were developed: Land Data
Assimilation Systems (LDAS) were built using the European meteorological modelling infrastructure. Both
water and carbon terrestrial cycles required a similar data assimilation approach in which a LSM was
constrained by as much relevant data as possible. Indeed, water and carbon cycles are closely linked, and
the integrated LDAS includes all the processes. The prime advantage was that consistency could be achieved across a range of products based on satellite data. The modelling and data assimilation works were associated with a verification component based on in situ observations. A link was made to the atmosphere component of COPERNICUS (the MACC2 project) using the existing infrastructure/tools developed by ECMWF. Leaf area index and surface soil moisture products derived from SPOT/VGT and from ASCAT, respectively, were used to analyze the vegetation biomass and the root-zone soil moisture. Finally, this work contributed to the specification and to the assessment of the geoland2 global biophysical variable products. The products and the product access are described in a Product User Manual document, available on the geoland2 data portal (www.geoland2.eu/portal/documents/CA80D681.html). The integration of the model into the operational ECMWF Integrated Forecasting System is described in Bousetta et al. 2012

NARMA Core Information Service: Space based solution for Monitoring Land Conditions in sub-Saharan Africa

The African Monitoring of the Environment for Sustainable Development (AMESD) programme is a partnership between the European Union and the African Union Commission. It extends the operational use of Earth Observation to environmental and climate monitoring applications. There is an increasing need for environmental information for the implementation of international cooperation policies such as aid and development. Satellites provide an operational and cost-effective way to obtain systematic information on land conditions at the continental and regional scale in Africa.

Benefits to Citizens

To date, decision makers tend to use non-spatial indicators of environmental conditions and human impact. Accordingly, there is a requirement for new indicators describing the land and vegetation condition.

Evidence-based policies need this information, and motivated by these user demands, geoland2 has provided technical support to AMESD. Its work package “Natural Resource Monitoring in Africa” (NARMA) has developed an environmental monitoring capacity, through the deployment of an Earth Observation processing system (eStation, estation.jrc.ec.europa.eu) over 48 African countries. This activity serves the needs of both the European Commission services and African Institutions, and also benefits citizens by providing environmental information across vast regions, assessing change objectively. Information from space can be incorporated into Country Environmental Profiles to analyse the state of the environment in sub-Saharan Africa.

Space Based Solution

The European Commission’s user needs were focused on spatial and temporal changes in rainfall and vegetation patterns in sub-Saharan Africa. These analytical results support the process of identifying regions that are affected by droughts and floods, and show improvements or a deterioration of the vegetation condition. The examination of rainfall patterns was conducted using the highest spatial resolution rainfall data currently available from a combination of satellite and ancillary data. The 8 km data are provided by the FEWSNET project, which is run by US-AID. The vegetation condition is assessed with a 1 km scale vegetation index, based on data from the VEGETATION sensor on-board the SPOT satellite. Through the e-station, users can download the data every 10 days, and provide African meteorological services with an early warning system if agricultural production is low. Both the rainfall and vegetation greenness data are available over long time scales, dating back to at least 2001. Annual environmental
assessments can therefore be derived. Rainfall and vegetation trends over the last decade were investigated. The relationship between increases or decreases in rainfall and vegetation greenness can provide clues to reasons for changes in land due to climate variability or non-climatic changes (for example human-induced land degradation). This solution permits the comparison of land condition for different administrative areas at national, sub-national and regional scales. This space-based information is crucial for government institutions and decision makers at various levels to support the implementation of environmental policies.

Outlook to the Future
This operational land condition monitoring for Africa will be continued, beyond the end of AMESD in 2013, through the MESA program (“Monitoring of Environment and Security in Africa”) supported by the European Development Fund and implemented by the African Union (2013-2018). MESA will address the needs for improved management of natural resources and sustainable development in Africa. The bio-geophysical parameters will be provided to MESA by the Global Land component of the COPERNICUS land monitoring core service. ESA PROBA-V gap-filler mission and Sentinel-2 and 3 satellites will provide data continuity after the end of the SPOT-VEGETATION mission.

Global Crop Core Information Service
Objectives
The Global Crop Monitoring Core Information System (CIS) aims at providing objective and timely information on crops to support European policies on agriculture and food security. The main contributions made in the frame of geoland2 include:
• Assimilation of EO data into crop development models;
• Yield estimation using EO data and statistical approaches;
• User assessment of BioPar VGT products;
• Demonstration and assessment of crop area estimates using EO high and low resolution data.
The CIS was implemented by four partners: JRC-MARS (Joint Research Centre of the European Commission, Monitoring of Agricultural ResourceS), ALTERRA (Wageningen University), VITO (the Flemish Institute for Technological Research) and IGIK (Institute of Geodesy and Cartography, Warsaw), with subcontractor (TAMSAT, University of Reading).

User Demands
CROP- CIS responds to policies and legislative frameworks at different levels: Global (supporting to UN Food Security as part of the 1st Millennium Development Goals, but also the recent G20 Initiative on market Transparency of Agricultural commodities), European (Common Agricultural Policy and the Food Security Policies) and national (EU Member states and third parties). Final users of CROP CIS services range from United Nations organisation (Food and Agriculture Organization, World Food Program), to Directorate of Services of the European Commission (DG AGRI, DEVCO, ECHO and EU external Services) to national ministries of agriculture and rural development, and national services in charge of agricultural statistics or early warning systems.
The core information required both for agriculture monitoring, trade or food security is the total production of crops of interest, which results from 2 components – cultivated area and mean yield - needing to be monitored / forecast, every year.
The final products from the user point of view are simple figures (area and yield quantitative estimates), which can be broken down at an appropriate administrative unit level (and illustrated by statistical maps). Mapping products, derived from EO or weather data, are generally considered as intermediate or ancillary, qualitative information. However, they play a crucial role for the detection of hot-spots, in particular in early warning systems, but more generally to locate specific conditions or extreme events affecting the crop conditions. CROP CIS applications use both spatial and temporal analysis (time profile during the crop development; anomalies compared to reference periods) and the wide range of EO spatial / temporal resolution. Crop maps produced in support of area estimates are also used as agricultural “masks”, to extract relevant LR biophysical parameters.

In practice, CROP CIS products are grouped as both internal products (used within CROP CIS processing chains) or external products (delivered for some categories of external users) to be used in appropriate working environments.

Production of crop area estimates using EO high and low resolution data

In geoland2, two ways of estimating crop acreages were demonstrated and assessed:
• One based on intensive ground surveys, where classified HR to MR remote sensing data are used to complement the ground estimates derived from Area Frame Sampling (i.e. adjust the estimate and reduce their variance through the regression estimator).
• The second one based on LR data using a neural network trained on a classified HR image of the area. Although clearly less accurate than the AFS approach (but also less expensive), this approach may be of interest over large areas and/or where ground surveys are not feasible.

Conclusions

CROP monitoring activities were already rather operational applications, but CROP CIS activities contributed to foster the sustainable use of EO derived information.

EO is expected to play a growing role by the incorporation of EO derived state variables in crop development, but also in response to the general need or several independent and converging evidences to support proper analysis. With the increasing length of the available archive, CROP specific indicators or downstream products (crop profile, similar year) are now providing high value-added information for crop monitoring, and in some conditions, efficient and timely predictors for yield forecast (as demonstrated in Tunisia).

The improvement of biophysical parameters needs to go hand-in-hand with a long term commitment on data continuity and interoperability, in order to secure seamless services for operational users. In this context, one of the key challenges for Land GIO (COPERNICUS initial Operation) will be to ensure or prepare the replacement of SPOT VGT by PROBA V or Sentinel 3 programs.

The efficiency of LR sub-pixel classification is highly dependent on the quality of the training (HR classification) data, and of the spatial variability of the LR response (e.g. gradients of phenology and crop calendar) as a given mixture of crops is assumed to have the same NDVI profile over the whole area of application of the model. Inter-comparison between two methods in Ukraine and a comprehensive set of testing on 4 campaigns in China, resulted in a number of findings and practical recommendations. However, further assessment and investigation is required, probably with MR data.

AFS combined with HR EO can be considered as operational approaches for area estimates. However the cost efficiency of EO strongly depends on the cost of the imagery and the quality of the classification.

Sentinel 2 satellites, with its large swath HR, an higher revisit capacity, and new spectral bands are expected to be much more efficient, and could permit an operational monitoring of countries with a high crop importance.
inter-annual variability of cropped areas.

Potential Impact:
Socio-economic Impact

Geoland 2 continued the development of pan-European procedures such as Corine Land Cover or the former and ongoing GMES projects that lead to internationally harmonised and interoperable procedures and nomenclatures. This permitted the production of significant lots leading to economies of scale during production, and therefore cost reductions in the operational phase. These developments permit also that the monitoring of environmental policies becomes more cost-effective, by directing EC spending towards hot-spots and assessing positive / negative impact of programmes/plans before and after implementation. The two Core Mapping Services which are currently acquiring the status of pre-operational services, that is, EUROLAND and BioPar, have integrated new product lines during geoland 2. EUROLAND offers more thematic content on natural / seminatural classes (e.g. forestry, grasslands, wetlands) to support better environmental management. It will also assure higher throughput in production supported by an extension of service partners within a distributed European network. BioPar has provided a comprehensive set of biogeophysical parameters of environmental interest in near real time. This capacity is new in Europe, as the Eumetsat / SAF produces operationally NRT products over a limited set of parameters only; while a portfolio of a large panel of parameters exists in Europe, but not in near real time. In addition, new parameters has become available such as biogeophysical parameters at high spatial resolution.

The SATChMo CMS is a consolidation activity (or service evolution activity) and cannot be qualified at this stage as a pre-operational service. Neither can the CIS be qualified as such, since they have been appointed in geoland 2 as support tasks for validation & verification, and remain still in a consolidation phase.

The portfolio in geoland 2 is significantly extended with respect to that of geoland, as it now integrates the results of parallel GMES activities (ESA GSE and DUE programs mainly) excluded from the geoland integration process:

- **EUROLAND**: for the local LMCS component baseline specifications already exist. For the continental LMCS on the Imperviousness and the Forest Layers are consolidated. The other layers (wetlands, grasslands, small water bodies) are still under discussion. Euroland will develop scientific sound and technical feasible approaches and will demonstrate the look and feel and related costs of possible service specifications as a basis for decisions by the GMES stakeholders. In addition, Product Manuals, intermediate products and change information based on efficient and proven change detection approaches will be offered.
- **BioPar**: for the global LMCS component baseline specifications are taken from geoland. A few additional products will be taken on board based on consolidation activities during geoland 2. New products are HR bio-physical parameters.
- **SATChMo**: reflected on consolidated information service requirements from the LUCAS experience and from national approaches for area frame sampling to underpin in-situ measurements in order to enable the understanding of changes and to support verification and validation approaches of the other two LMCS service lines. In addition seasonal to annual land cover / use change layers will be offered over Africa and Europe. Since SATChMo produces novel services at pre-operational level, it definitely extends the FTS portfolio. The development chain (from design, through benchmarking, demonstration, validation to quality assurance and training) is constructed in a way that allows for a seamless absorption of data from new Galactic polar orbit constellation and Sentinel satellites.
sensors. Similarly, it assures sustainability of value added services built on its results, as far as the core services will be supported in the future.

- CIS: have provided pan-European products selected from consolidated geoland/GSE downstream information services. For services supporting agri-environmental issues based on an integrated service consolidation, innovative indicators have been offered.

A key issue is the sustainability of the Copernicus process. The geoland2 project has contributed to the sustainability of European value-adding services in several ways:

- geoland2 strengthened the general GMES movement by which modular and distributed production lines are progressively established, at least with a pre-operational status. This approach will allow an answer to operational requests more easily, by simply up-scaling production lines and service network. However, full sustainability is achieved only when the overall system becomes fully operational in the frame of Copernicus (initial) operations.

- The technical work achieved in geoland2 leads to firmly based cost estimates, in a process by which a budget discussion takes place with user organisations and policy makers. This process builds confidence between all stakeholders (service providers, user organisations, policy makers), which is key to reach sustainability.

- The large integrating scope of geoland2 permits to keep and preserve the know-how, good-will, and momentum of previous GMES activities. These are assets that contribute also to the establishment of pre-operational processing lines and confidence-building.

- The reliability of services will improve through strict validation, QA, and review / benchmarking schemes established in geoland2.

- The timeliness of delivery will improve, in particular through the new NRT product delivery.

With respect to competitiveness the extensive R&D effort allocated in geoland2 will permit to reach a high-level quality for all product lines, which in turn will make the geoland2 products more competitive at an international level. The geoland2 products can enter a discussion at GEOSS level for example for international benchmarking or the construction of international standards. In addition, products will become more competitive through better quality at reduced cost. This will in turn increase European uptake and export opportunities.

The geoland2 project results will help providing Europe with the capacity to evaluate its policy responses related to environmental planning and efforts to mitigate climate change in a reliable and timely manner. According to Europe’s Common Foreign and Security Policy (CFSP), including the European Security and Defence Policy (ESDP) the question of European independence is of strategic importance. The Copernicus program has made the choice so far of a strategic approach towards reliable EO data access. The geoland2 work program has definitely oriented its choices towards European sensors (for example, nominal global vegetation products will be derived from the European VEGETATION and MERIS sensors, while MODIS is considered as a back-up solution for the continuity of services (in case of sensor failure).

Non-European sensors are considered in the nominal plan only when they are part of an international network (e.g. meteorological sensors). The sources of in-situ data cannot obviously be controlled by Europe in external countries, they must be considered as issued from bilateral or international agreements, made under the umbrella of GEOSS or other international ventures.

geoland2 contributed to European independence not only in the field of data access, but also in the field of services. We establish independent European service & analysis capacities both on supplier, and user
Contributing to the establishment of a European Spatial Data Infrastructure the Copernicus and GEOSS programs participate actively to harmonisation of data specifications and accepted validation procedures. More specifically geoland2 will participate as well to these international harmonisation efforts. In addition, the independent user driven quality assurance approach of the CMS is expected to build the necessary trust / acceptance to turn “project results” into valid inputs for a formalised standardisation process (e.g. through INSPIRE, CEOS).

In addition, the land information (state, cover, use, and land cover change) provided by geoland2 has been of direct use to various other sectoral application fields such as the Atmospheric GMES Pilot Service and to the Emergency FTS. Furthermore climate change is a transversal issue of GMES which can benefit from the products of the vertical services (Land, Atmosphere and Marine). In particular the GEMS/GHG project and the GMES Atmospheric Service monitor integrated global, European and regional concentration fields of greenhouse gases enabling the determination of sources and sinks by using inversion techniques. This top-down approach (from the atmosphere to land surfaces) requires background information about land surface fluxes. To this end, the upgraded land surface models produced by the Land Carbon CIS of geoland2 will be used. In the Land Carbon approach of geoland2, all types of information sources available over land (land use, process models, NRT biophysical products, in situ data) are integrated in order to produce a bottom-up estimate of the terrestrial carbon sources and sinks of the biosphere. This approach is particularly relevant in the context of the EC inventory system, as established under the EC inventory system, as established under the EC Monitoring Mechanism (DECISION No 280/2004/EC) and its Implementing Provisions (2005/166/EC).

The global land information will improve the efficiency of agricultural crop yield forecast systems supported by Global CROP Monitoring. GCM CIS will contribute to the demonstration of methods and to the global deployment of crop monitoring by MARS during the 7th FWP and will facilitate the integration of GMFS portfolio in the future activities on food security. GCM CIS will increase the awareness of the users and stakeholders on the capacities of Earth observation in the fields of Food Security and GCM monitoring, and more generally on strategic importance of the GMES Land Fast Track Services. It will directly contribute to the sustainable development and global implementation of GMES core services and applications related to crop monitoring, crop yield forecasting and food security.

The geoland2 information will be of help as well to operate NRT management of sustainable land-use in Africa supporting a wide range of further services, such as early warning on droughts, fires, etc. The collaboration with user organisations is an integrative part of geoland2, to show measurable progress towards becoming more operational. The geoland2 consortium will collaborate actively with:

- the Implementation Group LMCS at Coordinator level to support programmatic decision making by the Commission
- GMES Land User Working Groups (across GMES land related projects) to support opinion building towards data harmonisation, standardisation and programmatic implementation in support of public decision making taking benefit of the efforts started by GSE Land and continued by Boss4GMES
- dedicated geoland2 user organisations for specific technical work and utility assessments.

Disemnination Activities

Geoland2 dissemination effort can be reviewed in details in the Communication dossiers and the
periodical reports. In general the dissemination activities included
• Communication and discussion of the project’s service standard recommendations
• Distribution and access to the demonstration service results
• Transfer of know-how to user organisations to enable them to take full benefit of the new services available
• Transfer to know-how to service providers to ensure a trusted market offer through qualification of staff and sound understanding and implementation of commonly agreed quality control methods and procedures
• Exchange of validation results and communication of identified bottlenecks among scientists
• Public communication to high-level stakeholders and the European citizen.
The project’s dissemination mechanisms included three levels of targeted dissemination: direct links with important decision makers, federation through stakeholder platforms, and public dissemination of information.

1. Direct (bi-lateral) links to user organisations, decision making bodies and key technical working-groups:
• European high-level users are monitoring the geoland2 progress and results as members of the advisory board. This mechanism has not only guided the consortium through a changing GMES environment, but is also expected to support opinion making within the Implementation Group, the GMES Bureau, and the DGs involved.
• INSPIRE contributions continued through the GMES Land SDIC, pro-actively collecting and disseminating the findings of the FP6 Integrated Projects geoland and BOSS4GMES (FTS Land task), and ESA’s GSE Land.
• GEOSS collaboration was initiated through the GEOSS committees and participation to technical working groups.
• European, national and local user organisations are part of the consortium or have committed their technical collaboration through a user letter. They are expected to spread their findings within their organisation to decision making levels, and within dedicated working groups of public bodies (e.g. national WGs, WISE, EIONET).
• In addition, geoland2 members took benefit from their established contacts with European and national decision makers within governments and parliamentary bodies.

2. Stakeholder platforms to disseminate information, stimulate feedback and debate, and support opinion making beyond the project, with the three major stakeholder groups involved (user organisations, service providers, researchers):
• User Platform: the user platform gathered all user organisation committed to the on-going GMES Land activities geoland, BOSS4GMES, GSE Land, and GSE Forest Monitoring. geoland2 provided complementary resources to set-up new working groups, support document writing and work-shop organisation, and sustain the growing activities beyond the lifetime of the present activities until 2011. The platform supported informal technical discussions and opinion making among Europe’s publicly mandated organisations in the land sector, before proposals on new service standards can be formally submitted to legally mandated working groups for adoption. The recent experience shows, that such discussion is necessary to enable decision taking on novel items (e.g. see the geoland Forum User WGs discussing the FTS in 2005 and 2006 in preparation of the EEA’ decisions in mid-2006). User groups of the land services comprise environmental protection agencies, national mapping agencies (if mandated to implement land cover mapping), water authorities (incl. international river basin authorities), and agriculture agencies in Europe. The few International user organisations will be directly addressed and federated through GEOSS Th l tf ill b i db b fth ETCSIA
GEOSS. The user platform will be organised by members of the ETC-SIA.

- Service Provider Platform: To support a trusted market offer on supply side, service and validation standards, qualification of service providers, and training of user organisations had to be organised. Furthermore, political decision making on new standards and procurements budgets/mechanisms can be supported with facts from the lessons learnt in the GMES and related operational projects. The service provider platform and its working groups were open to all geo-information service providers with a proven heritage in LMCS-type services – across all relevant projects. It is apparent that geoland2 and other project findings cannot lead to a wide adoption without broad discussion with all service providers, who are interested to engage themselves. The service provider platform was organised by the “Land Network e.V.” association initiated by geoland, GSE Land, and GSE Forest Monitoring service providers.

- Science Platform: The science platform provided independent scientific review support to the geoland2 project and ensured dissemination and discussion of geoland2 findings in scientific working groups and conferences. The science platform was organised by EARSeL.

3. Public dissemination of project results will be published through the project web-site, publications, and conferences on coordination level. The coordinator and the task managers made sure that up-to-date project results are available on the project web-site and on the geo-data-server. Key results and events will be accompanied by press releases and/or publications in relevant technical, scientific, user or public newspapers / magazines. An events list was maintained to facilitate communication with geoland2 members, the presentations held / papers provided was published, as well as geoland2 public document deliverables. In addition, geoland2 took care that the GMES User Newsletter initiated and funded by GSE Land and BOSS4GMES so far will be continued. Once a year, a geoland2 Forum invited all GMES Land players to present their findings featuring user working groups, training events, technical sessions, and programmatic high-level user presentations and round tables.

List of Websites:

http://www.gmes-geoland.info/

http://www.geoland2.eu

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