




Synthesis of strategic issues based on expert workshops and status quo study reports

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Change log

Issue	Date	Section	Changes
0.1	28/07/2010	All	Outline and 1 st draft of selected text elements by WP 10000, based on EUGENE expert workshops and draft status quo study reports.
0.2	17/09/2010	All	Updates to reflect comments made by project partners.
0.3	08/10/2010	All	Updates to reflect comments made at 2 nd EUGENE Review Meeting.
0.4	14/02/2011	All	1 st full draft based on Issue 0.3 and SBA-specific draft strategic papers on Climate, Disasters and Water.
0.5	02/03/2011	All	1 st full draft after review by all partners, for submission to workshop with HLWG
0.6	22/06/2011	All	Revision of intro, SBA and cross-cutting sections to implement changes as proposed by HLWG representatives during Workshop on 16 March 2011. ToC and Exec Summary added
0.7	25/07/2011	All	Incorporation of EEA comments, new structure for final chapter, Improvement of Executive Summary
1.0	29/07/2011	All	Finally reviewed by EUGENE project consortium, including all WP leads and coordinator, for release as Version 1 to GEO High-level Working Group.



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Executive Summary

International cooperation is not an end in itself. In fact, it requires additional efforts and resources. In the domain of Earth Observation, though, the benefit for international cooperation is clear: Its requirements, systems and applications are often global by nature, its costs are high, and sharing the burden is a suitable means. This is why Europe – its member states and the EC - has made a commitment to the objectives of GEO. By using its strengths, capabilities and investments in the field of Earth observation to substantially contribute to the build-up and successful operation of GEOSS for the societal benefit of humankind, Europe is one of the indispensable cornerstones of this global endeavour. In return this serves Europe's policies in the fields of environment, energy, disaster management, development aid and climate. Furthermore, these efforts support major UN conventions and programmes and promote Europe's role as a strong and capable partner in the international efforts of adapting to global change and sustainable management of natural resources.


To achieve the vision for GEOSS and to promote Europe as a strong and capable partner in the framework of GEO, Europe's mission is to define and realise the contributions to, and the needs from, GEOSS by leveraging European operational Earth Observation programmes, R&D programmes, and relevant European coordination activities. Maximum efforts are needed to achieve progress within the 2012 – 2015 timeframe which corresponds to the implementation plan for building up the GEOSS.

The current status and challenges of European Earth Observation for climate, disasters and water issues have been thoroughly analysed¹. In general, Europe is well advanced in many areas of Earth Observation and even world leading in various respects. Europe's EO capacity and expertise is characterised by various programme activities, such as

- Systematic, long-term, operational observation systems (both in-situ and space) and reliable services for decision making at European and Member State level, but also with a global perspective, to achieve better knowledge on the status and processes of the Earth System (GMES, EEA, European Meteorological Infrastructure),
- Exploration of Planet Earth from space (ESA, national space programmes),
- Modelling and forecasting the Earth System and its interlinkages (ECMWF, national centres),
- Development of scientific, technical and operational know-how (through the 7th EU Framework Programme and its successor, as well as national research programmes),
- Capacity Building initiatives to empower infrastructure, people and institutions for operating and using EO systems (e.g. AMESD, "GMES and Africa"),
- Specification and implementation of accessible and interoperable geodata infrastructures (INSPIRE).

Long term funding/resourcing in order to achieve sustained operation of the necessary EO infrastructure (space-based and in-situ) and improved access to and exchange of data and

¹ See <http://www.eugene-fp7.eu/documents.htm>

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information is of paramount importance for all societal benefit areas (SBA's) under consideration.

Based on the work that has been conducted within the EUGENE project, the European GEO approach should be guided by the following principles:


- Fully implement GMES and secure continuity and further development of GMES and other European EO systems, such as the European Meteorological Infrastructure (EMI), in close cooperation with GEOSS, where appropriate;
- Intensify contributions to GEO standardisation activities to promote INSPIRE and other European standards and specifications;
- Further invest into European scientific expertise and innovative capabilities and offer expertise within international collaboration frameworks, such as GEOSS;
- Offer cooperation to the developing world, with a focus on Africa;
- Participate more actively in GEOSS user fora to better bring in European requirements;
- Take advantage from GEOSS and its political profile, especially taking account of the
 - sustainability and interoperability of systems,
 - promotion and implementation of the Data Sharing Principles,
 - strengthened in-situ systems,
 - documented data quality, and
 - user-driven recognition of information requirements for the benefit of decision making.
- Improve coordination of European GEO actors on all levels.

GMES is expected to be a critical framework for achieving a strong and visible European contribution to GEOSS. This is valid not only for satellite-based observations, where ESA and EUMETSAT provide very well-suited mechanisms, but also for in-situ networks through the GMES in-situ component coordinated by EEA. EEA is developing approaches to address issues related to access to in-situ capacities, observational gaps etc., to ensure sustainable availability of in-situ observation systems for GMES services, but also as a contribution to GEOSS.

The full and timely implementation of GMES will contribute considerably to the successful implementation of GEOSS. Additionally, best use of GEOSS for Europe can be made within the GMES programme. Therefore, it is important to carefully define the relationship of GMES with GEOSS and other international frameworks.

While services related to disasters and climate are well reflected in the GMES structure and relation to GEOSS is straightforward, the Water SBA has only been intrinsically addressed by GMES (land services) up to now. In general, GMES as an emerging large-scale infrastructure programme has yet to fully define some important aspects, such as data sharing policy, the partnership with the EMI, the organisation of the in-situ component, and the embedding in the international arena.

However, GMES is not the only relevant framework for GEOSS in Europe. The EMI also contributes considerably to GEOSS, by its own programmes, and by bringing its vast

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experience and infrastructure into GMES. For achieving sustained in-situ observations, the European Strategy Forum on Research Infrastructures (ESFRI) is another important framework. INSPIRE sets associated geodata interoperability specifications and data access conditions which are also highly relevant to GEOSS.

Connected to these programmes and frameworks mature (EMI) or emerging (GMES) user engagement structures with a strong European and national focus exist. Valuable synergies with the global level are yet to be developed.

The explicit inclusion of GEOSS into the framework of FP7 and the funding of projects dedicated to GEOSS has been highly successful in improving European participation and visibility in GEO. This should be continued in the new EU Framework for Research and Innovation (Horizon 2020) and fully integrated with research dedicated to GMES. Other R&D mechanisms, such as the ESFRI Roadmap, whilst also having great potential to make contributions, should also make explicit reference to GEOSS, to foster interaction of related activities with GEOSS.

Europe is strongly engaged in capacity building for Earth observations through numerous programmes, and thus well positioned to support GEO, but coordination should be enhanced at European level to make more use of GEO and its capacity building activities.

With its undisputed strengths and capacities in Earth Observations, Europe can be a strong partner in GEO and related international Earth Observation programmes. Building on its existing assets and structures, Europe should enhance coordination, intensify communication activities, and leverage the political profile of GEO to strengthen European political support for GEO and thus raise the efficiency and effectiveness of the European GEOSS contribution.

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Background and purpose of the document

Europe – its Member States and the EC - has made a commitment to the objectives and strategic targets of GEO. Numerous European actors are strongly involved at all levels of GEO and the building of GEOSS. However, an overall European GEO approach based on political aspects as well as scientific and technological strengths and user needs is not yet in place. Coordinated, concrete actions at an implementation level are needed to bring forward Europe's political/strategic position within GEOSS and its nine SBAs. Consequently, Europe, as a strong partner in GEO, has to define the contributions, commitments and benefits of, and to, European space-based and in-situ EO systems. The EUGENE² project aims, on the basis of thorough status quo studies and expert consultations, to provide inputs to stimulate the discussion and development of a European GEO strategy, started by the GEO High Level Working Group (HLWG).

The purpose of this document is to synthesize the strategic aspects of the EUGENE studies and workshops on the European status quo in the GEO SBAs “Climate”, “Disasters” and “Water”. This strategic synthesis aims to feed the European internal discussion on the European GEO approach, including a set of recommendations for the short and medium time frame, mainly referring to the time period remaining until the end of the current GEO 10-year implementation plan in 2015. The document also aims to provide a more generic framework into which other related aspects originating from studies beyond the EUGENE project could be incorporated.

Strengthening European Earth observation activities and programmes, while improving European collaboration and coordination of and taking due account of the GEO strategic targets, will improve the European role in GEO. EUGENE's analyses on the status quo of European Earth observation³, and related discussions with European experts at dedicated EUGENE workshops⁴, identified potential strategic actions in the SBA's of Climate, Disasters, and Water.


Additionally, a number of cross-cutting issues and organisational aspects of Europe's Earth observation activities have been recognised. As a result, the following elements for a European GEO strategic plan for the years 2012-2015 and beyond have been identified.

² The EUGENE project was started in order to foster collaboration between pan-European organisations in the field of Earth observation and to strengthen the coordination of national and regional programmes and organisations in their work towards GEO for selected GEO Societal Benefit Areas which correspond to European political priorities: Water, Climate, and Disasters. This also encompasses intrinsic cross-cutting issues, such as data sharing, with special attention to the relationship between relevant European frameworks and initiatives (GMES, INSPIRE, FPx) and GEOSS.

³ reference documents, all available at <http://www.eugene-fp7.eu/documents.htm>:

- 1) EUGENE - Work Package 2000 - Climate Status Quo Report, Issue 1.1
- 2) EUGENE - Work Package 3000 - Status Quo Report Disasters, Issue 1.0
- 3) EUGENE - Work Package 4000 - Status Quo Report Water, Issue 1.0

⁴ EUGENE Workshop Reports are available at <http://www.eugene-fp7.eu/documents.htm>.

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1 Climate

GEO Strategic Target by 2015: Achieve effective and sustained operation of the global climate observing system and reliable delivery of climate information of a quality needed for predicting, mitigating and adapting to climate variability and change, including for better understanding of the global carbon cycle.

Status Quo of European contribution: Europe is very well positioned in the international context with the active participation of ESA, EUMETSAT, ECMWF, EC and national agencies in key frameworks (e.g. IPCC, GCOS, CEOS, CGMS, GSICS, SCOPE-CM, WCRP....). These key frameworks are, in turn, closely connected to the implementation of the relevant GEO Climate tasks and targets. This is complemented by strong, individual, contributions from European Member States' meteorological services, oceanographic services, modelling centres and in-situ data centres. In addition, comprehensive bilateral and multi-lateral arrangements exist between Europe and international partners (e.g. Initial Joint Polar System (IJPS) between NOAA and EUMETSAT) resulting in the coordinated implementation of selected Satellite-based Earth Observing Systems.


Within Europe there is a strong "political will", at the highest levels, to address climate issues. This "political will" provides a solid backdrop to exploit Europe's scientific and operational strengths in climate which are often "world class", e.g.:

- Systematic, long-term, operational meteorological observations (both in-situ and space) through EUMETNET and EUMETSAT, with in-situ record lengths exceeding 100 years in some cases;
- The commitment of EUMETSAT and ESA (CCI) to generate GCOS compliant climate data records;
- The research and development investment by ESA, and national space agencies, in observing systems (which in some cases are the forerunners of operational missions);
- Extensive modelling capabilities addressing *inter alia* Earth system processes, Reanalysis (e.g. ECMWF) and Climate Prediction and Projections;
- Specific, diverse, expertise (e.g. polar monitoring, coastal seas and storms, energy technologies, cloud assessment...) that complement general capabilities;
- The commitment of the European Community to address climate issues through the use of Research Funding.

European Target: Increase and sustain its already prominent scientific and operational contributions to international frameworks based on the "political will" within Europe to address climate issues, leveraging both National and European-level activities.

Recommendation CL-1 (Sustainability and Frameworks): Strengthen the overall European contribution to the GEO Climate SBA by targeting some specific activities with secure, long-term, funding.

Long-term funding of crucial activities is of major importance in order to ensure sustainability and further improve the European strengths in the field of climate.

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The future GMES Climate Change Service, as an overarching framework for European Climate activities, should be implemented in a way that both adds value and is compatible with existing frameworks.

- Develop a sustained and coordinated GMES Climate Change Service that takes due account of other mechanisms and initiatives (e.g. FP7 and successor, the ESA Climate Change Initiative, the EUMETSAT Climate activities, the Global Framework for Climate Services (GFCS), research programme activities and infrastructures, the JRC Work Programme, “Climate activities in developing countries”, the Policy on Climate Mitigation and Adaptation, and Europe’s contributions to international conventions) in order to add value and avoid inefficient overlaps.

Potential areas to be addressed by the GMES Climate Change Service include:

- i) Maintain, extend and strengthen terrestrial and oceanic in-situ networks, filling remaining regional gaps, and improving interdisciplinary access to in-situ data;
- ii) Create long time-series Climate Data Records and take measures for data rescue and homogenisation (with a particular focus on in situ data);
- iii) Construct long time-series of Essential Climate Variables based on satellite data, where possible;
- iv) Implement standards for metadata documentation;
- v) Make provision for regular reanalysis cycles.


Concerning i), three major issues have been identified with in-situ networks: data gaps, network sustainability and access to data.

In-situ data gaps affect both terrestrial and oceanic domains, i.e.:

- problems of data availability from the GCOS Surface and Upper-Air Observing Networks in Eastern & Central Europe and North Africa;
- the sparseness of data from the oceans is a problem for both the initialisation of climate prediction models and the reconstruction of past ocean behaviour (as part of the climate record). Also, as the oceans control the rate of climate change there is a need to get more out of the sparse observations using modelling and assimilation methods and through the bias correction of older data.

Problems of in-situ network sustainability also affect both the oceanic and terrestrial domains and, in the case of the terrestrial domain, are intimately connected with data access:

- in the oceanic domain, at a global level, most in situ observing activities continue to be carried out under research agency support, with associated research programme time constraints. A particular concern is the fragility of the financial arrangements that support most of the present effort; there has been very limited progress in the establishment of national ocean or climate institutions tasked with sustaining a climate-quality ocean observing system. Thus, the primary agents for implementation for ocean observations and analyses remain the national and regional research organisations, with their project time-scale focus and emphasis on principal investigator-driven activities.

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- Also, the ice-free upper 1500 metres of the ocean are now being observed systematically for temperature and salinity for the first time in history, because both the ARGO profiling float and surface drifting buoy arrays have now achieved global coverage. This data is critical for decadal prediction.
- Therefore there is a need to strengthen these valuable oceanic in-situ networks and put these predominantly R&D-funded networks on a more sustained footing.
- regarding the sustainability of terrestrial networks, it is noted that most European networks are managed by European NMHSes and there is a tendency, due to budget constraints, to reduce the number of observing stations and/or a deterioration of the network as a result of decreasing maintenance activities. Such networks generally struggle to find resources as funding agencies/programmes normally consider observational networks to be (national) infrastructure. This situation is, in turn, reflected in the often restrictive national data policies which hamper open and free access, as income from in situ data is needed for network maintenance.


Concerning ii), long time-series Climate Data Records (CDRs) are very valuable for climate applications and the creation of such CDRs sometimes requires the rescue and homogenisation of long-term analogue data records (generally in-situ). This requires significant resources and there is a need to prioritise which datasets should be rescued first in order to rapidly fill record gaps in space and time. There are a number of initiatives underway addressing data rescue and homogenisation, but more remains to be done.

Concerning iii), the feedback received from climate modelling centres has emphasised the need for consistent, long time-series of stable, good-quality, inter-calibrated satellite-based Essential Climate Variables (ECVs). The mechanisms of SCOPE-CM, the EUMETSAT SAF Network and the ESA CCI could be further used to foster the generation of consistent, high-quality data products across the different ECVs.

Concerning iv), in order to ensure that climate data can be "discovered" by the various users, there is a need for the data custodians to provide metadata describing the outputs of the data production and processing chains (applicable to both satellite and in-situ data). The WMO Information System (WIS) addresses (*inter alia*) the need for coherent metadata standards, the creation of metadata and the data delivery mechanism. Increased emphasis could be placed on WIS as a mechanism to address the problem of the creation of coherent metadata (and data discovery).

Concerning v), reanalysis enhances the value of historical observations for climate applications. Within Europe, this important activity is currently carried out on a project basis and is not covered by sustained funding. This lack of sustained long-term funding inhibits coordination between centres concerning their production schedules for new reanalyses. All reanalyses activities need to be supported by evaluation teams (e.g. to document the products and their quality) and in order to maintain technical competence between reanalysis cycles and to ensure the regular implementation of reanalysis, the funding of reanalysis activities should be put on a sustained footing.


Regarding the potential arrangements for any GMES Climate Change Service, efficient feedback mechanisms should be implemented to allow international expert communities to monitor the future shaping and scope of the GMES Climate Service, and its compatibility with other relevant European and global mechanisms, to focus appropriate attention on the areas that need particular strengthening.

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Recommendation CL-2 (Coordination of European Actors): Member States to better ensure coordination between the relevant major European organisations to maximise effectiveness and efficiency of the extensive European activities in climate monitoring in the international arena.

Notwithstanding the successful inter-agency coordination mechanism that exists between EC, EUMETSAT and ESA, there is a further need to ensure coordination between the relevant European actors, namely ESA, EUMETSAT, ECMWF, EUMETNET, EEA, EC etc.. The importance of this coordination activity is underscored by the funding, provided by member states, to individual European organisations. Enhanced coordination between such organisations, driven by member states, is fundamental in order to further improve the efficiency of European activities in the high-priority area of Climate and Climate Change.

- Highlight to Member States areas of common interest related to activities of various European organisations and emphasise issues that potentially require a coordinated position across the organisations in order to obtain the maximum benefit from the available funding.

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2 Disasters

GEO Strategic Target by 2015: Enable the global coordination of observing and information systems to support all phases of the risk management cycle associated with hazards (mitigation and preparedness, early warning, response, and recovery).

Status Quo of European contribution: Europe contributes to the GEO Disasters SBA with a variety of services and products, mainly through the GMES Emergency response service, its operational forecasting services and the European Meteorological Infrastructure. Additionally, European entities significantly contribute to international mechanisms like the International Charter on Space and Major Disasters and UN-SPIDER. However, there is a need to intensify European efforts to achieve the GEO strategic target and to increase collaboration among existing international mechanisms to the benefit of both the international partners and Europe itself.


European Target: Further strengthen harmonisation and collaboration of services related to disasters at the European and international level and improve relevant global activities by contributing the European expertise and infrastructures to the success of international risk management.

Recommendation DI-1: Support an improved international coordination of Earth observation based contributions to emergency response

The coordination and harmonisation of services using Earth observation data to provide information for disaster management should be improved at a global level. While the activation mechanism of services in case of disasters is well advanced and the acquisition of and access to satellite data (through mechanism like UN-SPIDER or the International Charter on Space and Major Disaster) has been considerably improved, deficiencies still remain in the global coordination of service providers and their products in the case of major disasters. This was very apparent in the Haiti Earthquake⁵. The activities of the European GMES Emergency Response Service and other organizations involved in rapid mapping and international activities like the International Charter on Space and Major Disasters, Sentinel Asia, SERVIR, UN SPIDER, and GEO activities, such as the Geohazards Supersites Initiative, should be better coordinated to avoid confusion among the user community.

- **European organisations involved in Disaster Management to participate actively in relevant GEO Work Plan tasks** and consultations in the frameworks of GEO and the UN to discuss best practice solutions for emergency mapping, information exchange, and an improved world-wide coordination of activities.
- **Europe to increase its visibility in GEO by incorporating pan-European initiatives.** In particular, a high visibility for the GMES Emergency Response Service should be aimed at, and additional European activities, such as FP7 projects associated with GEO, should be integrated into the GEO work plan.
- **Promote the development of quality standards and guidelines for EO based emergency response products:** It is necessary to develop standards and guidelines

⁵ In the case of the Haiti earthquake, a large amount of EO-based disaster information (several hundred products) had been produced by several service providers. These products contained redundant and sometimes even contradictory information and were of different quality. As a result users had difficulties to choose the most reliable product.

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in order to provide users with clear indications about information quality and uncertainty, along with the product itself. In this respect, Europe draws on the results and significant experiences gained in the context of GMES and other disaster-related projects and activities.

- **Improve the link between relevant stakeholders such as data providers, service providers, scientists and end users:** To achieve better coordination among different European as well as global actors, GEO could serve as an appropriate platform for exchange. For geohazards, the Geohazard Community of Practice (GHCP) could take a facilitating role, as it already incorporates important stakeholders. Good European participation in the GHCP should be achieved, and an enlargement of the work undertaken by the group to include other hazard types should be fostered within GEO and promoted by Europe.
- **Foster collaboration of GMES Emergency Response Service (ERS) and the International Charter on Space and Major Disasters.** Based on the good collaboration between European Charter members and the pre-operational GMES ERS “Safer”, cooperation should be further promoted while the operational ERS is being implemented. Good communication and collaboration between both mechanisms will avoid a waste of resources in case of parallel activities. In addition, mutual benefits can be achieved, e.g. by a division of work in the case of extreme disasters, data sharing where possible/appropriate, and a provision of GMES rapid-mapping capacities to the Charter in cases of Charter activations with relevance to European users or policies.

Recommendation DI-2: Facilitate the access to in-situ data and their integration into all stages of disaster management

Access to space-based Earth observation data on a European and international level has been considerably improved through coordination by the European Space Agency (ESA), EUMETSAT, and international partners and initiatives, e.g. the International Charter Space and Major Disasters. Access to in-situ data, however, still remains difficult and is not yet harmonized and operationally implemented, although appropriate in-situ data provide essential inputs for disaster modelling, risk assessment etc. On-going activities, such as the GMES in-situ coordination (GISC) project led by EEA, are currently aiming at enabling an easy and open access to in-situ data in the GMES framework.

- **Extend and dovetail existing in-situ data networks relevant to disaster management within the frameworks of GMES and GEOSS:** Most in-situ datasets exist on national level, which means that they are hard to find and to search for up to date information is time-consuming. Especially during the emergency response phase, fast access is required. In addition, these datasets display different levels of quality. Availability and interoperability of data relevant to all stages of disaster management should be improved by linking and harmonising national data collections and national, European, and international networks, as far as possible. On a European level, the European Environmental Agency (EEA) is establishing the GMES in-situ component by making use of existing networks and extending their functionality, interoperability, and sustainability through its current work within the GISC project. Ways for best possible incorporation of these networks into GEOSS via the GEOSS Common Infrastructure (GCI) should be analysed, and an extension to a user-friendly world-wide “net of networks” would serve the needs of European as well as world-wide actors operating in the field of disaster management

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- Promote the work of future GEO tasks dealing with in-situ data for disaster management:** While task DI-06-09 (Use of Satellites for Risk Management) of the GEO 2009-2011 work plan is especially dedicated to the space-based Earth observation system no similar task has been assigned to deal with in-situ data. Thus, Europe should make an effort to promote the work within GEO on improving access to in-situ data according to the new work plan for the period 2012-2015. Depending on the outline of the plan European organisations should actively participate in the relevant tasks. In addition, possible contributions from the activities of the GISC project should be analysed and promoted if considered beneficial.


Recommendation DI-3: Improve organisational links and interaction between existing forecasting services and emergency response services to facilitate a fast and efficient reaction in case of a disaster

The interaction between forecast services (e.g. meteorological services) and emergency response services should be improved. Especially for hydro-meteorological hazards a number of operational forecasting and early warning systems exist in Europe and world-wide. For instance, European services are provided by the Joint Research Centre of the European Commission, e.g. via the European Flood Alert System (EFAS), the European Forest Fire Information System (EFFIS), or the Global Disaster Alert and Coordination System (GDACS). In order to enable satellite tasking as soon as possible after the occurrence of a disaster and facilitate the timely reaction of emergency mapping services, closer links should be established between emergency response and forecasting services.

- Establish direct links between Forecasting Services and the GMES Emergency Response Services:** European forecasting systems (e.g. EFAS, EFFIS, meteoalarm or geofon) and GMES emergency response services should analyse ways of beneficial cooperation (relevant information, means of rapid data exchange, etc) and means to implement them. One main issue is the restricted data policy. Data of some forecasting services (e.g. EFFIS, medium-range weather forecasts by ECMWF) is only available to a constrained user group (mainly national authorities), due to restrictions imposed by the member states. While links between different forecasting services do exist (e.g. co-operation agreement between JRC and ECMWF in order to use ECMWFs meteorological forecasts as input into flood forecasts provided by EFAS), links to Emergency Response Services (e.g. SAFER) do not yet exist. Representatives from Forecasting and Emergency Response services as well as from member states should commonly aim at establishing the necessary structures and procedures for a better cooperation. The exchange of data in this case does not imply a free and open access to the general public, but an exchange between the different services.

Recommendation DI-4: Promote the establishment of global early-warning systems and missing services

The GEO Work Plan Task DI-09-03 (Warning Systems for Disasters) of the GEO 2009-2011 work plan specifically deals with global early warning systems for tsunamis and wildland fires, while other hazards are not yet being targeted. Through the experiences gained in establishing existing systems such as EFFIS and EFAS, as well as EUMETNETs Meteoalarm and ECMWFs medium-range weather forecasts and Extreme Forecast Index, Europe could considerably contribute to the establishment and operationalisation of a global early-warning system of systems.


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- Europe to actively promote the establishment of a global early warning system within GEO:** In the aftermath of the devastating 2004 tsunami in the Indian Ocean, the UN recognised the need of a global early warning system and since then has worked on that topic. In close cooperation with the UN, GEO should support the establishment of an early warning system of systems. This system is not supposed to replace existing ones, but to serve as platform consolidating the information for the user. This is especially necessary for systems dealing with the same hazard. The platform can further help to use synergies of systems dealing with different hazards (e.g. usage of common communication networks, procedures or institutional frameworks). Europe should support this work by incorporating its systems like EFFIS and EFAS.
- Promote establishment of missing services:** While Europe has advanced forecasting services for hydro-meteorological hazards, operational systems for other hazard types such as landslides and volcanoes do not exist. Also a lack of a ground movement services important for the preparedness with regard to geohazards has been identified. Efforts should be made to close gaps of coverage within Europe and on a global scale, especially in developing countries (e.g. within the GMES and Africa initiative).
- Europe to promote enlargement of focus of GEO to incorporate all types of disasters:** While the current work plan only aims at establishing warning systems for a limited number of hazards, European early-warning system providers should take a strong position in the coming GEO work plan task(s) dedicated to early warning systems. The aim should be to broaden the scope of the current in order to take into account additional types of disasters.

Recommendation DI-5: Improve benefits of Earth-observation based disaster management products through capacity building

So as to use disaster management products in a beneficial way, users need to be trained. This is especially important with regards to early warning systems where short reaction time and reliability of warnings are highly important to ensure the effectiveness of such systems. Furthermore, decision makers need to be made aware of existing products and services. The case of the Pakistan floods 2010 showed that not necessarily the lack of appropriate data, but the ignorance about its existence hinders effective disaster management during the preparedness phase. Meteorological data as well as the Extreme Forecast Index (EFI) from the ECMWF indicated the unusually strong rainfalls 6 days before the event. The EFI was available to the Pakistani authorities and additional, more precise data would have been provided upon request.

- Foster capacity building activities within GEO:** In order to ensure an effective usage of available services and products, users need to be educated about the benefits and the correct usage as well as the way to access the data. The capacity building tasks within GEO could serve as appropriate platforms and European service providers should actively participate in these tasks.
- Promote distribution of information on available products and services among relevant actors:** As the Pakistan floods 2010 indicated, decision makers and rescue services need to be informed about available services and products. Europe should promote the registration of its services and products into GEOSS to increase their visibility and to make them more widely known.

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3 Water

GEO Strategic Target by 2015: Produce comprehensive sets of data and information products to support decision-making for efficient management of the world's water resources, based on coordinated, sustained observations of the water cycle on multiple scales.

Status Quo of European contribution: Europe has developed extensive capabilities and expertise in the water sector and has a significant share in the implementation of various international frameworks. Europe is well positioned to contribute to the closure of hydrological observational gaps in GEOSS, to support the development of new technologies and observation systems as well as to contribute to the development of capacity in the use of Earth observations. While many European and national players are active in this sector, there is evidence for the potential of an improved coordination of initiatives and actors at all levels.


European Target: Improve coordination and sustain observations of water cycle components, remove obstacles from sharing of hydrological data and facilitate monitoring and continuous assessment of the status of water resources. Europe intends to offer its expertise to GEO partners to develop capacity in the use of Earth observations in different parts of the world.

Recommendation WA-1: Improve coordination of GEOSS-related hydrological activities in Europe.

Europe has developed extensive capabilities and expertise in the water sector through the engagement of various pan-European organisations and Member States. However, Europe is also facing a certain fragmentation of institutions involved in environmental monitoring of the water cycle, which mainly originates from the thematic diversity of the areas affected by water and the associated institutional responsibilities.

GEOSS is addressing a wide range of topics related to water through the concept of the nine Societal Benefit Areas (SBA) along with the possibility to widen the scope of topics should the need arise. Hence, GEOSS offers itself as an overarching framework for Europe to establish a pan-European coordination process in the water area to improve coordination of existing Earth observation activities at European and national level. Since GEOSS addresses key international players and initiatives, a pan-European coordination process related to GEOSS may serve to coordinate Europe's contributions to the implementation of international frameworks.

- **Establish links of the HLWG to existing European expert groups in the water sector as coordination platforms for European GEOSS activities.** Many EU Member States contribute to international hydrological efforts via memberships in different working groups on European and international level. These groups represent potential overarching frameworks for Member States to organise their involvement in GEOSS and to improve coordination on a national level. The WMO Working Group on Climate and Hydrology (WG-CH) within the Regional Association VI (Europe) could be used by Member States as a platform for GEOSS-related technical discussions and cooperation. It is recommended to consider establishing a formal link and regular exchange between the WG-CH and European GEO stakeholders in the Water SBA. and making use of the WG-CH as a European coordination entity in the water sector with links to the European GEO High Level Working Group (HLWG)

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Recommendation WA-2: Establish a coordinated European presence in the GEO Water SBA.


Coordinated, concrete actions at implementation level are needed to bring forward Europe's political/strategic position within GEOSS and its nine SBAs. Participation in relevant GEO Work Plan Tasks and committees enables the exchange of expertise and the establishment of links with international partners. A strong European participation in the Water SBA will help to identify observational gaps and to develop solutions based on European capabilities. Further, a strategic orientation of European programmes, such as GMES and FP8, is needed to assure both strong European contributions to and benefits from GEOSS.

- **Establish an active European branch under the GEO Integrated Global Water Cycle Observations Community of Practice.**⁶ The implementation of activities in the Water SBA is supported by the Water Cycle Community of Practice. This community features regional subgroups, which address regional aspects related to the deployment of integrated observations of water cycle components. A regional community of practice provides an ideal forum for the European water community to identify water-related user requirements, to increase visibility of European Earth observation capabilities, and to take opportunities for Europe on a global level. It generally enables European organisations to exchange ideas, increase cooperation with relevant international actors and contribute to the implementation of the Water SBA.
- **Improve coordination of European contributions to GEO Water Tasks.** It is recommended to increase coordination of abundant European contributions to GEO Work Plan Tasks by conducting regular European GEO Task workshops, preferably back-to-back with the already established GEOSS European Projects Workshops (GEPW). Relevant European activities need to be better communicated on GEO Task level. The development of the GMES in-situ component (GISC) by the European Environment Agency (EEA) and the GMES Africa Action Plan are highly important processes in this context. Participation of European stakeholders and project coordinators in GEO Water Tasks is an efficient way of achieving coordinated contributions.

Recommendation WA-3: Develop coordinated, targeted observations of the global water cycle and assure a proper European 'branding'.

- The closure of observational gaps is an important step to achieve the Strategic Target of the Water SBA. On a global scale, this can only be achieved by a joint, coordinated effort of the international Earth observation community. Europe has developed extensive capabilities in the water sector such as operational hydrological networks maintained by National Hydrological Services, pan-European archives of water-related information, technology for monitoring and early warning systems for hydro-

⁶ An informal cooperation with the GEO Integrated Global Water Cycle Observations (IGWCO) CoP has already been established on the occasion of the EUGENE project. An informal reporting mechanism has been established to identify concrete possibilities for cooperation of European organisations and the IGWCO.

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meteorological hazards, and expertise in the development of hydrogeological maps of continental scale.

- **Support the deployment of remote sensing technologies for hydrological applications.** Europe is contributing successfully to the development of remote sensing technologies for hydrological applications and should intensify international cooperation in the GEOSS framework. For example, the Committee on Earth Observation Satellites (CEOS) has established different virtual constellations (VC), which address certain Earth observation requirements through combined, overlapping use of different satellite systems as a contribution to the implementation of the GEO Work Plan. Europe should provide suitable technology (e.g. ESA's SMOS satellite) to the VCs and support the development of a VC for hydrology.
- **Contribute Earth observations components in the framework of the Water SBA Tasks.** In addition to the registration of Earth observation components in the GCI, Europe should take strategic opportunities to provide dedicated components to specific Water SBA Tasks. The Task framework facilitates international coordination and increases the visibility of European contributions.

Recommendation WA-4: Foster the exchange of hydrological data, with a focus on in-situ observations.

Besides technological issues, restrictive and complex data policies still pose a major obstacle for the exchange of hydrological data. With the recently adopted GEOSS Data Sharing Principles (DSP), GEO intends to facilitate the exchange of Earth observation data on a global level. Three major European frameworks for (hydrological) data exchange contribute to the development of GEOSS: the INSPIRE Directive, the Water Information System for Europe (WISE) as a part of the planned "Shared Environmental Information System (SEIS)", and the Global Monitoring for Environment and Security (GMES) programme with a dedicated in-situ observation component currently under development. European stakeholders are also deeply involved in the efforts of international standardization organizations such as ISO and OGC. The GEOSS initiative represents an international framework, which supports Europe in enabling access to and exchange of hydrological data.

- **Support the development of standards for the exchange of hydrological data.** Efforts to develop specifications and standards for data formats and interfaces to facilitate the exchange of hydrological data should be followed in the context of international standardization activities such as the WMO/OGC Hydrology Domain Working Group. Especially, existing INSPIRE related standards need to be taken into consideration.
- **Work towards compatibility of INSPIRE and the GEOSS Data Sharing Principles.** Through the INSPIRE process, Europe has acquired considerable experience in the field of spatial data standards and infrastructure development, which should be brought into the GEO process in a coordinated way.
- **Enable the access to the WISE database through the GEOSS Common Infrastructure.** In addition to the registration of components such as WISE in the GEOSS Registry, interoperable access to such information systems through the GCI should be aspired.
- **Facilitate the implementation of GEOSS Data Sharing Principles in European Member States.**

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4 Cross-cutting issues

4.1 Architecture and Data

GEO Strategic Targets by 2015: (Architecture) Achieve sustained operation, continuity and interoperability of existing and new systems that provide essential environmental observations and information, including the GEOSS Common Infrastructure (GCI) that facilitates access to, and use of, these observations and information.

(Data Management) Provide a shared, easily accessible, timely, sustained stream of comprehensive data of documented quality, as well as metadata and information products, for informed decision-making.

European status quo: The European Meteorological Infrastructure (EMI) has, over decades, developed a very well-functioning user-driven architecture. EMI provides sustained operations of EO systems and service continuity while being gradually upgraded and well integrated in the relevant international cooperation frameworks.

GMES as emerging large-scale infrastructure programme has entered its initial operations phase, while some important aspects, such as data sharing, the partnership with EMI, organisation of the in-situ component, and embedding in the international scene is not fully defined yet.

The European Strategy Forum on Research Infrastructures (ESFRI) also has the potential of being an important framework supporting GEOSS. At the same time, Europe is well advanced in implementing standards for geodata interoperability and data sharing regulations through the EU INSPIRE directive.


ESA with its R&D capacities and EUMETSAT as operational organisation for meteorology and climate are central pillars of the European space-based EO architecture and are fully connected with GMES and the European meteorological programmes. They are crucial supporters of the Committee of Earth Observing Satellites (CEOS), the space component of GEOSS. ESA also contributes significantly to the GCI, e.g. by operating the GEO Portal.

European target: Achieve sustained operation and continuity of GMES and other major European contributions, interoperable with and accessible to the GEOSS Common Infrastructure, and exchange observations and products of documented quality for the mutual benefit.

Recommendation AD-1: Provide relevant European key activities with secure long-term funding to both serve European and internationally agreed requirements.

Many relevant EO activities are currently funded from R&D sources. Other systems planned as operational systems, are threatened by a disruption of continuity. Transfer of activities from R&D to sustained operational activities secured by long-term budgets is a major challenge at global and European level, and a precondition for most of the applications benefitting from EO. A major example is GMES that faces the challenge of transferring from its initial to full operations. The continuity of EUMETSAT's Polar System is another near-term example.

Recommendation AD-2: Implement within GMES a key framework for European GEOSS contributions as part of the international GMES cooperation strategy

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While GMES has always been considered to be Europe's main contribution to GEOSS, and GEOSS is explicitly and repeatedly mentioned in GMES policy documents⁷, the relation with GEOSS is yet to be fully defined. Such a definition should include the following elements:

- Consider the potential of increased international cooperation, inter alia through GEOSS, for the build-up of both the GMES space and in-situ component;
- Identify GMES resources suitable to be shared with the international community and register them in the GCI, whilst ensuring a proper 'branding';
- Consider the GEO data sharing principles in the implementation of the GMES data policy;
- Foster participation of GMES activities and representatives in relevant GEO tasks and oversight bodies.

Recommendation AD-3: Intensify involvement in GEO activities targeting standards for metadata and data quality in order to promote the European INSPIRE and other standards and maximise benefits from GEOSS to European systems and programmes.

INSPIRE as the legal basis for geodata exchange at European public level must be the guideline for the European approach to GEOSS interoperability arrangements. GEOSS can benefit from the rich European experience and expertise generated by the INSPIRE process. This should be complemented by European involvement and visibility at the GEOSS front-end (the GEO portal) and its core GCI functions. The relevant activities of ESA should be maintained.


Recommendation AD-4: Promote and implement the GEOSS Data Sharing Action Plan within GMES, other relevant major European programmes and coordination bodies, funding agencies, and Member States.

A major GEO added value so far is the progress achieved with the GEO Data Sharing Principles which have contributed to the shaping of European data policies. In the case of GMES, they have been fully implemented in ESA's principles of the GMES Sentinel data policy, but a full and comprehensive GMES data and information policy is yet to be defined. To make GMES a success, and allow data sharing with international partners, the GEO Data Sharing Principles need to be promoted in the further process of GMES data policy definition. In the case of the EMI, GEO data sharing principles have been promoted through e.g. the Oslo Declaration, however, further progress is needed to fully implement them.

Recommendation AD-5: Link the GMES In-situ Coordination activity (GISC) with the GEOSS implementation process to foster mutual benefits for GISC and GEOSS.

GISC is a major process to improve data access for GMES Services to European in-situ observing systems, and should also be a major contribution to GEOSS. Due to the global nature of many GMES Services, access to global in-situ networks is a crucial need and major challenge. By actively engaging in the relevant GEOSS in-situ task and implementation

⁷ Explicit reference is made in the EU regulation on GMES and its initial operations (No 911/2010), but also in the various EC communications on GMES, such as COM(2005)565 („From concept to reality“), COM(2008)748 („We care for a safer planet“), and COM(2009)589 („Challenges and Next Steps for the Space Component“).

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oversight body, Europe will be able to shape and profit from a well performing global in-situ coordination process. The challenge of in-situ data coordination cannot be solved independently in thematic silos; on the contrary it calls for a combination of cross-cutting and thematically oriented coordination activities to set up efficient and sustainable in-situ infrastructure solutions; Europe's contributions to GEO/GEOSS should reflect this.

4.2 Science and Technology

GEO Strategic Target by 2015: Ensure full interaction and engagement of relevant science and technology communities such that GEOSS advances through integration of innovations in Earth observation science and technology, enabling the research community to fully benefit from GEOSS accomplishments.

European status quo: The explicit inclusion of GEOSS into the policy framework of FP7 and the related funding of dedicated projects has been highly successful in improving European participation and visibility in GEO Tasks. Other European R&D mechanisms, such as the ESFRI Roadmap, while also having great potential to make contributions, do not make explicit reference to GEOSS, with the result that interaction of related activities with GEOSS is hampered.

European target: Ensure full interaction and engagement of relevant European S&T communities with GEO such that both GEOSS advances through increased integration of European innovations and the European S&T communities profit through intensified international cooperation and access to data.

Recommendation ST-1: Continue and further focus GEOSS relevant research.

The example of FP7 referencing GEOSS shows how effective the interaction of large European R&D projects can improve European participation and visibility in GEOSS implementation. Making such reference should be continued with the successor framework of FP7, while scientific excellence and proper reference to other related international initiatives should be maintained.


Beyond the current FP 7 actions dedicated to GEOSS, there are many more highly relevant European-funded R&D activities not directly referencing GEOSS. Coordination of GEOSS-dedicated FP7 actions with those other activities, e.g. under GMES, the ESA Climate Change Initiative (CCI), ECMWF, the ESFRI Roadmap, or national R&D programmes should be improved.

Recommendation ST-2: Continue in fostering an increased involvement of European research communities within GMES and GEOSS.

While there is world-class science and technology available in Europe, the best should be made known to the international community. Contributing to GEOSS is a suitable means to achieve this visibility. Therefore, GEO/GEOSS should better be promoted within relevant European and national R&D institutions and programmes, and appropriate incentives should be developed.

4.3 User Engagement

GEO Strategic Target by 2015: Ensure critical user information needs for decision-making are recognized and met through Earth observations.

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European status quo: There are numerous studies and databases on European user requirements available, most of them established and maintained by the large scale operational EO programmes, such as GMES and the European Meteorological Infrastructure. These programmes also include mature (EMI) or emerging (GMES) user interface structures with strong European and national focus, but no particular global view.

European target: Continuously maintain and further develop the user interfaces and requirements databases of GMES and other major European programmes and maximise synergies between European and international user requirements.

Recommendation UE-1: Intensify and focus European participation in GEO user engagement activities and structures by linking European structures with GEO.

The importance of user-driven approaches is recognised and implemented by European operational programmes. Due to the potential of these programmes for GEOSS contributions and benefit from GEOSS, the global perspective should be addressed more explicitly within their user engagement fora. This will contribute greatly to a more focused European participation in GEO user engagement activities.

Recommendation UE-2: Participate in user needs and gap analyses of GEO and communicate the European perspective.

The analysis of user needs and unmet requirements is pursued by the User Interface Committee, the Science and Technology Committee, and by GEO Work Plan Tasks. Participation of European stakeholders in user needs and gap analyses needs to be increased to communicate the needs of European users and to identify strategic opportunities for Europe to contribute to the development of GEOSS.

4.4 Capacity Building


GEO Strategic Target by 2015: Enhance the coordination of efforts to strengthen individual, institutional and infrastructure capacities, particularly in developing countries, to produce and use Earth observations and derived information products.

European status quo: Europe is strongly engaged in capacity building for Earth observations through dedicated programmes such as PUMA/AMESD, EUMETCast, and TIGER. Dedicated actions are ongoing, such as DevCoCast. Moreover, the GMES Africa Action Plan is currently being developed. Due to this wide expertise, Europe is well positioned to support GEO in this important task, especially on the African continent.

European target: Increase coordination of Europe's capacity building programmes with the corresponding GEO activities to develop sustained capacities for the use of Earth observations.

Recommendation CB-1: Europe to get strategically involved in capacity building initiatives being fostered and implemented by GEO.

While highly relevant European programmes exist, they should be brought to the attention of the respective GEO tasks (e.g. the African Water Cycle Coordination Initiative (AWCCI)), with the aim to build a strong and sustained GEO capacity building component and to further dovetail European and other international capacity building activities to avoid duplication.

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5 European Coordination and Outreach

In addition to the above outlined issues related to the cross-cutting themes as defined by GEO, there is a need to intensify coordination and outreach measures within Europe to effectively foster the fulfilment of the GEO strategic targets and to achieve a strong and sustained European role and visibility within GEO.

European target: Enhance coordination structures, intensify communication activities, and leverage the political profile of GEO to strengthen European political support for GEO and thus raise the efficiency and effectiveness of the European GEOSS contribution.

Recommendation CO-1: Take more benefit from the political profile of GEO to obtain support for addressing the issues of continuity, data access and gaps/opportunities within Europe.

While there is consensus in Europe that a potential added value of GEOSS is its global political profile, more action is required to leverage the political profile of GEO in Europe. The process of GMES operationalisation and in particular the initialisation of its global services (Global Land, Marine, Atmospheric Core Services, International collaboration of the Emergency Response Core Service, initialisation of the GMES Climate Service) will be a suitable opportunity for this.

Within GEO, those initiatives addressing identified observational gaps whilst at the same time representing areas of European political priority should be supported, such as carbon monitoring, biodiversity observations, etc.. As a result, European organisations could take a strong role within GEO, promote European targets at global level and take benefit from an improved visibility of their activities at the political level.

Recommendation CO-2: Enhance European coordination mechanisms to facilitate a strong European role in GEO.

Whilst the European GEO High-Level Working Group (HLWG) is a useful forum to discuss and coordinate high-level strategic issues at European level, functional intra-European coordination at an implementation level is not yet in place. To improve effective and coordinated participation of European experts in all areas of the GEOSS implementation, management, and oversight, European points of contact should be established for each of the GEO strategic targets (or any alternative emerging GEO work plan implementation oversight structure), forming a European coordination network that is linked with the HLWG.

The evolving GMES international cooperation approach must be fully compatible with GEOSS. Therefore a mapping exercise between GMES and GEOSS is needed as a basis for an improved coordination between the two initiatives.

Recommendation CO-3: Increase communication of European GEOSS activities

The visibility of European GEOSS activities in GEO has been greatly improved in the past years. Internal visibility of European GEOSS activities, mechanisms, and achievements related to GEOSS, however, is also needed to communicate GEOSS and increase public support. Possible means may be a dedicated website and regular newsletters produced by the newly established European GEO coordination network in order to inform the stakeholders, the wider Earth observation community, and the public.