



Global Monitoring for Environment and Security

**Final Report for the
GMES Initial Period (2001-2003)**

10 February 2004

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Foreword

The GMES initiative was launched in May 1998 in Baveno and adopted by the ESA and EU Councils respectively in June and November 2001. Member States have shown a keen interest in GMES from the early days, by hosting several high-level conferences and workshops to further progress on the GMES definition (Lille, Stockholm, Brussels, Noordwijk, Athens and most recently Baveno).

For the Initial Period (2001-2003), GMES efforts have been implemented according to a shared EC/ESA Action Plan, with an initial emphasis on agreed thematic priorities, most of them referring directly to the 6th Environmental Action Plan of the European Community. The objectives of the Initial Period were twofold:

- To deliver of a set of pilot information and products for these priority themes, based on existing European capabilities, allowing to assess the current technical, organisational and institutional capabilities to meet users' needs;
- To prepare a report proposing how to progress through the next GMES period (2004-2008).

This document is the final report for the GMES initial period (2001-2003). It proposes a way forward for the period 2004-2008 as requested by the Council of the European Union of 13 November 2001 and the Council of ESA of 19 June 2001.

In accordance with the GMES EC Action Plan (COM(2001)609), this report has been generated by a joint EC/ESA team and further reviewed and commented by the EU and ESA Member States through the GMES Steering Committee (GSC). A number of working groups under the GSC have made valuable contributions to the efforts that have lead to this report.

Introduction

The overall aim of the Global Monitoring for Environment and Security (GMES) initiative is to support Europe's goals regarding sustainable development and global governance by providing timely and quality data, information, and knowledge.

Access to information has strategic value in the development of nations and regions. GMES will contribute to Europe's ability to fulfil its role as a world player. This entails the capacity to have independent access to reliable and timely information on the status and evolution of the Earth's environment at all scales, from global to regional and local. GMES must also ensure long-term, continuous monitoring on a time-scale of at least decades.

The information delivered by GMES will serve three main themes as identified in previous policy documents¹:

- **Meeting Europe's environmental obligations:** contributing to the definition, negotiation, implementation and verification of the European environmental policies, national regulations and international conventions;
- **Supporting sustainable development** both within EU territory and globally. This requires the integration of the environmental dimension in European policies from other Directorate-General's of the Commission, such as agriculture, forestry and fisheries, transport, regional development, external relations including humanitarian and development aid, and possible other policies at national and international level;
- **Contributing to the security of citizens** both within Europe and globally, by providing the information support to decision-makers and to operational actors such as civil protection teams and NGOs.

Thus, GMES will contribute to key policies of the European Union:

- The 6th Environmental Action Plan from 2004 to 2010², which addresses four priority issues: Climate Change, Nature and Biodiversity, Environment and Health, Natural Resources and Waste
- The European Union Strategy for Sustainable Development³, adopted at the Gothenburg European Council of June 2001, which calls for "establishing by 2008 a European capacity for global monitoring of environment and security (GMES)"
- The Common Foreign and Security Policy of the European Union

GMES activities will contribute to the fulfilment of the Lisbon objective to become by 2010 the most competitive and dynamic knowledge-based society in the world, the EU policy on good governance⁴, which requests adequate information for and involvement of its citizens in the Union decision process, and to the objectives of the Aarhus Convention (June 1998) requesting open access to the environmental information for the benefit of citizens.

As GMES progresses, it will provide information services that serve wider policy needs, such as those within the Common Agricultural Policy, and the policies of Regional Development, Justice and Home Affairs and others.

GMES also addresses a global challenge, being the European contribution to international efforts to understand the functioning and evolution of the Earth system. This is expressed in existing multilateral agreements and initiatives such as begun under the auspices of the World Summit for Sustainable Development in 2002 and the Earth Observation Summit in 2003.

¹ COM (2001) 609 and ESA/PB-EO(2001)56, rev.1

² COM (2001) 31

³ COM (2001) 264

⁴ COM (2001) 428

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Mutually beneficial opportunities also exist for regional, multilateral and bilateral international co-operation.

The recent White Paper on Space⁵ highlights GMES as a major contribution to the European Space Policy.

The provision of information services from GMES to meet the user requirements will be wide-ranging. The development of the capacity required to meet the objectives of GMES will therefore need to be carried out in an open and dynamic framework that will support a broad range of continually evolving implementation options. Such flexibility will allow the best available scientific knowledge, together with advanced observing network, information system and other state-of-the-art technologies to be brought into GMES when ready.

The results and recommendations of the GMES Initial Period (2001-2003) are the fruit of a close and sustained joint effort by the European Commission and the European Space Agency Executive. This includes collaboration within the GMES Support Team to ensure the complementarity of research activities within the 6th Framework Programme for Research and the ESA GMES Service Elements activities and mutual assistance in the activities related to the GMES Steering Committee and GMES Forum. Continuing collaboration is planned throughout the proposed GMES Implementation period (2004-2008), taking appropriate advantage of the ESA / EC Framework Agreement as concluded in 2003.

⁵ COM (2003) 673

I. Information Needs

I.1. Policy Requirements

From Global to Local, from Space to Earth

The GMES initiative is driven in equal measure by information relevant to the environmental, sustainable development and security needs of the European Union and to support Europe's role globally on these issues.

I.1.1. The Environmental Dimension

The knowledge-based approach to policy making advocated by the 6th Environmental Action Programme (EAP) provides the basis for framing information needs for environmental sustainable development. Information is needed to help guide policy formulation, to help monitor and enforce these policies, to assess the impact of existing and planned policies and to provide early warnings on areas for new policy action. The 6th EAP identifies a number of priority areas: climate change, biodiversity, environment and health and sustainable use of resources, which require - to different degrees - information and assessment from the local to global scales. So, for example, global processes such as climate change impact on biodiversity and resource availability at the local level. Therefore, GMES users will consist of a great variety of stakeholders from cities and rural areas to regions, up to countries and international institutions and organisations.

The ongoing work under the 6th EAP strategies on soil, air, urban, marine, health and natural resources, whilst recognising substantial progress on information provision in Europe, nevertheless further underscores the need for better information and for more integrated ways of information gathering and assessment. In this way the inter-linkages between these issues are fully accounted for and policy makers and the public are provided with a fuller picture on which to base their decisions. There is therefore an urgent need – as identified in the EEA and European Commission (Directorate General for the Environment) work programmes - for improved information and for better integration, analysis and dissemination of this information to support decision-making processes relevant to the many users at different levels.

The integration of environmental concerns into other community policies such as the Common Agricultural and Regional Development policies broadens the scope and efficacy of GMES, as information collected already for environmental policy domains can be used also for assessing links to other policies. The Gothenburg and Lisbon processes underline this need for environmental data to support sustainable development across economic, social and environmental policy domains, including - for example - the Cardiff sectoral integration process.

Such information is also much needed to mitigate the risks due to natural and man-made hazards and environmental pressures, resulting from climate change and socio-economic activities. Recent examples of such events are the catastrophic flooding in Germany and central Europe in 2002 and the Prestige tanker oil spill on Europe's Atlantic coast in 2003. There is an overall need to develop preventive approaches and foster the dialogue between the policy decision levels and the citizens in communities at risk. This requires the collection of information from local to global scale to better characterise those risks and build targeted information and decision-support systems.

The information needed to support decision-making processes should be underpinned by a number of principles, namely that the information must be:

- timely, forward-looking and proactive, in that it is available as far as possible before damage occurs and can predict problems before they happen;
- inter-sectoral – so that policies in different areas can be designed to avoid environmental damage and have a combined beneficial effect on the environment;
- explanatory – so that causes of environmental damage can be identified and impacts tracked through the environment from source to effect;
- comprehensive – in that it addresses all the major policy issues and geographic areas of concern in a thorough and balanced way;
- scientifically credible – in that it is based upon sound scientific evidence, accurate and robust;

I.1.2. The Security Dimension

The concept of security has changed since the end of the Cold War and Europe faces new threats that are more diverse and less predictable. The borderline between civil and military responsibilities is becoming blurred and the term “security” finds itself used in a variety of contexts. A working group mandated by the GMES Steering Committee worked on defining the scope of security within GMES. The group reviewed the main policies linked to conflict prevention and crisis management: civil protection, humanitarian aid and the EU Common Foreign and Security Policy (CFSP)⁶.

Civil Protection

The EU Civil Protection Unit and civil protection authorities within Member States of EU and ESA are involved in risk mapping, early warning and crisis management. Whether the origin of the disaster is natural, accidental or deliberate (e.g. terrorist/malicious action) the same mechanisms will be used to deploy the necessary resources to help the population. Most of the actions are undertaken in Europe; however civil protection teams may assist countries outside Europe in the framework of co-operation agreements and in the context of CFSP in the field of civil crisis management.

In case of major crises, the civil protection authorities of the affected country (or the EU Civil Protection Unit) can invoke the International Charter “Space and Major Disasters”⁷. Through the Charter the requesting party obtains easy and free of charge access to satellite data, with top priority in satellite tasking. Weaknesses of this system are due to limited satellite resources, exclusion of conflict-driven crisis and lack of services for data interpretation other than on an ad-hoc basis.

Humanitarian Aid

The impact of disasters - whether abnormal natural events such as floods or hurricanes, human-induced events such as armed conflicts or simply poor harvests - is much greater in the developing world than in the developed one. The EU through ECHO, its Humanitarian Aid Office, and Member States of EU and ESA are involved in programmes to provide aid to

⁶ The security dimension of GMES - Position Paper of the GMES Working Group on Security - 29 September 2003

⁷ Charter on co-operation to achieve the co-ordinated use of space facilities in the event of natural or technological disasters <http://www.disasterscharter.org>

developing countries, much of it channelled through Europe's non-governmental organisations.

To improve the effectiveness of aid requires increasing the quality and quantity of information available on regions outside Europe. This applies both for those who need to decide rapidly whether to deploy resources and for those – including NGOs, as well as public authorities – that operate on the ground in remote areas with limited communications and poor infrastructure. In this context, satellite-based imagery plays an increasing role, especially to provide a rapid update when existing maps are obsolete. Satellite imagery has to be complemented by other topographic, socio-economic and statistical data in order to meet specific information demands.

Common Foreign and Security Policy

In the context of CFSP, the EU is acquiring the necessary resources to undertake crisis management operations. Tasks include humanitarian and rescue tasks, peacekeeping tasks and tasks of combat forces in crisis management including peacemaking⁸. Resources for these tasks can be entrusted to either the EU's military or civil instruments by decision of the Council. CFSP also covers activities in favour of conflict prevention such as information gathering for anticipating potential crisis and monitoring international agreements.

By providing accurate and timely information, Earth observation assets can support decision-making from routine situation monitoring, through the build-up to a potential crisis, to support for crisis management operations. Space-based observation assets are mostly free from the restrictions of geography and sovereignty and are therefore particularly useful in this context. Such systems would best support decision-makers if they are capable of large area surveillance, detection, reconnaissance and identification of objects of interest world-wide, day and night and in all weather conditions; with adequate acquisition and revisit times. These systems must be supported by a comprehensive ground exploitation capability.

Specific needs of security

Needs in support of external aid and security policies are identical to some needs for environmental monitoring such as improved access to Earth observation data, sustainability of the data, and better integration of Earth observation data with background data. However some needs are specific to security, because in this domain decision-makers are dealing with crisis management, where timeliness of information is crucial and sensitive data requires special handling to secure the information and missions accomplished outside Europe in remote areas with limited communications and poor infrastructure.

There is also a strong need to improve the gathering and integration of many different types of information. For example, standardised mapping - an essential element for planning crisis management – is not readily available in up-to-date digital form for many of the EU's areas of interest. The updating of traditional hardcopy maps is very costly and requires highly trained cartographers. Photo-maps, on the other hand, can provide a cost-effective and relatively fast alternative, and commercial satellite imagery is well suited to the production of such items. Geographic information systems combined with a wide range of attribute data, such as data on population density, age distribution, health, infrastructure, land use, etc. are extremely useful to planners and decision-makers who need to have a global picture of the situation as it develops.

⁸ Article 17.2 of the Treaty of the European Union – the so-called "Petersberg Tasks" (a WEU term). Within the terms of Article 17.2, operations are considered on a case by case basis including where NATO as a whole is not engaged.

At present, the Commission, the Council and ESA all have separate imagery databases and imagery analysis and photo-mapping facilities, albeit working in separate subject areas. GMES should facilitate the easy access to the multitude of databases or meta-databases relevant to crisis management.

I.1.3. The Global Dimension

The need for international co-operation was recently reinforced at the highest political levels at the World Summit on Sustainable Development (WSSD) in Johannesburg, August 2002. At this event, the heads of state called for improved global observations for better decision-making, underscoring the critical link between global observations from space, airborne and in situ platforms.

The G8 Summit in Evian, June 2003, resulted in the G8 Action Plan on Science and Technology for Sustainable Development. The Summit expressed clearly the need to develop close international co-ordination of global observation strategies for the next ten years. This includes the need to identify new observations to minimise data gaps by building on existing work to produce reliable data products on atmosphere, land, fresh water, oceans and ecosystems.

As a result of the EO Summit in Washington in July 2003, an ad hoc Group on Earth Observations (GEO) was established to prepare a 10-year implementation plan for co-ordination of global observing strategies. GMES is the major European contribution to this goal, but at the same time must satisfy the specific needs of European policy-makers.

As stated in the previous section of this report, the security context of GMES is not limited to civil protection issues within the borders of the EU.

This global vision and commitment recognises that policy decisions, environmental impact assessments and mitigation strategies for environmental, natural and technological risks cannot be developed without sound environmental and spatial information and that sharing of information is of paramount importance so that its use and benefits are maximised.

I.1.4. Summary of Policy Requirements

Given this European and global context, GMES should therefore support the policy information needs related to:

Europe's commitments to monitoring the global environment through monitoring land cover, deforestation, biomass, biodiversity, sustainable forest management, fire, oceans and the atmosphere in the context of sustainable development, global change and development programmes, and in particular the implementation of the EU's Kyoto Protocol reporting obligations;

Environmental policies with a European geographic focus through protection of the marine environment, biodiversity and nature protection, urban environment and living space, soil protection, environment and health, environmental impact assessment and sustainable development;

European civil protection through flooding and forest fires alert systems, risk assessment from geophysical hazards such as landslides and earthquakes, technological and transport risks such as those arising around industrial sites and the transport of hazardous material over sea and land (e.g. marine oil-spill monitoring, pipelines and Seveso-type sites);

The Common Agricultural and Fisheries Policies through monitoring area-control measures, forecasting crop production – both inside and outside Europe – the monitoring of

the implementation and compliance of agri-environmental practises and the detection and identification of fishing vessels;

European Union external aid, development and security policies through provision of mapping and decision support services for aid, reconstruction and development of tools in the context of CFSP (crisis management and conflict prevention). The potential exists for application to policies related to Justice and Home Affairs activities of the EU, such as border surveillance.

In support of the **Lisbon strategy**, the increased availability of information will stimulate innovation and economic activities among information providers in the private sector, including SMEs.

I.2. Lessons from GMES Initial Period Activities

There are at present a number of areas where information services:

- are being provided satisfactorily (e.g. meteorological services)
- could be improved through better co-ordination or provision of resources (e.g. air quality reporting)
- have significant gaps that need to be filled to support policy requirements (e.g. biodiversity information provision)

To improve the state of Europe's capacity to produce the required services, a number of thematic and assessment projects were selected in the Initial Period of GMES (2001-2003) to examine the relevant issues and needs and undertake measures. These projects are a crucial element in the 'deliver to learn' and 'assess to structure' strands to which the GMES Initial Period Action Plan⁹ refers.

In addition to these projects, other related activities of the Member States and the Commission services, such as the Infrastructure for Spatial Information in Europe¹⁰ (INSPIRE) initiative and JRC activities have contributed to these strands of activity.

Additionally, more than 400 organisations, mainly based in Europe, participate in these projects. More than 100 experts from EU25+ Member States, EFTA countries and networks of the European Environment Agency contributed to the assessment of the EU capacity to share geospatial information in the context of the INSPIRE initiative.

All of these organisations are engaged in various aspects of environment and security implementation as well as information service provision and development. These include a variety of public sector end user organisations. The private sector, both through Small and Medium Enterprises and international industrial concerns participate mainly as service providers and system integrators. In addition there is an important participation of European and national R&D organisations together with inputs from expert consultants.

The intrinsic role of these projects is to bring together the many users and suppliers of information around their common themes of interest and build up gradually a detailed understanding of the user's needs for information and the feasibility to satisfy them.

⁹ Outline GMES EC Action Plan (Initial Period: 2001 – 2003) - COM(2001) 609 final

¹⁰ Memorandum of Understanding between Commissioners Wallstrom-Busquin-Solbes of 11 April 2002, on the development of the INSPIRE initiative as a legal initiative of the EU. It will address technical standards and protocols, organisational, co-ordination and data policy issues, including data access and the creation and maintenance of spatial information. (<http://www.ec-gis.org/inspire/>)

The majority of GMES-related thematic and assessment projects started their activities in the first semester of 2003. Therefore, their intermediate results at this stage are not yet fully conclusive although significant progress has already been achieved through the policy analysis and the intensive interaction between user and supplier communities in defining the information products and delivery constraints.

User and Information Needs

Thus, a number of general findings and conclusions regarding the general user and information needs can already be drawn at this stage. User needs are significantly different depending on where they operate in the policy implementation and monitoring cycle:

- Information needs expressed in policy documents are often implicit rather than explicit. Policy decision-makers at global and European level rely for their policy review and formulation on indicators. Different indicator methodologies and varying quality of data sources make pan-European and global comparability difficult in most areas.
- However, where policy information needs are more explicitly formulated, such as for air pollution and the emerging Water Framework Directive, more detailed information requirements have been already agreed but not yet fully implemented. GMES should support achieving this, for example by being more focused on ecological and human health aspects.
- Reporting obligations are driven both by the obligations to provide inputs to develop indicators and those related to specific legislation within the EU and its Member States. They place an increasing burden on organisations in the Member States, responsible for the different issues and acting often at different administrative levels. This burden could be reduced by critically assessing the information demands, integrating them across policy needs and focusing only on those data really needed for policy compliance checking, review and formulation.
- A second measure to reduce the burden is to develop the capacity to transfer and use information across the different administrative levels, and to co-ordinate between user and providers the collection and use of common information, leading to better policy co-ordination and data utilisation. This would require designing common standards and improved interoperability between monitoring systems, exploiting opportunities for data sharing and use for multiple purposes.
- In addition to policy review and formulation, policies require implementation. This is generally achieved at the local and regional levels where data and information needs often become more detailed and specific. However, to avoid duplication of data collection efforts it is of paramount importance that information used at these lower levels is inherently consistent and nested with those needed at the state and EU levels.

At present, valuable information is available at local and regional levels, but is difficult to exploit in a broader context for a variety of reasons. The data are often of unsatisfactory or undefined quality, based on proprietary standards and managed through closed systems and therefore not sufficiently accessible to users. Therefore, activities that need to combine information coming from various sources to provide policy-relevant information are often time-consuming and costly. Here again GMES can act in support.

Access and integration of socio-economic and other non-environmental data (e.g. demographic, cadastral and health data) will be important for many information services in order to provide the maximum added value. Important sources will include Eurostat and the national statistical offices of participating states and UN agencies. Additional private sources may also be employed.

Needs for Education and Training

Education and training will be required at all levels for those involved in the production and utilisation of information. This will include in particular the decision makers and other users. It is clear that the scope and content of such activities will need to be tailored to the specific targeted communities, be an integral part of the services provided and will apply to both more and less developed regions within and outside Europe.

The development and implementation of a communication plan for GMES, geared towards users and providers at various levels (including the public) would increase awareness of the benefits to be achieved and promote the activities that Europe is undertaking.

Needs for Capacity building

Important gaps have been identified in terms of the completeness and continuity of observation networks. Efforts should be dedicated to the development of such sustainable capabilities. This applies both for the European states directly involved with GMES as well as associated parties, inside and outside Europe.

Needs for Data Integration and Information Management

On the basis of these lessons learned, a number of requirements related to information availability, integration and access can be formulated. Users require:

- continued and timely delivery of quality, certified and documented data from Earth observation sources, in situ measurement networks and socio-economic data sources;
- a set of commonly needed core data for the formulation of indicators and policy implementation;
- improved use and integration of data by developing methodologies and tools for forecasting, planning and decision-making. This includes the development and improvement of modelling capabilities;
- improved mechanisms to respond to crises in the context of international co-operation, humanitarian aid and CFSP;
- policies aimed at reducing duplicated data collection and to assist and promote the harmonisation, broad dissemination and use of data;
- co-ordinated action to better understand the current gaps and deficiencies in the data collection and information supply infrastructures;
- continuing research and technology development to address identified deficiencies in the provision;
- documented quality and use conditions of existing data held by the public sector according to common agreed European and international standards;
- cross-calibration and – as necessary – reprocessing of long-term series of data sets to allow the detection of changes and trends;
- open standards for data and services based on existing and emerging European and international standards and translation services;
- co-ordinated infrastructures and services allowing anybody to query, view, access and trade the information held by distributed public and private sector bodies;
- a data policy framework and sharing agreements between bodies in the public and private sector.

But above all, the ultimate beneficiaries of all such information services - the citizens - need more reliable and comprehensive information on the environment and on the modern threats they are facing. This information has to meet their needs and concerns and has to be presented in the form that is easily accessible and understandable.

I.3 Socio-economic Benefits

The ability to manage its own environment effectively and to contribute to the management of the global environment is of critical economic social and political importance for Europe. The capability for precise, reliable autonomous monitoring of the environment is an essential precursor to effective management.

GMES provides direct users with improved information on the environment and civil security, but the vast majority of its benefits will accrue to society as a whole as indirect or social benefits.

Given the ambitious and wide-ranging nature of GMES, precise quantification of these benefits would be a great challenge at this stage. However, to set the scene, a preliminary socio-economic impact study¹¹ under the European Commission's 5th Framework Programme for Research has identified the areas of socio-economic impacts of GMES. This report identified the economic costs and losses associated with natural geo-hazards, ocean monitoring, air quality monitoring and climate change research. A simple three-step model was used to highlight the potential benefits that could be accrued by GMES through:

- An improvement in monitoring capability leading to better data and information access, and effort on characterising environmental events and issues.
- A better understanding of events based on a more comprehensive integrated service bringing together diverse but complementary data sources and stakeholders
- An improved capability for forecasting and prediction.

The issues and opportunities

With regard to geo-hazards, floods, earthquakes, windstorms and droughts have been identified as the most costly for Europe in terms of humanitarian costs (people killed) and related damages (people affected). Considering these hazards together with extreme temperatures, forest and scrub fires, and volcanic eruptions, GMES could reduce the overall risk and therefore losses of life and losses due to damage to the value of €74 million by improved monitoring. This would increase to €370 million by improved understanding of these events, and to over €1,000 million if significantly improved forecasting and prediction could be achieved.

In the area of ocean monitoring, an economic valuation of marine resources and services in the EU15 of approximately €384 billion per year has been estimated by the EuroGOOS project. An improved monitoring service under GMES could lead to the economic benefits in the order of €4 billion per year. Looking at a fully integrated ocean observing system with forecasting and prediction capabilities, the potential economic and social benefits will be considerably higher. By comparison, in the US an estimate of €8 billion per annum potential savings has been made, which includes the impacts on maritime transportation, commercial fishing, offshore energy production, defence organisations, and search and rescue. Benefits in other domains (agriculture, energy production, forestry, tourism) could also accrue through improved weather and climate forecasting. For example, it has been estimated that improved forecasting of ENSO (El Niño/Southern oscillation) could save the US economy between \$0.5

¹¹ GSeS Socio-economic Impacts Report. ESYS-2002386-RPT-04

and 1.1 billion per event. Estimates from Australia have equated \$1 billion in lost agriculture revenues with every 0.5 °C of ENSO related cooling of the waters of north of their continent.

Looking to the atmosphere, an estimated 3 million people die each year because of air pollution (WHO, 2000). The economic impact of air pollution in Europe is estimated to be around €360 billion. Hence in this area GMES has a huge potential to contribute economic benefits through more accurate monitoring and attribution which could support more effective regulation.

A cost benefit analysis for INSPIRE¹², which looks at the measures to be taken to improve the access to data and information in the EU within the scope of GMES, gives a total of €1.2 to €1.8 billion annual net benefits. These benefits will accrue gradually during implementation.

Sustainable development in Europe has been in jeopardy from several existing pressures in the past, mostly non-climatic (e.g. land-use change, environmental pollution, atmospheric deposition). Yet climate change adds an important element to the threat to the environment. Changes in sea-level, retreating alpine glaciers, migration and change of many ecosystems as well as possible local extinction of species challenge existing management policies on how to best manage these changes. Improved understanding of climate change will have long-term benefits for Europe and the rest of the world. A present value of \$50 billion is calculated for resolving specific uncertainties about climate change now, rather than in 40 years time¹³.

Mechanisms to secure the benefits

The figures quoted above identify the scales of the problems that GMES will tackle and the *potential* benefits that could accrue. These are targets for GMES. The actual benefits will only accrue through specific mechanisms where GMES can deliver information to support policymaking, decision making and actions that would not otherwise have been possible. The mechanisms through which GMES will deliver benefits will include:

- Better forecasting of the timing, extent and magnitude of natural hazards will lead to a reduction in economic losses through better preparedness for destructive events and adaptation to non-destructive events.
- More accurate appraisal of the area and extent of damage after natural disasters. More efficient disaster management will lead to lives saved and a reduction in the number of people affected by subsequent events.
- Improved monitoring will lead to a better understanding of the state of the environment enabling more appropriate policy making and enforcement. This will avoid damage to the environment through inaction, but also unnecessary over-regulation and the associated costs of compliance that would burden both government and industry.
- More accurate understanding of the likely impacts of global climate change. The range in possible adaptation and mitigation costs is huge. Better understanding of likely outcomes will avoid wasteful expenditure on either inadequate or unnecessary adaptation.
- By supporting the creation of a knowledge-based society and improved public access to quality data and information, GMES will increase the legitimacy of government interventions in the environment and raise the level of public awareness and debate.

These mechanisms require observations (from space and in situ), modelling and the timely delivery of information appropriate for decision makers. Successfully enabling these

¹² Contribution to the extended impact assessment of INSPIRE <http://www.ec-gis.org/inspire/>

¹³ GSeS Socio-economic Impacts Report. ESYS-2002386-RPT-04

mechanisms is the challenge for GMES, which must effectively integrate these needs into a coherent European service.

Political and strategic benefits

In addition to the social, economic and environmental benefits that could accrue from GMES, it will also give rise to benefits on a strategic and political level. An autonomous capability to monitor the environment and independence in assessment of environmental and security issues are benefits of GMES that are of strategic value to Europe.

GMES will also deliver political benefits - both internal to the Union, through better information and hopefully participation of its citizens to societal debate (good governance), and external to the Union, by contributing to and showing leadership in global initiatives.

The above summary is based on only a preliminary assessment of a subset of the types of services that will be provided under GMES. As the portfolio of services evolves, it will be necessary to perform a more comprehensive analysis of the costs and benefits of those services and of GMES as a whole.

II. GMES Capacity in 2008

Part I of this report has described the information needs relevant to the environmental, sustainable development and security needs of Europe. One of the fundamental purposes in seeking to establish a European capacity for GMES by 2008 is to achieve cost-effective delivery of comprehensive, consistent and readily accessible information services, of a known quality, to meet these identified information needs. The provision of these services will underpin European environment and security policies as a contribution to sustainable development and global governance. As noted in the section on information needs, this implies the production of a wide variety of types of information at a range of scales from local through to global.

II.1. Services

The users of services are public institutions and agencies at the European (and global), national and regional level together with industries (including SMEs), NGOs and the general public.

GMES services need to respond to user information needs and lead to clear socio-economic benefits. Hence, the necessary infrastructure and organisational framework should evolve with political priorities, and technical and scientific maturity. In addition, services may contribute to and benefit from international collaboration activities.

Prioritisation of Services

The number and variety of GMES services is potentially large. The implementation approach:

- is progressive as from 2004;
- uses the available funds, up to 2006, from the 6th Framework Programme for Research of the Commission and ESA GMES Service Element activities;
- will request funds, as from 2007, to support the development and delivery of operational services;

This calls for the establishment of priorities on the basis of the following criteria:

- **EU political priorities:**
GMES services need to provide information services required in the formulation, implementation and monitoring of EU policies. This criterion encompasses the notion of socio-economic and strategic importance, including – but not limited to - support to sustainable development, industrial competitiveness and innovation, security and international co-operation.
- **Technical feasibility/maturity:**
The extent to which the related science is sufficiently well understood, the observing technologies are available and networks are in place, or can be made available within reasonable costs and timeframes.
- **Benefits and added value:**
The socio-economic gains identifiable from the provision of a given service. The notion of added value also includes the potential for use of a particular service across environmental domains (e.g. in order to follow complex multi-disciplinary interactions), a number of policy areas (e.g. in the interests of integrated policy assessment), a variety of different users and a wide geographical scope.

- **Cost efficiency:**
The costs of implementation and maintenance must be balanced against the benefits and added value of the service. Requirements that are considered to be strategic may put less emphasis on cost.
- **Maturity of the user community**
The readiness of a specific group of users is key to successfully incorporate information into the working methods and decision-making processes. (Implementation of services must address preparation of users through dialogue and demonstration activities.)

With the initial¹⁴ GMES thematic priorities as starting point, priority services are to be selected on the basis of:

- the above selection criteria
- the results of the cross-cutting and thematic studies (FP5)
- the ESA GSE Consolidation Phase progress
- the discussions of the GMES Forum and the GMES Steering Committee and its Working Groups

Proposed Service Categories for the Period 2004-2008

The following service categories are proposed for implementation from the beginning of the Implementation Period in 2004:

Global Climate Change (the Kyoto Protocol) and Sustainable Development;

- the monitoring of climate change within the Earth System, (i.e. in the atmosphere, on land, in fresh waters and marine seas and oceans);
- the knowledge on the state, composition and evolution of the global atmosphere;
- the monitoring of the global oceans for current circulation and sea-state prediction;
- the use of renewable resources (vegetation, forestry, food supply, land cover/use, biodiversity).

European environmental policies;

The 6th Environmental Action Programme of the EU forms the basis of the services categories in the following list. (The aspects of the plan relevant to climate change are already addressed in the list above.)

- the air quality;
- integrated spatial assessment of inland, coastal and marine waters; land (including land use by agriculture, transport infrastructures and urban settlements and related social aspects such as health);
- the European soils strategy with respect to the state of soil, performance of soil functions and the use of land;
- the implementation of the Natura 2000 programme and assessment of the conservation status of habitats and species to halt the loss of biodiversity;
- the monitoring of river basins, inland water resources and quality;
- the monitoring of snow and inland ice;
- the monitoring of water quality for the European seas and coastal zones;

¹⁴ Cf. GMES Initial Period Action Plan, COM (2001) 609

- the management of coastal zones (erosion, sedimentation,...).

European civil protection;

Risk management including prevention, monitoring and assessment at European level related to:

- natural hazards with particular attention to floods, forest fires and climate related pressures (e.g. drought, extreme weather conditions) and geophysical related hazards (e.g. landslides, volcanoes and earthquakes);
- technological hazards with particular attention to risks associated with industrial activities;
- maritime transport and security, including oil spills and ice monitoring.

The Common Agricultural, Fisheries and Regional Development Policies;

Providing support to monitor the implementation of and compliance with these policies including:

- the Common Agricultural Policy: monitoring of crop conditions, irrigation, evolution of the agri-environment;
- the Fisheries policy: supporting fish stock assessment, the detection and identification of fishing vessels;
- the Regional Development policies: the planning and use of the territory.

Development and Humanitarian aid;

- The provision of data, information and decision support services required to respond to the needs associated with the organisation and distribution of development aid, humanitarian aid and support to reconstruction (damage assessment) for geographical areas of priority identified by ECHO and other GMES Stakeholders.

EU Common Foreign and Security Policy

In support of conflict prevention and crisis management:

- monitoring of international treaty for preventing the proliferation of nuclear, chemical and biological weapons
- monitoring population (settlements, movements, density etc.)
- assessment of sensitive areas for early warning
- rapid mapping during crisis management

To develop and implement these priority services, committed end-user organisations must be identified in Europe. In addition, the technical feasibility and scientific maturity to deliver the required information products should be shown to exist. GMES should provide information services to such end-user organisations as a priority objective, providing improved accessibility to the information need by these stakeholders. The direct provision of information to stakeholders such as cities and regions will also be required, particularly in the area of civil protection. This means that in order to develop and implement the priority services listed above, GMES must develop end-to-end services, whilst also providing easy and rapid access to specific data sets needed at global, European, regional and local levels.

During the development and implementation activities, due account will be taken of the need to ensure the linkage and combination of data and information across environmental domains, policy areas and geographic scales.

II.2. Space Observing Systems

II.2.1. Situation Today

Over the last two decades, Europe has fully demonstrated its capability to develop and launch advanced Earth Observation systems. This applies to the point where leadership can be claimed in areas such as imaging radar applications and, in particular, radar interferometry and high-resolution optical imagery. The most prominent European civilian achievements include:

- The meteorological satellite systems operated by EUMETSAT based upon developments by ESA. Meteosat first and second generation satellites are in geostationary orbit, and in low Earth orbit METOP will be launched in 2005 as the first in the EUMETSAT Polar System (EPS);
- The SPOT series of satellites, providing high resolution, multi-spectral optical imaging capability complemented with a medium resolution capability optimised for global vegetation monitoring;
- The ESA ERS and ENVISAT satellites, using advanced all-weather radar technologies and optical observation techniques to monitor the earth's environment, in particular the chemical composition of the atmosphere, the coastal and ocean environment and land surface processes;
- The TOPEX-Poseidon and Jason-1 missions in co-operation between CNES and NASA, embarking radars for the continuous monitoring of the world oceans and preparing for operational ocean surveillance successors. Jason-2 scheduled for launch in 2007, transfers this series to an operational status through the involvement of EUMETSAT and NOAA in a four party Programme with CNES and NASA.

Other recent developments include the recent launches of elements of the Disaster Monitoring Constellation, which involves European and non-European partners. In addition, Europe has access to many non-European satellites. These are mostly research or demonstration systems (with the exception of Radarsat-1 and Landsat-7). Plans are in preparation for getting access to such missions from the US, Japan and Canada. Additionally, new ESA Earth Explorer missions will be available in the years to come.

With the exception of the operational meteorological component, for which the continuity for both the geo-stationary and the polar orbits is ensured until 2015/2020, nearly all other European satellite systems currently in orbit have their nominal lifetime terminating in 2007/2008. Today Europe relies to a large degree for its space-borne observing capacity on research satellites. Measurement continuity is needed to guarantee on-going GMES services. This includes, in particular, measurements of atmospheric chemistry components, ocean surface parameters, vegetation / land use / land cover and ice characteristics.

II.2.2. 2008 Objectives

GMES requires in the long-term the deployment of a comprehensive and complementary set of operational space missions providing, at global / regional / local scales, permanent and continuous observing capabilities of the Earth's system components namely, the atmosphere, the oceans, the land surface and the ice masses. These systems should provide long-term continuous access to the following measurements:

- Very high (1 meter or better) to high (10 meters) spatial resolution, panchromatic and multi-spectral optical imagery for local observations over land surface and coastal zones. This is needed particularly in support of disaster management (natural and technological), conflict prevention and crisis management, humanitarian aid, urban and coastal management;

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- All-weather imaging capability at high and medium resolutions for land, coastal zones and ice observations in cloudy regions and during night coupled with radar interferometry capability for detection of small (millimetre or sub-millimetre level) ground movements, with the appropriate frequencies and operating modes required to support the GMES services. This is needed in support of disaster management, urban management and security, humanitarian aid and conflict crisis management, coastal zone pollution monitoring and ice surveillance;
- High (10 meters) to medium (200 meters) spatial resolution, wide field-of-view, multi-spectral and multi-directional optical imagery for global / regional observations over land and ocean surface. This is needed in support of global vegetation (including forestry) and biosphere monitoring, coastal zone water quality management, coastal surveillance, disaster management and humanitarian aid;
- Advanced optical and microwave sensing for determination of atmospheric composition and its effects on climate change. This is needed in support of atmospheric pollution management, to better understand and predict climate change and to monitor air quality for public health;
- Operational ocean monitoring. This is needed in support to ocean circulation and sea-state forecasting with associated economic maritime applications. It is equally needed as a contribution to global climate change understanding and modelling.

Attention should be given to the associated ground facilities that will be required to adequately operate these space systems in a co-ordinated and efficient way, in particular, to deliver specified / tailored products in near real time to users.

Imagery from very high to high resolution (1-5 meters) optical and radar satellites will be provided by national projects such as Pleiades, TerraSAR, Cosmo-Skymed and possibly by other national initiatives under development, such as the Spanish National Earth Observation System. All these systems have fully acknowledged dual (or multiple) use objectives, including the security dimension.

Based on the preliminary requirements and demonstrations of services (e.g. ESA GSE, EC FP6 projects) the current priorities for development appear to be the following:

- A radar satellite providing high resolution imagery for continuity with ERS and Envisat-class radars, with an interferometric capability for small surface motion monitoring and a medium resolution mode with the widest possible coverage for marine and ice surveillance. Co-ordination will be sought with the Canadian Radarsat mission to increase observation frequency and geographical coverage.
- Multi-spectral optical imaging satellites at two spatial resolutions:
 - High resolution for local and regional operational monitoring applications (continuity of SPOT and Landsat classes)
 - Medium resolution for global applications (continuity of ENVISAT-global imaging and SPOT-Vegetation -classes), with multi-spectral capabilities and optimized for vegetation, cloud & aerosol and ocean color
- Atmospheric dynamics and chemistry monitoring, including instruments providing continuity to ERS and ENVISAT-class data streams
- The ocean operational monitoring capability is partly implemented by EUMETSAT programs Jason-2 and METOP. This should be complemented through GMES with a polar altimetry capability.

The operational continuity of meteorological data of interest for GMES is currently well covered by on-going and developing programmes under EUMETSAT responsibility or based on international co-operation.

In order to provide the appropriate observation frequencies (i.e. revisit times) to meet the sampling requirements for some GMES services such as support to risk and disaster management, peacekeeping and humanitarian aid, the deployment of satellite constellations will be necessary. The Disaster Management Constellation and the planned Pleiades and Cosmo-Skymed systems are possible contributions to address this vital requirement.

The space component will also include the necessary capability for the collection and distribution of large data quantities at high speed, in response to specific service requirements. This capability will include access to wide band satellite channels, terminals for data collection, transmission and reception which will support also the rapid collection of measurements and observations from in situ stations, buoys, aircrafts, drones, etc.

Early approval (in 2004-2005) for development is required to avoid any gaps in the provision of data coming from current satellites.

II.3. In Situ Observing Systems

II.3.1. Situation Today

The current situation of the in-situ observing systems is considered a critical limiting factor to the successful deployment of the GMES services by 2008. This assessment is based on the preliminary results from the GMES projects, the work of the GMES Steering Committee working groups and inputs received directly from the GMES Steering committee.

Gaps in availability of data are many because of:

- difficulties in accessing data and insufficient standards and classifications to enable consistent data collection;
- the historical development of in situ monitoring (lead by legislative objectives) with insufficient consideration of integration and to what degree the data is representative;
- the absence of monitoring for many more recent policy issues such as environment and health.

At the same time, redundancies and duplications are many because of:

- fragmented and inefficient designs tailored to legislative needs;
- insufficient coordination between the many organisations and communities developing efforts in this domain.

These issues are being addressed by INSPIRE and the Framework Directive on Reporting currently prepared by the European Commission. GMES has an opportunity to implement coherently the overall system supported by the member countries, improving and streamlining its efficiency by filling the present gaps and removing unnecessary costs linked to data collection and management.

To reap all the benefits of GMES, in situ observations in their broader scope should also be addressed. Such networks should cover also surveys aimed at collecting socio-economic data, land cover and land-use data, geology, soil conditions, bio-diversity information and other geographical data such as administrative boundaries and elevation.

There are a number of in situ observing systems in place or under development. Their usefulness and quality varies, depending on the accuracy, calibration, continuity, density, and maintenance of their individual measuring devices.

At the European level, most in-situ monitoring systems or surveys are currently operated and conducted by a wide variety of public sector bodies or as research infrastructures at a national

level, with some exceptions in the context of the EU research and development framework programmes. Important monitoring is currently carried out by member states for the purpose of compliance to European regulations and international conventions. Countries also monitor enforcement of national standards in particular related to health issues, management of natural resource and natural heritage. Such monitoring also serves to support research and information to the public. The cost of this monitoring is high, and estimates from countries where data are available suggest spending of several billions of euros per year.

EU environmental legislation, voluntary collaboration agreements between public sector bodies and agreements established in the context of various global international and regional conventions are driving factors behind the implementation of pan-European in-situ networks and surveys. In this context the following evaluation can be made:

- Significant progress has been achieved with regard to meteorological in situ networks (e.g. the EUMETNET Composite Observing System (EUCOS) programme), operating in conjunction with real time space monitoring. Yet, additional measurements are needed outside the European boundaries to improve forecasting capacities.
- Harmonised pan-European in situ networks for air, water, vegetation and soil are still under development and important gaps and inconsistencies between regions continue to exist while also greater monitoring efforts need to be directed towards the measurement of key pollutants of environmental and health concern. Despite recent improvements, global terrestrial networks remain to be fully implemented, the ocean networks lack coverage and commitment to sustained operations and atmospheric networks are not operating with the required global coverage and quality.

Thematically, the most comprehensive network at this stage is the EEA/EIONET. Five broad areas are covered: inland and marine water, nature protection and biodiversity, air and climate change, waste and material flows, and terrestrial environment (spatial analysis, land cover change, coastal assessment, soil assessment). In addition, sectors are assessed as a contribution to the Cardiff process: agriculture, transport, energy and tourism. Finally, the EEA runs actions on emerging issues such as environment and health or chemicals. In total, about 300 national organisations are co-operating regularly with the EEA.

- With regard to reporting obligations under the UN Framework Convention on Climate Change and its Kyoto Protocol, the Second Adequacy Report to the UNFCCC has catalogued many shortcomings in current in situ observing networks on which climate change adaptation policy development continues to depend. Current EU climate change policy is focussed on mitigation through emission control, which is largely unverified by environmental monitoring. Current European networks contribute little to global greenhouse gas measurement, particularly of CH₄ and N₂O. In situ monitoring is missing for greenhouse gases and their isotopes and ozone depleting substances, including flux measurements, across Europe and in regions with poor coverage in Africa and Asia. Such data could support regional and global verification of emission assessments and claims under the Kyoto and Montreal Protocols and would make a valuable contribution to the characterisation of sink mechanisms too.
- A key requirement for policy appraisal in the field of biodiversity is for inventories and maps of terrestrial and marine habitats and for information about their dynamics and the ecosystems that populate them. In situ monitoring in this context is especially important in providing information on habitat condition and species numbers/distribution. No global or even European framework yet exists, however, to deliver this information in a consistent manner today.

- Within the EU, survey data and maps on land cover and land use, including air photographs and cadastres and geographic data, are widely collected at local, regional and national levels for a wide variety of applications. However, despite of recent progress, pan-European datasets needed to support GMES services addressing cross border issues such as flood mitigation or future Kyoto protocol verification remain underdeveloped. At the global level these data are often lacking or remain of too poor quality for GMES services in the fields on humanitarian aid, food security, and for crisis management and conflict prevention outside Europe.
- Population and socio-economic survey data are collected within the EU from local to pan-European level and are considered a vital input to many GMES services. However, timely updating requires improvement especially to meet the needs of those services in support to the mitigation of natural and technological hazards, both within the EU and other areas around the globe.

GMES services are in many cases end-to-end i.e. from data collection to the delivery of final information. Significant improvements to the in-situ capacity are therefore possible and desirable at national, European and global levels.

II.3.2. 2008 Objectives

The greatest challenge is to develop an affordable observation approach that integrates space and in-situ observations across the atmosphere, ocean and land surface.

Following an in-depth assessment of the in-situ data needs of the current pilot GMES services as they will evolve in the 2004-2007 timeframe the following objectives are to be met by 2008:

- An improved co-ordination in the deployment and operations of the different thematic in-situ networks and surveys shall be achieved. This to maximise synergies between investments, to avoid redundant data collection and by focusing on meeting common needs. Such co-ordination shall be in place at EU and global level.
- The gaps and deficiencies existing in the EU in situ observing networks and survey data to support the implementation of current environmental legislation are to be closed gradually and their long-term sustainability assured.
- High priority is to be given to the deployment of operational in situ networks and the availability of survey and geographical data to allow the mitigation of natural and technological hazards at local and regional levels.
- Maximise the collection of in situ and survey data in support of crisis management and conflict prevention on priority areas outside Europe.

As an immediate action in the implementation of GMES, in situ observing systems should be assessed and upgraded where necessary. Priority should be given to all networks of sensors aimed at measuring air quality, atmospheric conditions, the meteorological conditions, the state of the cryosphere, the state of marine and inland water bodies, the conditions of vegetation cover, seismic activity and land stability. The aforementioned networks are deployed on land, water and on airborne platforms.

For effective integration and assimilation of data and information, in situ and space-based observations will need to be matched in terms of their respective quality (e.g. homogeneity, accuracy and spatial coverage of measurements).

II.4. Data Integration and Information Management

II.4.1. Situation Today

The assessment of today's situation is again based on the preliminary results from the GMES projects, inputs received from the delegations of the GMES Steering committee and the work of the GMES and other European expert working groups active in this field.

The capacity to combine and link data from different sources and to manage information flows is a crucial element of any GMES service. GMES services need integrated data and information from different sources and often over long periods of time. This requires in all cases, conformity of geographical scale, spatial resolution, reporting period/intervals and data formats across the different information sources. In addition GMES services need to integrate reliable historical information to serve as baselines against which to assess the current situation and as a means of detecting and evaluating significant change and long-term trends.

The preliminary assessment across the different GMES priority themes has led to the **identification of a number of obstacles** that currently limit today the efficient integration and management of information:

- **Standards of documentation**

Inadequacies have been noted across all application themes in the standards for metadata, for the wider availability of data catalogues and other data discovery tools.

- **Data and information access**

Problems are widespread across all thematic areas, particularly when accessing information from different sources and across disciplines. These problems are of: 1) a technical nature (e.g. functionally different retrieval systems, lack of technical standards, language differences and uncertain data quality), 2) an institutional nature (e.g. differences between conditions of access and security and use and a lack of incentives to maintain databases) and 3) a legal and commercial nature (e.g. issues of ownership, privacy and confidentiality, intellectual property rights, pricing and licensing).

Speed of access is a significant issue, primarily in relation to the requirement for rapid response to disasters resulting from technological accidents, geophysical events, humanitarian disasters and food security crises

Regarding archiving, there are many valuable archives in Europe and world-wide but there is also much to be done to enable existing databases to be accessed in near real-time and in delayed mode. The systems for this are generally not in place.

- **Interoperability**

The capability to transfer data freely and seamlessly between different information systems is generally low and prevents easily bringing together different data in a consistent format in order to derive and deliver information. The main obstacles to interoperability today are:

- insufficient data and exchange standards
- the lack of consensus on sound methods and arrangements for linkage between different data sources (e.g. EO, ground-based and management-derived data) and systems for generating information
- missing arrangements for integration across different sectors and policy areas, for example, the linkage of environmental and non-environmental data.

- **Modelling**

There is an important need to work towards a consensus on which models to use to integrate the various types of data into the needed information in operational GMES Services. Quality control of models is considered no less important than that of data

supply. Model testing and validation against high quality data is crucial in this regard. This is rarely conducted in a sustained systematic manner.

It is clear from that concerted actions and networking is currently not sufficiently in place to insure the widest and fastest access to comprehensive, coherent and compatible data sets by the operational and scientific communities. Missing is a professional, semi-distributed, multidisciplinary data management infrastructure able to give an appropriate access to the national data holdings, merge them with new data collected in real time and delayed mode and prepare the best timely integrated data products, that scientific, technical and economic studies require.

Today's global and European networks in the field of environment, such as for example the comprehensive network EIONET of the European Environment Agency and the EUMETNET/EUMETSAT form the basis of this future networking. However, networks in other domains are largely missing and linkages to the many local and regional networks too poorly developed.

II.4.2. 2008 Objectives

The development of the Internet started with government-sponsored research involving experimentation, agreements on basic protocols, incremental refinements and an appropriate management structure. All this was instrumental for the "explosion" of the Internet's public and commercial applications of today. Could this top-down and bottom-up approach be a "model" for the information architecture development that could ultimately lead to breakthroughs for GMES services?

A key feature of the GMES information architecture is the need to support collaboration between geographically dispersed GMES users and service providers. Collaboration has to be supported by an electronic infrastructure enabling GMES users not only to communicate but also to access resources such as very large data collections or archived information, scientific experiments and computing power. For the data- and computationally intensive areas of GMES, such as real-time modelling based on Earth observation data or climate modelling, high-performance networks and GRID-based computing are essential for mining, sharing and analysing data and visualising results.

For GMES to become a success, the architecture needs to facilitate the integration of stand-alone data and information elements. It should allow to the selection and aggregation of information from heterogeneous sources and should provide the capability to translate data and information between the various sources in real time. This applies as much to the incorporation of socio-economic data and information, as well as products derived from the space and in situ observing networks.

GMES must therefore provide a structured framework for data integration and information management, (i.e. a European shared information capacity). The following key architectural and user-oriented requirements will therefore drive the implementation of GMES:

- **Openness**, based on agreed open standards, facilitating **seamless communication** and **interoperability**, i.e. the ability of different devices or systems (usually from different vendors) to work together, as well as enabling **user service autonomy**;
- **Federated architecture**, enabling systems to grow and evolve;
- **Simplicity** of architecture (e.g. modularity of components), to break the complexity barrier, systems must be made easier to design, administer and use;
- **Self-configuration, programmability, scalability** (e.g. to handle various levels of operational load and external conditions);
- **Dependability**, i.e. the system's resilience to security threats or breakdown;

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- **User-friendliness** of services and interfaces, e.g. in the handling of user request services, access control, workflow management, delivery management, visualisation, data extraction (e.g. “multilinguality”), multiuser sessions, administration;
- **Data security**, protection of provider and user data against alteration, theft and misuse;
- **Quality of service**;
- **Ubiquity of access**, including global reach.

The GMES architecture will progressively evolve from a set of unconnected networks to a fully integrated network and services, where each user might participate in several virtual networks, one being the original regional or national network and others being pan-European theme-focused networks.

The capacity will include methodologies, models, databases, tools (e.g. Geographical Information Systems) and facilities for data and information management. Access to data sources, training for the users and expertise to validate and accredit the operational services will also be necessary. Services will be performed in priority at existing facilities by augmenting and adapting them as necessary or in new ones if necessary. The national and international organisations that already provide adequate services will be used as building blocks. If necessary new centres might be set up to fill the gap and reach a European level aimed by GMES.

The GEANT¹⁵ network could provide the necessary infrastructure to access all main public data sources and to support not-for-profit activities. Thematic sub-networks will then progressively be built up. Sub-networks could encompass existing networks, as well as a range of new scientific networks bringing together scientists working in specific domains (atmosphere, ocean, in-land water, coastal zones etc.).

The above considerations support the development of a European Spatial Data Infrastructure (ESDI) as foreseen in the context of the INSPIRE framework, to ensure the overall coherence and access to the wide variety of data and information sets. Such an ESDI will take into account the on-going activities towards a Global Spatial Data Infrastructure. The development of a Spatial Data Infrastructure requires the following actions:

- Development of open standards for data documentation, data models and services based on existing and emerging European and international standards.
- Development of tools and services allowing anybody to query, view, access and trade the information held by distributed public and private bodies.
- Establishment of a data policy framework, both at European and global level, and a range of data and information sharing agreements.
- Establishment of funding procedures aimed at aligning and leveraging Community and national financial resources to develop the needed monitoring tools and fill gaps in data.

Although the development of GMES services needs to be seen in the light of the European Union's commitment to have by 2008 an operational capacity for GMES, it is important to note the dynamic nature of the GMES process. New GMES services are being launched e.g. under the EU 6th Framework Programme for Research and the GMES Service Elements activity of ESA, while future policy developments may lead to readjusting and adding priorities in the years to come.

The combination of an ESDI together with high-speed technology networks (GRID and GEANT), space and in-situ monitoring and data collection capacities and future and current

¹⁵ GEANT is a project of the European Commission's Information Society Technologies (IST) Programme that will provide pan-European interconnection between in Europe at Gigabit speeds between National Research and Education Networks of 25 European countries.

networks such as the Environmental Agency's EIONET and the meteorological EUMETNET/EUMETSAT networks, will cover the full functionality of the European shared information capacity.

A Balanced Approach

The data policy framework for GMES services has to find the balance between "non-discriminatory access" on the one hand and security concerns which might require regulation or other measures to limit the access to certain services, information or data under specific circumstances. GMES is likely to include information from multiple-use or military origin and in addition some added value services may generate more sensitive information.

There is a need to set up mechanisms to cope with the existing variety of data policies adopted by providers and at the same time to conduct an analytical approach to identify which data policy or policies would be required to gain the maximum and sustainable success for GMES. This may be summarised as follows:

- Promote the maximum beneficial use of services, information and data thereby maintaining/achieving leadership in spatial data and related technologies;
- Promote collaborative and multiple use of services, information and data;
- Take into account existing and emerging data policies of main actors such as the EU, World Meteorological Organisation (WMO), Intergovernmental Oceanographic Commission (IOC), ESA, national governments and institutions and commercial providers;
- Promote a business perspective attractive to European industry and conducive to the development of industrial capabilities and innovation. This should cover the complete end-to-end data and information service chain (e.g. data supply and pre-processing, data analysis and modelling, information production and dissemination, systems (hardware and software) and use of services);
- Support convenient and consistent standards, calibration and metadata use;
- Ensure long-term archiving practice. This is of particular importance to research, whereas the tendency of commercial and certain operational practice is to focus more on recent data.

Existing national and European Union initiatives and data policies should be duly taken into account. Examples include INSPIRE, the Public Sector Information Directive¹⁶ and the Copyright Directive¹⁷ currently being transposed. The latter initiatives aim to facilitate an internal market for digital content products and services. Another example is the follow-on to the eContent Programme, which is currently running for a 4-year period from January 2001.

Tackling the problem of cross border information supply based on the use of public sector information (e.g. through INSPIRE) is an area where the EU can add substantial value. The attention given to the use of metadata should be reinforced.

Further, data policies cannot be pursued independently of the international environment. International initiatives affecting data policy, such as the activities by the ad hoc Group on Earth Observation (GEO) and the OECD should be followed and influenced to ensure an international GMES environment conducive to co-operation and as consistent as possible with the needs of GMES.

¹⁶ COM(2002) 207, proposal adopted by the Commission on 5 June 2003.
¹⁷ 2001/29/EC, adopted on 22 June 2001.

II.5. Research, Technology Development and Demonstration

Science and research provide the knowledge on which sound policies can be established. (A recent example is the work of the Intergovernmental Panel on Climate Change in support to UN Framework Convention on Climate Change.) Technology development and demonstration provide the means by which scientific knowledge is harnessed on a routine basis for operational monitoring and assessment.

Research, technological development and demonstration activities will cover high priority requirements such as:

- Enhancement of environment monitoring networks and associated instrument technologies;
- Improvement of models and the capacity for analysis, forecasting, planning and decision support. (This entails model parameterisation, assimilation tools, re-analysis of historic data using new models and improved calibration information);
- Improvement of interoperability and linkage between monitoring systems (space and in situ), data sources (environmental data and socio-economic data) and monitoring standards;
- Improved accessibility to long-term data archives, implementation of meta-data standards, actions to facilitate information retrieval and dissemination;
- Knowledge development and exchange including basic research on environmental processes (policies can only be based on scientific knowledge), on methodologies, training and capacity building.

All the above gaps are important obstacles for the smooth and efficient development of a strong European GMES capacity and will require the mobilisation of all expertise and competence available in industry, academic sector and governmental organisations to be overcome. It is furthermore assumed that the current resources for R&D and Technology, both at national and European levels, will be maintained for all areas of relevance to GMES. Growing insight into GMES requirements will influence priorities and allocation of these resources.

III. Implementation and Organisation

III.1. Implementation Principles

GMES must ensure long-term, continuous global monitoring on a time-scale of decades – not just over a few years. This is the single most crucial and demanding requirement on GMES. This is the result of both the length of the policy cycle (from definition up to verification) and of the environmental/security processes at issue. Thus, the requirement for the long-term provision of services implies that funding and development of data sources and infrastructures is fully ensured.

GMES will address multiple environmental and security issues and provide information on a hierarchy of spatial scales, from local up to global. GMES will also have to address an extremely diverse set of users, distributed across Europe, all working within different policy, institutional and cultural environments. This places demanding performance and throughput requirements on the GMES observation, modelling, data handling and service provision capabilities. Also, education and training will need to be systematically integrated into the service provision for these users, to ensure that the maximum benefit is derived. To achieve these challenging requirements, the GMES implementation will be based on a number of key principles, including:

Subsidiarity

Within the European nations concerned, GMES will make full use of appropriate existing infrastructures, space and in-situ observing systems, facilities and institutions for the production of information. This applies at not only national level, but also regional/provincial and local levels. The specific and differing needs of regions must be recognised, while also encouraging the association of European regions that have particular but similar information needs (e.g. coastal zones, mountainous, forested, arid or ice-bound regions etc). GMES will also rely on existing national and regional communication and distribution networks and facilities for data access and transfer and for distribution of products to users' organisations.

Therefore, it is important to recognise that European-level funding for GMES is not intended as a substitute for national funding, but as a complement that adds value, supporting those activities that are best performed at European level.

Evolutionary and open process

Given the large range of targeted issues and users, GMES must be gradually implemented, by a stepwise augmentation and adaptation of the proposed perimeter of services as well as the integration of new infrastructures and facilities. The evolutionary process is a direct consequence of the continuous dialogue between users and providers characterising GMES, leading to the preparation of the next generation of operational Earth observation satellites and in situ developments required for the services in the timeframe 2008-2012.

Involvement of industry

European industry, and in particular small and medium service companies (SMEs) should be involved at the core of the GMES implementation, including a role in identifying and addressing the needs for information, technologies and effective data policies. It is anticipated that the bulk of the GMES technical capacity will be obtained through contractual procurement schemes with industry and operational and RTD institutions, under the responsibility of the appropriate management entity.

Industry involved will range from large-scale companies to SMEs for provision of services and infrastructure. GMES will take advantage of the best available expertise and technology in Europe, adequate for the size and efficiency of the development and operation efforts required for GMES.

Furthermore, GMES will allow the emergence of a downstream servicing industry, where all interested parties may indeed take advantage of the guaranteed access to data to further develop services in new fields.

Role of research and technology development and demonstration

To remain fully operational, affordable and up to date, the GMES technical capacity has to continuously integrate the research results as well as new observational, data management and information technologies. This strong link between the operational character of GMES and the research domain is to be secured. GMES can take advantage of the existing capacities at regional, national and European level.

III.2. GMES Organisation

The Situation Today

At the European and national levels, a number of organisations already hold key competencies in the use, development and operations of systems which produce environmental and security information. Examples at European level are:

- European Commission services;
- Agencies of the European Union;
- Inter-governmental organisations;
- Non-governmental organisations.

These organisations have well-defined competencies, organisations, programmes and funding in specific domains but are largely self contained, with various different collaborations and interfaces. Co-ordination of the activities across these key actors requires strengthening.

With the exception of the meteorological domain and a few other specific examples, current institutional arrangements do not allow current European-level actors to prioritise and fund operational services in a coherent manner. Specifically they do not sufficiently allow:

- **identification of information needs and establishment of priorities** given the large number and wide variety of actual and potential users (including policy-makers, researchers, NGOs and the public, accounting for national and regional needs and differences);
- **development of coherence between competencies and programmes** (co-ordination to cover gaps and eliminate any overlaps, co-ordination/coherence of national-level activities; identification of commonalities in the needs for information and data);
- **development of necessary operational infrastructure, facilities and research** (lack of operational funding)
- **interoperability** for the sharing of information, data and assets
- **adoption of common service standards and policies** for data and information management, exchange and access
- **coherent contributions to international initiatives and organisations**
- **best use to be made of available European expertise** (industrial, commercial, scientific, legal and political)

Requirements for the organisation of GMES in 2008

The requirements for the organisation of GMES and the resulting scenarios benefited from the deliberations of the GSC working group that addressed institutional and socio-economic aspects of GMES. The achievement of an operational GMES capacity by 2008 will require institutional arrangements that provide the following functions:

- Political ownership and sustainable funding of the GMES initiative
- Observance of the principle of subsidiarity
- Implementation of a shared programme for the establishment of operational information services
- Establishment and maintenance of appropriate mechanisms for advice and consultation
- Overall management of the process, with clearly defined responsibilities

To ensure the establishment of an effective organisation in the required timeframe a streamlined institutional organisation is preferable, taking advantage of existing mandates and institutional agreements and avoiding as much as possible the creation of unnecessary new structures and entities.

It is important to identify and involve all the appropriate actors and to create arrangements that facilitate the gradual evolution and build-up of the GMES capacity. Such an organisational set-up needs to be capable of effective international co-operation and coherent contributions to global initiatives. Thus, collectively, the involved parties would form a critical mass for the efficient and sustained provision of information services serving evolving European public policy priorities.

A. Political Ownership

This aspect of the institutional set-up has been identified by GMES stakeholders as a crucial element for the success of the GMES initiative. Political ownership is taken to include the following tasks:

- Setting the political priorities to be served by the initiative
- Ensuring the availability of sustainable operational and research funding
- Setting the framework and orientations for international co-operation

The political owners of GMES should have the competence and authority to deal with both the environmental and security aspects of the initiative as they evolve. They must also be capable of creating the necessary political agreements that encompass national and international activities. These attributes suggest the highest possible levels of European and national authority and thus points to the European Union and the Member States of the EU and ESA.

This configuration recognises subsidiarity and the role of Member States as funders (and users) of national infrastructure and services that are essential for the success of GMES, as well as their authority in security matters.

B. Management Entity

A management structure is proposed to have responsibility for the overall management of the GMES process. Among many possible tasks, the most important functions would be:

- Preparation and implementation of a GMES programme, as approved by the political owners, including:
 - overall responsibility for the establishment of an operational service capacity and the required services
 - making recommendations for the required observing networks

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- Monitoring of the coherence and complementarity of related activities, programmes and funding schemes and making appropriate proposals
- Animation of a sustained and structured dialogue with GMES stakeholders

A unitary management structure is favoured, in order to provide coherent and consistent direction to the required activities. The following are among the options thought to be suitable:

- i.) A GMES Task Force or Interim Structure, possibly using the provisions of the Commission/ESA Framework Agreement, composed of Commission and ESA personnel and possibly experts from intergovernmental organisations
- ii.) A Joint Undertaking (on the basis of Article 171 of EC Treaty and taking into account the Galileo experience)
- iii.) An executive agency of the EU (on the basis of Council Decision (EC)58/2003) or a non EU agency

For the early part of the Implementation Period, option i) is favoured. The Task Force/ Interim Structure will explore the merits of the various organisational options and recommend a structure to the GMES Political Owners. Some of these options could evolve into or give way to others (e.g. for the Management Entity option i) could be replaced by option ii) and in turn be replaced by option iii).

C. Advisory Committee

The idea for this entity recognises that the Member States of the EU and ESA would expect a more direct degree of consultation and/or oversight than would be afforded within the ESA and EU Councils and the governing bodies of the individual members of any “partnership”.

Assuming that a Management Entity is made responsible for drawing up and implementing a GMES programme, the function of the Advisory Committee would be to provide comments and advice on the GMES programme to the Management Entity and to the political owners

Such a body could be an evolution of the GMES Steering Committee.

D. GMES Partnership

The notion of a “partnership” refers to the possible configurations of significant GMES actors and the roles and relationships required between them for the success of GMES.

The important European-level actors would be encouraged to progressively orient their activities/budgets/remits to help the fulfilment of GMES. The partners would agree to adhere to GMES principles and standards and may undertake to fulfil specific roles or tasks within a common GMES programme. An additional form of partnership could be envisaged, where a “core” or “operating” partnership of European organisations would deliver elements of GMES and collectively provide end-to-end services, consistent with a GMES programme.

Implementation period (2004-2007)

It is recognised that further analysis must be performed in order to arrive to a better definition of the definite role and configuration of the political ownership, GMES management entity, GMES Partnership and GMES Advisory Committee.

The objective is to arrive to a definite proposal by end 2004, to be enforced by end 2007.

In the meantime, it is proposed to go ahead with the following mechanisms:

A.

The political ownership will be as already stated above.

B.

The Management Entity will be set-up as a small ad-hoc interim structure (in line with option i) proposed above), initially comprising staff members from EC and ESA. This structure will be implemented in accordance with the provisions of the Commission/ESA Framework Agreement. It might possibly invite some expert staff from other prominent actors, on an ad hoc basis.

C.

The Advisory Committee will be created as a follow-on to the current Steering Committee, with changed Terms of Reference, with the intention to further involve, only as observers, representatives of the users communities and of industry.

D.

Senior mutual advice and consultation of GMES prominent partners will be provided through ad-hoc mechanisms, such as a yearly high-level meeting, to discuss the further possible orientation of GMES and coherence of supporting programmes.

III.3. Additional Essential Interfaces

III.3.1. Service providers

Two main possible approaches are considered by which operational services will be delivered to users. These are:

- i.) Use of an operating association consisting only of European-level organisations, which would be in charge of the provision of the services and underlying infrastructure.
- ii.) Procurement of services on the basis of competition, where the Management Entity would have direct responsibility to set up and manage contractual relationships with organisations and industrial consortia for the provision of operational services to users. This could be via invitation to tenders and lead to the granting of service concessions. Organisations and consortia already exist in some cases that are naturally placed to provide operational services. New groupings may also form to compete to fill gaps in service provision and may consist of public and/or private sector organisations (including industry, research establishments and public agencies etc).

It is recognised that the possible service provisions scheme require further analysis. A firmer proposal is expected by end of 2004.

III.3.2. Structured Stakeholder Dialogue

As mentioned above it will be the responsibility of the Management Entity to organise a structured dialogue with the wide variety of GMES stakeholders. This will include users and information and data providers from government, industry, the research community, NGOs and citizens. The dialogue will have the aim to feed insights, requirements and advice into the process of the definition and on-going implementation of new operational services. The dialogue could take place on a thematic basis and will incorporate scientific, legal and commercial advice.

III.4. International Co-operation

GMES - and thus Europe - will benefit from international co-operation, through activities such as the co-ordination of monitoring capabilities and the exchange of data and information and capacity building. At the same time the European Union can make its contribution to the international community and help fulfil the leadership role to which it aspires by providing services to its partners. It will be one of the responsibilities of the GMES political owners, with the support of the partnerships, to define the extent and the modalities of this international co-operation.

Important and effective co-operation already exists in the field of meteorology e.g. within the activities of the World Meteorological Organisation. Particularly close co-operation is being established between Europe (EUMETSAT) and the US (NOAA) in this domain, for polar-orbiting meteorological satellite activities.

The potential within GMES for international co-operation encompasses the following countries and regions:

- Canada, which, by its involvement in ESA programmes supporting GMES, and by a major potential contribution for both the in-situ and the space-borne information systems, may indeed be a preferred co-operating partner.

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- States and institutions that, while not belonging to the European Union or ESA, are nevertheless already involved in GMES. Examples include countries associated to EU environmental programmes, the 6th Framework Programme for Research (Iceland, several Balkan countries) or are members of EUMETSAT (e.g. Turkey).
- The Russian Federation, in the context of shared concerns for environmental and climactic changes, resource management and other areas such as security of energy supply. GMES will also be a continuing point of focus regarding the EU-Russia partnership on Space;
- Other European neighbour states and regional organisations interested in GMES, for example the states on the Southern Rim of the Mediterranean basin (Barcelona convention), Ukraine and Byelorussia. These partners might be involved in a more or less active co-operation modes: from simple access to GMES servicing over their homeland, up to access to their in-situ observation network;
- Nations with significant or emerging space and in situ monitoring and information producing capabilities such as the US, Japan, India China, Brazil, Israel etc;
- Trade partners of the European Union and the states and regions with which the Union has a preferred partnership on development aid (e.g. African, Caribbean and Pacific countries).
- Africa forms a distinct regional focus in the context of the Johannesburg Action Plan of the World Summit for Sustainable Development in 2002. GMES activities can contribute to and benefit from activities such as the African Monitoring for Environment and Sustainable Development (AMESD) initiative, lead by the European Commission.
- On the global level, collaboration needs to be considered:
 - with all parties involved in global efforts for monitoring the Earth and its environment particularly the UN agencies such as the UN Environment Programme, UNESCO, the World Meteorological Organisation (WMO), Intergovernmental Oceanographic Commission (IOC) and the Food and Agriculture Organisation (FAO).
 - through initiatives like the ad hoc Group on Earth Observation (GEO), initiated by the first Earth Observation Summit in 2003, where GMES will be the major European contribution, or other efforts such as the Integrated Global Observing Strategy Partnership (IGOS-P) and the Committee on Earth Observation Satellites (CEOS);
 - on a multilateral basis, with signatories of Multilateral Environmental Agreements , such as the Kyoto Protocol of the UN Framework Convention on Climate Change, or security-related international agreement, where GMES services may act as a both a unbiased verification tool;
 - with all parties needing urgent help related to natural disaster, where the International Charter “Space and Major Disasters” may be seen as a precursory tool.

An appropriate balance between international co-operation and European autonomy must be defined for GMES. Where Europe may afford to depend on secured data exchange scheme, the autonomous capacity to process and analyse those data must remain in Europe. Further examination of these considerations and the adoption of a coherent policy on international co-operation will be required.

III.5. Funding

The GMES long-term objective is to ensure sustained operational services relying on inputs issued mainly from observing systems including space and in-situ systems and by having adequate data integration and information management in place.

The funding addresses the following components geared towards sustained operational services:

- A. The implementation of the priority services as from 2004. The provision of operational services and further developments as from 2007.
- B. The preparatory and implementation activities related to future space observing systems as from 2004 and continued in 2007 and beyond.
- C. The preparatory and implementation activities related to future in-situ observing systems as from 2004 and continued in 2007 and beyond.
- D. The progressive build-up of Data Integration and Information Management as from 2004 and continued in 2007 and beyond.
- E. The R&D activities in support of above components.
- F. The management of the development of the above components.

For the above components, funding is either available or still need to be found. It is anticipated that the new funds will come primarily from public sector as GMES stems from strategic concerns and is directly linked to specific policy needs. Consequently the potential for contributions from policy owners should be explored.

National-level funding for these activities exists in many cases and will continue to be important to maintain and adapt to the needs of GMES. Unless otherwise stated, only budget lines at European level are included in the values given below.

The funding strategy is based on the above facts and each component along two distinct periods (2004-2006 and 2007 and beyond) which reflect the different budgetary periods of the European Union.

A. Service Component

Implementation of operational services (2004-2006)

The activities starting in 2004 will use currently available funds from EC/FP6/Space/GMES (€100M) and ESA/GSE¹⁸ (€83 M).

These funds are used according to the timing of the FP6/Space/GMES Calls and ESA/GSE programme schedule. The first batch of FP6/Space/GMES Integrated Projects is foreseen to start early-2004 and the next batches are planned for 2005 and 2006. Giving the time span of these projects (~ 3 years), capacities and associated operational services will come into life progressively as from 2006 up to 2008, in line with the overall planning. ESA has started its consolidation phase and planned to enter implementation of operational thematic services in late 2004.

Provision of operational services (as from 2007 and beyond)

Following the progressive implementation of GMES operational services, adequate operational funds are required to bring them in and sustain full operational status.

These operational funds should cover the following expenditures:

¹⁸ GMES Services Element funded by ESA Earth Watch programme

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- performance of operational services by appropriate staff, including users training
- access to data sources when not funded otherwise
- applied research for services improvement
- facilities running and management
- upgrade of the service capacity as required per evolving user requirements
- development of new service capacity in response to new user needs

The associated cost estimate is function of the number of services ready to undergo full operations at a given date. It is anticipated that it will be in the range of €80 M in 2007 and stabilised at €150 M per year as of 2008. The possibility of funding could be explored through all parties involved e.g. EC, ESA, member states, etc.

Supporting research activities in each thematic area should continue and must be provisioned in the context of future EC Framework Programme, ESA and national research programmes. They should be accessible to the entities performing the services through standard access mechanisms to these research programmes.

B. Space Component

Implementation of operational space systems

Period 2004-2006

In order to have the operational space elements in place as from the beginning of the full operational phase (2007-2013), the preparatory work should start in 2004.

As anticipated in the European Space Policy White Paper under GMES heading, there will be different series of satellites, each series covering a given domain (high-resolution imagery, wide field imagery for ocean and land, etc.)

The period 2004-2006 will be dedicated to the following activities:

- Definition studies for each series,
- Start of the procurement of the first satellites of each series.

During this period it will be necessary to ensure access, within this cost item, to available space data sources and this will be achieved through the ground segment of the space component.

The estimated budget is a total of **€15 M over 2004-2006 timeframe**. ESA is planning to contribute at a level of €300 M and will present a programme proposal in this sense to its Member States at the end of 2004. The funding of the remaining €15 M could be envisioned through the European Investment Bank in the context of the European Growth initiative¹⁹. The earlier additional funds are available the more the procurement for new satellites can be accelerated.

Period from 2007 and beyond

The implementation of operational space elements of GMES will continue on this timeframe.

ESA plans to continue to support the funding of the space component with an expected average level of €100 M per year.

In addition, the European Space Policy White Paper has addressed the funding of the operational space observing systems with a progressively increasing "additional public

¹⁹ COM (2003) 690 final of 11.XI.2003

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expenditure" funding scheme. Satellite operations and access to space data sources will continue to be guaranteed within this funding. These figures are based on the White Paper political objective of reaching in 2013 for GMES related space components, the target of €340 M irrespective of the selected scenario. The spread over the 2004-2013 is done with a linear growth for time being, as no detailed planning for implementation is yet available.

2007	2008	2009	2010	2011	2012	2013	Total (€M)	Funding
100	100	100	100	100	100	100	700	ESA
110	150	190	225	260	300	340	1575	additional public expenditure

C. In-Situ Component

Implementation of operational in-situ systems

Monitoring is currently supported by European states at a significant level. The cost of this monitoring is high but not included here. Estimates from countries where data is currently known suggest spending at several billions of euros per year. (An assessment of the overall picture, in order to suggest options for integration and streamlining is necessary.)

Period 2004-2006

GMES operational services rely equally on in-situ measurements obtained through all types of ground, sea and air based sensors, the observed elements being at national (local), cross-national and global levels.

In this timeframe short-term investments could be envisioned in order to complete or update existing systems. The short-term investments of **€10 M per year** over 2004-2006 timeframe need to be confirmed after further assessment. Their possible funding by the Member States should be explored.

In this timeframe the existing in-situ capabilities and needs associated with the future GMES services will be assessed for the long-term investments in the 2007 and beyond period. The cost estimate (including procurement, operations and maintenance) for national, trans-national and global level in-situ observing systems should be assessed separately.

Period from 2007 and beyond

Deployment of new in-situ systems and maintenance/extension of existing ones will be performed during this timeframe.

Awaiting the assessment of the long-term investments mentioned above, an indicative cost estimate could be in the range of **€50 M per year**. Their possible shared funding between EC and Member States should be explored.

The particular case of socio-economic data (population census, statistics, etc.) needed also by GMES and gathered by other means (national or European entities such as EUROSTAT) are supposed to be available free of charge or being relatively low cost items to be budgeted separately.

D. Data Integration and Information Management

Period 2004-2006

In this period (€5 M) will be dedicated to run, in the context of the GMES thematic projects, activities to:

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- better estimate the investments needed to meet the GMES priorities,
- building on activities such as GEANT for high-speed networking and
- to initiate the step-wise development of open standards for data documentation, data models and data policy sharing agreements involving both public and private sector bodies.

This initial linking of space monitoring with in situ monitoring should come from funds specifically allocated to GMES from 6th FP funding.

Period from 2007 and beyond

The step-wise development of a European Spatial Data Infrastructure is estimated at approximately €200 M per year. Resources for setting up the infrastructure needed for linking space monitoring with ground based monitoring would be expected to come from funds allocated to GMES by the gradual redirection of national resources initially allocated to monitoring.

E. Research Technology Development and Demonstration

Science and research activities to provide the best knowledge for GMES related domains and the preparation of new pre-operational services for the period as of 2007 onwards.

The funding strategy is to use the standard science and research frameworks of EC (FP7), ESA and Member States.

F. Management

An appropriate entity has to carry the management of the GMES capacity and services implementation. It is envisioned that this entity will be staffed in early stages by EC, ESA and Member States personnel augmented in due time by additional contracted experts.

The running cost of the entity will be covered under EC and ESA available research budgets. In the hypothesis that this management entity continues its duties in 2007 and beyond the associated cost estimate has to be assessed accordingly.

IV. Recommendations for the 2004-2008 Period

Recommendation 1 – Establish a GMES organisational framework

- Establish a GMES Interim Structure by mid 2004
- Establish an operational GMES Management Entity, on the basis of proposals of the GMES Interim Structure, by end 2005
- Establish a GMES Partnership on the basis of proposals of the GMES Interim Structure, by end 2005
- Establish as required the advisory/supervisory arrangements for the concerned countries and organisations by end 2004.

Actionee(s): European Commission and Council, ESA and EU and ESA Member States

Recommendation 2 – Establish mechanisms for a permanent dialogue with users by end 2004, in view of:

- further assessing and structuring the information needs with respect to EU policies in the field of environment and security at European and global scales
- providing inputs for adjustments to running implementation contracts
- identifying new services

Actionee(s): European Commission and Council, ESA, EEA and EU and ESA Member States

Recommendation 3 – Begin implementation of priority services.

- Further develop and start to deliver services, as outlined in this report, through existing channels such as the EU FP6 RTD and ESA GSE programmes.
- Support the evolution and on-going evaluation of the portfolio of supported services, in close relation to Recommendation 2, by:
 - Establishing a directory of GMES-related services (including existing and planned activities at European, national and regional level) by end 2004.
 - Performing a comprehensive cost-benefit analysis for the priority services identified and GMES as a whole.
 - Providing a yearly report on the status of GMES services with the necessary details of the development and implementation activities. This report is to include the programmatic and technical aspects of products and services and recommend adjustments and/or new specifications.
 - Preparing a revised list of candidate services.

Actionee(s): European Commission and Council, ESA and EU and ESA Member States

Recommendation 4 – Develop a strategy with respect to data and information needed for and produced by GMES services by mid 2005

- Review the existing data policies in a European and international context, initiating the necessary dialogue and creating arrangements that address the needs of GMES users by mid 2005.
- Develop education and training guidelines for GMES information services by the end of 2004.
- Develop a GMES communication plan by end 2004.

Actionee(s): European Commission, ESA, EEA and EU and ESA Member States

Recommendation 5 – Develop the capacity and interfaces to improve access, exchange and sharing of data and information needed for and produced by GMES services by 2008

- To include definition, by mid 2005, of the European Environmental Spatial Data Infrastructure needed for improved data and information access and provide improved cost estimates and an implementation plan
- To consider the setting up of a European imagery and mapping capability building upon existing facilities and expertise to better serve security-related, as well as environmental policies
- To foster the cooperation with Eurostat, OECD and relevant UN agencies

Actionee(s): European Commission and Council, EEA, ESA, EU and ESA Member States and operational data and service providers (e.g. EUMETSAT).

Recommendation 6 – Develop the required elements of space capabilities for GMES by 2008.

On the basis of identified service priorities:

- prepare new space mission programme proposals.
- start the implementation phase with industry.
- undertake and complete the negotiation process to access data from European and non-European satellite systems

Actionee(s): ESA in consultation with EUMETSAT and national space agencies

Recommendation 7 – Assess the existing in-situ capabilities of relevance for GMES and prepare an implementation plan for complementary adaptations and/or new deployments.

- Provide a report on the existing, planned and required in-situ observing systems and provide an implementation plan (to include recommendations for integration, streamlining and gap-filling) by end 2004.
- Provide a report on the existing, planned and required sources of socio-economic data and statistics and provide an implementation plan by end 2004.
- Perform the initial upgrades in funding available in the 2004-2007 timeframe.

Actionee(s): European Commission and Council, EEA, Eurostat and EU and ESA Member States

Recommendation 8 – To organise and fund research, technology demonstration and demonstration (RTD) activities at a level sufficient to underpin the quality and progress of GMES services.

Among the required activities will be the filling of gaps in scientific knowledge and required technologies (including for space and in situ observing systems), implementation of pre-operational activities and the transfer of knowledge and expertise to GMES services.

- To identify early in the development of GMES services the RTD activities required to support the planned services and their possible evolution/improvement;
- To secure and maintain the appropriate levels of funding at national and European levels to ensure timely availability of required RTD elements.

Actionee(s): European Commission and Council, ESA and EU and ESA Member States

Recommendation 9 – Establish a policy for GMES international partnerships by end 2004.

This will include the extent and modalities of co-operation are to be defined for:

- activities such as co-ordination of monitoring capabilities and exchange of data and information
- the contribution to the international community by providing services and by capacity building

Actionee(s): European Commission and Council, ESA and EU and ESA Member States

Recommendation 10 – To ensure sustainability of GMES services through appropriate funding mechanisms by end 2006

The funding concerns the following aspects of the GMES system:

- development and maintenance of the observing data management and servicing technical capacity
- the efficient co-ordination and management mechanism for the effective organisation of GMES
- Investigate the establishment of dedicated GMES operational budget lines such as a Trans European Network (TEN) by end 2004.
- Create dedicated budgets for the provision of GMES operational services in the 2007-2013 timeframe.

Actionee(s): European Commission and Council and EU and ESA Member States, in consultation with the ESA Executive.

Annex 1. GMES Initial Period Projects

EC	APMoSPHERE	Air Pollution Modelling for Support to Policy on Health, Environment and Risk Management in Europe
EC	BIOPRESS	Linking Pan-European landcover changes to pressures on biodiversity
EC	CREATE	Construction, use and delivery of European aerosol database
EC	DAEDALUS	Delivery of aerosol products for assimilation and environmental use
EC	DISMAR	Data Integration System for Marine Pollution and Water Quality
EC	ESONET	European Sea Floor Observatory Network
EC	EUFORO	European Forum on the use of Earth Observation for Environment and Security
EC	EUROSION	Information for coastal erosion mitigation ²⁰
EC	GMES-GATO	Global Monitoring for Environment and Security - Global Atmospheric Observations
EC	ISIS	Humanitarian responses
EC	LADAMER	Land Degradation Assessment in Mediterranean Europe
EC	MERSEA	Marine environment and security in the European Area
EC	MAMA	Mediterranean network to assess and upgrade monitoring and forecasting activity
EC	Meth-MonitEur	Methane monitoring in the European region
EC	OCEANIDES	Harmonised monitoring, reporting and assessment of illegal marine oil discharges.
EC	RISKFORCE	Natural risk management
EC	Siberia	Multi-sensor concepts for greenhouse gas accounting of northern Eurasia
EC	TEASE	Telematics Architecture for Security and Environment
EC	BICEPS	Building an Information Capacity for Environmental Protection and Security
EC	DPAG	Data Policy Assessment for GMES
EC	GMES-Russia	Thematic network for GMES issues in the Russian Federation
EC	GSeS	GMES Socio-economic Study
ESA	GSE	Forest monitoring for forest management and Kyoto reporting
ESA	SAGE	Information for soil and inland water management
ESA	RiskEOS	Information for flood and forest fire risk assessment
ESA	TerraFirma	Information for urban subsidence and risk assessment
ESA	Urban Services	Information for urban environmental management
ESA	GMFS	Information for food security management in Africa
ESA	CoastWatch	Information for integrated coastal zone management
ESA	ROSES	Information for oil spill monitoring and coastal waters quality assessment
ESA	Icemon	Information for sea ice mapping
ESA	Northern View	Information for Arctic environmental management

Table 1. GMES Initial Period Projects

²⁰ EUROSION is a project managed by DG Environment and funded by the European Parliament

Annex 2. Opinion of the GMES Steering Committee

Summary

The GMES Steering Committee (GSC) believes that GMES can make an important contribution to achieving Europe's objectives for sustainable development and global governance. It considers the GMES Initial Period Report 2001-2003 to be a sound basis for discussion and subsequent decision on the best way for continuation and development of GMES in the period 2004-2008. It recommends that the GMES process should continue to be as open and transparent as possible.

Detail

The GSC, which includes representatives from EU and ESA member states as well as representatives from relevant EU institutions and other European bodies, has met throughout 2002-2003 under co-chairs from the ESA Executive and the European Commission. The GSC and its expert working groups have had full visibility of the underlying initial period work and have been able to give advice and comment throughout the initial period. The Report itself has been prepared by the European Commission and the ESA Executive.

The GSC believes that the underlying initial period work has identified a number of important issues which need to be addressed early in the development phase if GMES is to be successful in its development aims and, in particular, in its operational aims. Particularly important issues identified in the Report, on which further exploration may be needed before specific decisions or choices are made, include:

- the political ownership and future governance of GMES;
- scenarios for sustainable funding, especially for the operational phase;
- the structure of the proposed partnership between GMES actors, and the roles and relationships within that partnership;
- the security dimension of GMES;
- the ways in which GMES will contribute to the ad hoc Group on Earth Observation (GEO) process and other relevant international initiatives;
- the explicit GMES data policies which will optimise the use of services, information and data;
- how services, information and data can best be made readily accessible in the most efficient and effective way to the widest possible range of users and applications.

The Recommendations in the Report were made available to the GSC too late for it to be able to discuss them thoroughly and reach an overall opinion. Nevertheless, the GMES Steering Committee (GSC) considers the GMES Initial Period Report 2001-2003 to be a sound basis for discussion and subsequent decision on the best way for continuation and development of GMES in the period 2004-2008.

The GSC welcomes the open nature of the GMES process and the way in which the involvement of users has been stimulated. The GSC believes that its close involvement in the initial period process has helped form a consensus on which issues need to be addressed to take GMES forward. It hopes that the GMES process will continue to be an inclusive one to ensure that this consensus remains in place.

GMES Steering Committee
16 January 2004