

# **The Global Earth Observation System of Systems (GEOSS) 10-Year Implementation Plan**

*(As adopted 16 February 2005)*

## **Preamble**

Understanding the Earth system—its weather, climate, oceans, atmosphere, water, land, geodynamics, natural resources, ecosystems, and natural and human-induced hazards—is crucial to enhancing human health, safety and welfare, alleviating human suffering including poverty, protecting the global environment, reducing disaster losses, and achieving sustainable development. Observations of the Earth system constitute critical input for advancing this understanding.

Interested countries and organizations have collaborated to develop this Plan to ensure comprehensive and sustained Earth observations. It builds on and adds value to existing Earth observation systems by coordinating their efforts, addressing critical gaps, supporting their interoperability, sharing information, reaching a common understanding of user requirements and improving delivery of information to users.

## **1 Purpose of this Plan**

The purpose of this Plan is to summarize the essential steps to be undertaken, over the next decade, by a global community of nations and intergovernmental, international, and regional organizations, to put in place a Global Earth Observation System of Systems (GEOSS).

## **2 Vision for GEOSS**

The vision for GEOSS is to realize a future wherein decisions and actions for the benefit of humankind are informed by coordinated, comprehensive and sustained Earth observations and information.

## **3 Purpose and Scope of GEOSS, and the Group on Earth Observations**

### **3.1 Purpose of GEOSS**

The purpose of GEOSS is to achieve comprehensive, coordinated and sustained observations of the Earth system, in order to improve monitoring of the state of the Earth, increase understanding of Earth processes, and enhance prediction of the behavior of the Earth system. GEOSS will meet the need for timely, quality long-term global information as a basis for sound decision making, and will enhance delivery of benefits to society in the following initial areas:

- Reducing loss of life and property from natural and human-induced disasters;
- Understanding environmental factors affecting human health and well-being;
- Improving management of energy resources;
- Understanding, assessing, predicting, mitigating, and adapting to climate variability and change;
- Improving water resource management through better understanding of the water cycle;
- Improving weather information, forecasting, and warning;

- Improving the management and protection of terrestrial, coastal, and marine ecosystems;
- Supporting sustainable agriculture and combating desertification;
- Understanding, monitoring, and conserving biodiversity.

GEOSS is a step toward addressing the challenges articulated by United Nations Millennium Declaration and the 2002 World Summit on Sustainable Development, including the achievement of the Millennium Development Goals. GEOSS will also further the implementation of international environmental treaty obligations.

### **3.2 Scope of GEOSS**

GEOSS will provide the overall conceptual and organizational framework to build towards integrated global Earth observations to meet user needs. GEOSS will be a “system of systems” consisting of existing and future Earth observation systems, supplementing but not supplanting their own mandates and governance arrangements. It will provide the institutional mechanisms for ensuring the necessary level of coordination, strengthening and supplementation of existing global Earth observation systems, and for reinforcing and supporting them in carrying out their mandates.

GEOSS will capture the success of Earth observation research programs, and facilitate their transition to sustained operational use.

The established Earth observation systems, through which many countries cooperate as members of the United Nations Specialised Agencies and Programmes and as contributors to international scientific programs, provide essential building blocks for GEOSS. The implementation of GEOSS will seek to ensure effective consultation and cooperation with the UN system and other international and national agencies sponsoring or cosponsoring the major component global observing systems on which GEOSS will be built.

The contributing systems will range across the processing cycle, from primary observation to information production. Through GEOSS, they will share observations and products with the system as a whole, and will take the necessary steps to ensure that the shared observations and products are accessible, comparable, and understandable, by supporting common standards and adaptation to users needs.

GEOSS aspires to encompass all areas of the world, and to cover *in situ*, airborne, and space-based observations. GEOSS will be primarily focused on issues of regional and global scale and cross-sectoral applications, while also facilitating, if so invited, the operation and enhancement of Earth observing systems that are focused on national, local, and sector-specific needs. GEOSS will promote capacity building in Earth observation, building on existing local, national, regional, and international initiatives.

### **3.3 Group on Earth Observations (GEO)**

Membership in GEO is open to all member States of the United Nations and to the European Commission. GEO welcomes, as Participating Organizations, intergovernmental, international, and regional organizations with a mandate in Earth observation or related activities, subject to approval by GEO Members. GEO may invite other relevant entities to participate in its activities as observers.

## **4 Benefits of GEOSS**

Sound management of the Earth system, in both its natural and human aspects, requires information that is timely, of known quality, long-term, and global. Ensuring that such information is available to those who need it is a function of governments and institutions at all levels. Despite laudable efforts, the current situation with respect to the availability of Earth observations is not optimal. This situation is particularly true with respect to coordination and data sharing among countries, organizations and disciplines, and meeting the needs of sustainable development. There are large spatial and temporal gaps in data coverage. Moreover, there is an eroding observational infrastructure, inadequate long-term data archiving, and no assured continuity for many essential observing systems. Consequently, targeted collective action is needed to bring observing systems in line with the requirements for addressing a range of issues of concern to society.

### **4.1 Societal Benefit Areas**

GEOSS will yield advances in the societal benefit areas defined by its purpose and scope. Each area has compelling reasons for the Earth observation advances envisioned in GEOSS.

For information needs common to many societal benefit areas, GEOSS will facilitate the development and provision of common products such as maps of topography, bathymetry, river systems, infrastructure, and land cover and land use, and a geodetic reference frame for Earth observation. Interpretation and use of Earth observations requires information on drivers and consequences of change, including geo-referenced socio-economic data and indicators.

The following are brief summary statements of topics covered and key outcomes in each area.

#### **4.1.1 Disasters: Reducing loss of life and property from natural and human-induced disasters**

Disaster losses can be reduced through observations relating to hazards such as: wildland fires; volcanic eruptions; earthquakes; tsunamis; subsidence; landslides; avalanches; ice; floods; extreme weather; and pollution events. GEOSS implementation will bring a more timely dissemination of information through better coordinated systems for monitoring, predicting, risk assessment, early warning, mitigating, and responding to hazards at local, national, regional, and global levels.

#### **4.1.2 Health: Understanding environmental factors affecting human health and well-being**

Health issues with Earth observation needs include: airborne, marine, and water pollution; stratospheric ozone depletion; persistent organic pollutants; nutrition; and monitoring weather-related disease vectors. GEOSS will improve the flow of appropriate environmental data and health statistics to the health community, promoting a focus on prevention and contributing to the continued improvements in human health worldwide.

#### **4.1.3 Energy: Improving management of energy resources**

GEOSS outcomes in the energy area will support: environmentally responsible and equitable energy management; better matching of supply and demand of energy; reduction of risks to energy infrastructure; more accurate inventories of greenhouse gases and pollutants; and a better understanding of renewable energy potential.

#### 4.1.4 Climate: Understanding, assessing, predicting, mitigating, and adapting to climate variability and change

The climate has impacts in each of the other eight societal benefit areas. Coping with climate change and variability demands good scientific understanding based on sufficient and reliable observations. GEOSS outcomes will enhance the capacity to model, mitigate, and adapt to climate change and variability. Better understanding of the climate and its impacts on the Earth system, including its human and economic aspects, will contribute to improved climate prediction and facilitate sustainable development while avoiding dangerous perturbation to the climate system.

#### 4.1.5 Water: Improving water resource management through better understanding of the water cycle

Water-related issues addressed by GEOSS will include: precipitation; soil moisture; streamflow; lake and reservoir levels; snow cover; glaciers and ice; evaporation and transpiration; groundwater; and water quality and water use. GEOSS implementation will improve integrated water resource management by bringing together observations, prediction, and decision support systems and by creating better linkages to climate and other data. *In situ* networks and the automation of data collection will be consolidated, and the capacity to collect and use hydrological observations will be built where it is lacking.

#### 4.1.6 Weather: Improving weather information, forecasting and warning

The weather observations encompassed by GEOSS are based on the requirements for timely short- and medium-term forecasts. GEOSS can help fill critical gaps in the observation of—for example—wind and humidity profiles, precipitation, and data collection over ocean areas; extend the use of dynamic sampling methods globally; improve the initialization of forecasts; and increase the capacity in developing countries to deliver essential observations and use forecast products. Every country will have the severe weather event information needed to mitigate loss of life and reduce property damage. Access to weather data for the other societal benefit areas will be facilitated.

#### 4.1.7 Ecosystems: Improving the management and protection of terrestrial, coastal and marine resources

Observations are needed on the area, condition, and natural resource stock levels in ecosystems such as forests, rangelands, and oceans. GEOSS implementation will seek to ensure methodologies and observations are available on a global basis to detect and predict changes in ecosystem condition and to define resource potentials and limits. Ecosystem observations will be better harmonized and shared, spatial and topical gaps will be filled, and *in situ* data will be better integrated with space-based observations. Continuity of observations for monitoring wild fisheries, the carbon and nitrogen cycles, canopy properties, ocean color, and temperature will be set in place.

#### 4.1.8 Agriculture: Supporting sustainable agriculture and combating desertification

Issues addressed by GEOSS will include: crop production; livestock, aquaculture and fishery statistics; food security and drought projections; nutrient balances; farming systems; land use and land cover change; and changes in the extent and severity of land degradation and desertification. GEOSS implementation will address the continuity of critical data, such as high-resolution observation data from satellites. A truly global mapping and information service, integrating spatially explicit socio-economic data with agricultural, forest, and aquaculture data will be feasible, with applications in poverty and food monitoring, international planning, and sustainable development.

#### 4.1.9 Biodiversity: Understanding, monitoring and conserving biodiversity

Issues in this area include the condition and extent of ecosystems, distribution and status of species, and genetic diversity in key populations. Implementing GEOSS will unify many disparate biodiversity-observing systems and create a platform to integrate biodiversity data with other types of information. Taxonomic and spatial gaps will be filled, and the pace of information collection and dissemination will be increased.

### **4.2 User Involvement**

The benefits of GEOSS will be realized globally by a broad range of user communities, including managers and policy makers in the targeted societal benefit areas, scientific researchers and engineers, civil society, governmental and non-governmental organizations and international bodies, such as those assisting with the implementation of multilateral environmental agreements. Engagement of users in developing countries will maximize their opportunities to derive benefits from GEOSS.

GEO will perform a coordination role to address the adequacy, efficiency, and integrative way user requirements are being met and transmit recommendations for improvements to the relevant contributing systems.

The needs of users, and the technical solutions to those needs, change with time. GEO will organize regular GEOSS User Fora among and within societal benefit areas or sub-areas, making use of user communities where they exist and catalyzing the formation of new ones where they do not. It will also create an appropriate mechanism for coordinating user requirements across societal benefit areas. The function of the User Fora will be to document and review user requirements, assess the extent to which they are being met, and make recommendations to GEO with the objective of improving the delivery of information appropriate to user needs.

## **5 Technical Approach, Capacity Building, and Outreach**

GEOSS, collectively, has several functional components:

- To address identified common user requirements;
- To acquire observational data;
- To process data into useful products;
- To exchange, disseminate, and archive shared data, metadata, and products; and,
- To monitor performance against the defined requirements and intended benefits.

GEO will employ a range of methods to advance the implementation of the Plan, tailoring them as required to address each of the various implementation issues. The methods will include: establishment of standing and specific task-oriented GEOSS structures; referring specific tasks to participating international organizations or agencies; coordinating and cooperating with national agencies; collaboration between international organizations; providing a forum for dialogue and resolution of issues at varying levels from Ministerial and senior official levels to scientific and technical levels; and advocacy within and across existing systems and other mechanisms.

GEOSS will be based on existing observing, data processing, data exchange and dissemination systems, while fostering and accommodating new systems operated by GEO Members and Participating Organizations, as needs and capabilities develop. The technical commitments of a GEO Member or Participating Organization will apply only to those contributions that they have identified.

Long-term continuity of existing observations is required. In addition, activities to facilitate research, capacity building, and outreach will be carried out and coordination focal points will be provided.

The utilization of new technologies and know-how will be carried out in accordance with international and national legislations.

## **5.1 Observations and Modeling**

In the implementation of GEOSS, increased sharing of methods for modeling and analysis needed to transform data into useful products will be advocated.

Within 2 years, a mechanism will be established for coordinating user needs across the various societal benefit areas. GEO will facilitate the development and maintenance of a distinct and common user requirements database for GEOSS, building on and linking to existing user requirements databases. These requirements will include specifics such as location, frequency, and accuracy. In the same timescale, a collaboration mechanism to share costs and benefits will be developed for observations and infrastructures for which the defined requirements may not be met by single-party activities alone. GEO will also provide a framework for securing the future continuity of necessary observations and initiating new observations. GEO could act as a forum for discussion on common implementation issues at regional and trans-national levels, such as transportation of *in situ* observation devices across borders.

The implementation of GEOSS will facilitate, within 2 years, the establishment and maintenance of baseline sites for global *in situ* networks.

GEO will establish, within 10 years, its system of systems to provide timely data and products for local, national, regional, and international policy makers. In the implementation of GEOSS, harmonization of observations, real- or near real-time monitoring, integration of information from *in situ*, airborne and space-based observations through data assimilation and models, and early detection of significant and extreme events will be advocated. Integration of *in situ*, airborne and space-based observations within the various societal benefit areas will be encouraged, as will the establishment of global, efficient, and representative networks of *in situ* observation to support process studies, satellite data validation, and algorithm and model development, as well as the detection, documentation and attribution of change.

## **5.2 Products, Data Management, and Radio Frequency Protection**

Current status assessments and descriptions, as well as predictive products in each of the domains of socio-economic benefit are required. The implementation of GEOSS will facilitate, within 2 years, the development and availability of shared data, metadata, and products commonly required across diverse societal benefit areas.

GEOSS will encourage the adoption of existing and new standards to support broader data and information usability.

GEO will advocate, within 2 years, through appropriate representations to the International Telecommunications Union, the protection of radio frequencies critical to Earth observation.

The implementation of GEOSS will facilitate, within 6 years, data management approaches that encompass a broad perspective of the observation data life cycle, from input through processing, archiving, and dissemination, including reprocessing, analysis and visualization of large volumes and diverse types of data.

The implementation of GEOSS will establish, within 6 years, international information sharing and dissemination drawing on existing capabilities through appropriate technologies, including, but not limited to, Internet-based services.

### **5.3 Architecture and Interoperability**

The success of GEOSS will depend on data and information providers accepting and implementing a set of interoperability arrangements, including technical specifications for collecting, processing, storing, and disseminating shared data, metadata, and products. GEOSS interoperability will be based on non-proprietary standards, with preference to formal international standards. Interoperability will be focused on interfaces, defining only how system components interface with each other and thereby minimizing any impact on affected systems other than where such affected systems have interfaces to the shared architecture.

For those observations and products contributed and shared, GEOSS implementation will facilitate their recording and storage in clearly defined formats, with metadata and quality indications to enable search, retrieval, and archiving as accessible data sets.

GEO will establish, within 2 years, a process for reaching, maintaining, and upgrading GEOSS interoperability arrangements, informed by ongoing dialogue with major international programs and consortia. That process is to be sensitive to technology disparities among GEO Members and Participating Organizations.

Attention is drawn to the importance of using existing international standards organizations and institutes as a focal point for the GEOSS interoperability objectives as they relate to and use standards.

For the most commonly used open standard interfaces, the GEOSS process will advocate some implementations to have no restrictions on being modified freely, commonly known as "open source" software.

To enable implementation of the GEOSS architecture, GEOSS will draw on existing Spatial Data Infrastructure (SDI) components as institutional and technical precedents in areas such as geodetic reference frames, common geographic data, and standard protocols. GEO Members and Participating Organizations and their contributions will be catalogued in a publicly accessible, network-distributed clearinghouse maintained collectively under GEOSS. The catalogue will itself be subject to GEOSS interoperability specifications, including the standard search service and geospatial services.

## 5.4 Data Sharing

The societal benefits of Earth observations cannot be achieved without data sharing.

The following are GEOSS data sharing principles:

- There will be full and open exchange of data, metadata, and products shared within GEOSS, recognizing relevant international instruments and national policies and legislation.
- All shared data, metadata, and products will be made available with minimum time delay and at minimum cost.
- All shared data, metadata, and products free of charge or no more than cost of reproduction will be encouraged for research and education.

Use of data or products does not necessarily imply agreement with or endorsement of the purpose behind the gathering of such data.

## 5.5 Research Facilitation

GEO will advocate research and development in key areas to facilitate, on an ongoing basis, improvements to Earth observation systems, including:

- Improved and new instrumentation and system design for *in situ*, airborne, and space-based observation on a long-term basis;
- Life-cycle data management, data integration and information fusion, data mining, network enhancement, and design optimization studies; and,
- Development of models, data assimilation modules, and other algorithms that are able to produce global and regional products more effectively.

GEOSS implementation will promote research efforts that are necessary for the development of tools required in all societal benefit areas. It will also encourage and facilitate the transition from research to operations of appropriate systems and techniques. This includes facilitating partnerships between operational groups and research groups.

## 5.6 Capacity Building

The GEO capacity building strategy follows the World Summit on Sustainable Development concept of a global partnership between those whose capacity needs development and those who are able to assist in the process, recognizing that activities have intertwined social, environmental, and economic impacts.

The GEO capacity building strategy will be based on best practices derived from studying successful and less-successful approaches.

Within 2 years GEO will:

- Produce a comprehensive review and analysis of gaps and methodologies, based on existing and planned capacity building efforts;



- Facilitate, together with existing efforts, the maintenance and strengthening of education, training, research and communication;
- Facilitate, with developing countries and across all societal benefit areas, the establishment and maintenance of baseline sites for global *in situ* and remote-sensing networks that cannot always be justified on national grounds alone, in cooperation with relevant global research programs and activities to ensure that synergies in observations and understanding are achieved;
- Develop a network of experts involved in existing capacity building initiatives related to Earth observation, and encourage users to access this knowledge base;
- Encourage, in each societal benefit area, the development of capacity building components as a requirement to any network, project, activity, or User Fora that will be a component of GEOSS.
- Facilitate access to data and models, particularly for developing countries.

Within 6 years GEO will:

- Advocate funding of multinational projects to leverage the end-to-end value of observations including the establishment of necessary infrastructure;
- Produce monitoring and evaluation mechanisms for GEO capacity building efforts; and,
- Facilitate education and training to provide a global base of technical expertise for GEOSS.

Within 10 years, GEO will seek to have in place a sustained capacity building strategy that will have significantly strengthened the capability of all countries, and particularly of developing countries, to:

- Use Earth observation data and products (e.g., process, integrate, model) following accepted standards;
- Contribute to, access, and retrieve data from global data systems and networks;
- Analyze and interpret data to enable development of decision-support tools and to advance understanding in the nine societal benefit areas;
- Integrate Earth observation data and products with other data and products, for a more complete view and understanding of problems and derived solutions;
- Improve infrastructure development in areas of poor observational coverage; and,
- Develop recommended priorities for new or augmented efforts in capacity building.

## **5.7 Outreach Plan**

Outreach is essential to many aspects of GEO activities. The outreach objective is to promote and increase the general awareness of the benefits of Earth observation, especially among present and future users, beneficiaries and sponsors of relevant systems.

Within 2 years, GEO will produce and begin to implement an outreach plan directed toward key target audiences, including decision-makers and policy makers; the general public; industry and service communities; scientific and technical communities; education entities; non-governmental organizations;

public interest advocacy groups; and international financial institutions and official development assistance agencies.

In subsequent years, GEO will continue to implement and periodically revise the outreach plan.

GEO will develop its international outreach activities in partnership with its participating UN and other intergovernmental and international organizations. For instance, UNESCO is the lead agency for the 2005-2014 "Decade of Education for Sustainable Development" that has several key actions in common with GEOSS.

## **6 Governance**

### **6.1 Functions**

The functions of GEO include:

- Overseeing implementation of the Plan, including monitoring and evaluating progress;
- Further developing and periodically updating the Plan, taking into account existing activities and evolving needs and capabilities;
- Identifying opportunities and measures to minimize gaps in data, metadata, and products;
- Setting and addressing priorities for filling gaps;
- Coordinating efforts to involve and assist developing countries in improving and sustaining their contributions to observing systems, their access to and effective utilization of shared data, metadata, and products, and the related technologies;
- Facilitating exchange of shared data, metadata, and products;
- Measuring, monitoring, and facilitating interoperability;
- Drawing on the expertise of the international scientific and technological communities;
- Facilitating user involvement and conducting outreach at global and regional levels;
- Adopting an Annual Workplan and associated budget;
- Selecting the Director of the Secretariat;
- Establishing and adopting its operating rules and procedures;
- Consulting, coordinating, and liaising with relevant UN Specialized Agencies and Programmes, and international scientific organizations;

### **6.2 Organizational Structure**

GEO, comprising the Members and Participating Organizations, is established on a voluntary and legally non-binding basis, with voluntary contributions to support activities.

GEO will meet in plenary at least annually at the senior-official level, and periodically at the Ministerial level.

GEO will take decisions by consensus of its Members. Decisions on implementation of the Plan will be based upon sound scientific and technical advice obtained through appropriate consultation with the research and observation communities.

To support its work, the GEO plenary will establish:

- An elected executive committee;
- Subsidiary bodies as appropriate, including science and technical advisory mechanisms;
- A Secretariat.

### **6.3 Secretariat**

The Secretariat, led by the Director, will facilitate and support GEO activities. The Secretariat will consist of co-located, well-qualified, professional and administrative staff.

## **7 Funding and Measuring Progress**

### **7.1 Funding of GEOSS**

The total cost for implementing GEOSS will be significant, but only limited resources will need to be provided through GEO. Most of the resources will be provided through existing national and international mechanisms, and by voluntary contributions to special projects.

Unless otherwise agreed, any costs arising from GEO activities will be borne by the Member or Participating Organization that incurs them and will be subject to the availability of funds, personnel, or other resources.

Members and Participating Organizations may make voluntary financial or other contributions for GEO activities, including the baseline activities of the Secretariat, through a trust fund to be administered by the Secretariat. Other entities may make contributions to finance specific activities approved by GEO.

### **7.2 Performance Indicators**

GEO will develop performance indicators for GEOSS.

## **8 The Transition Period**

It is expected that time will be needed to make arrangements for the successor mechanism, following adoption of this Plan at the third Earth Observation Summit in February 2005. To maintain current momentum, the Terms of Reference for the *ad hoc* GEO will be extended until such Terms of Reference are superseded, recognizing that, in order for the necessary transitional arrangements to be completed, the *ad hoc* GEO Terms of Reference will need to continue until the first meeting of the successor GEO.