

## **Expert Advisory Group for a Results-Oriented GEOSS**

### **Terms of Reference**

#### **1 RATIONALE**

The ways in which Earth observations (EO) are captured, processed, analyzed and disseminated are undergoing a technological revolution world-wide. Petabytes of open data are available online, making the mission of GEO of empowering the world to make good use of Earth observations even more important than ever. In particular, GEO needs to take increased attention to the growing knowledge and institutional gap between the GEO members in the Global North and those in the Global South. GEO must respond by transforming itself from a data-centered organization into a results-oriented organization. By focusing on producing decision-relevant results that on collecting data references, GEO will provide a better service to its community.

A results-oriented GEO has to focus on what uses and applications of Earth observation data are relevant for decision-making. To do this, the Secretariat needs to identify scientific advances that are relevant to the GEO mission, and enable these innovations to be available to the wider GEO community. Since no single person is capable of having the broad vision that encompasses all opportunities and challenges pertaining to the transformation of GEO, GEO needs the support an Expert Advisory Group (EAG), composed of experienced, top interdisciplinary scientists.

The main task of the Expert Advisory Group is to provide expert advice to the Secretariat Director on how best to design a GEOSS capable of addressing the EO needs of monitoring frameworks for global policy initiatives and conventions, such as the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs), the Paris Climate Agreement, and the Sendai Framework for Disaster Risk Reduction, as well as emerging challenges such as Land Degradation Neutrality.

#### **2 PURPOSE**

The purpose of the EAG is to provide relevant and timely advice with respect to cutting-edge science and technology required for a results-oriented Global Earth Observation System of Systems (GEOSS) that will enable GEO to support its engagement priorities and other global policy conventions and initiatives.

The EAG will take, as its starting point, the document outlining a Plan for Action to establish the strategy for a results-oriented GEOSS. This Plan for Action which has been approved by the GEO Executive Committee in its 44<sup>th</sup> Session in July 2018. The final version of the document (with amendments made by the Executive Committee) is annexed.

#### **3 DELIVERABLES**

The principal deliverable of the EAG will be a document outlining a strategy for implementation of the vision for GEOSS (see 44<sup>th</sup> Executive Committee Document 44.6). This document will be discussed by the GEO Executive Committee (EXCOM) during its 45<sup>th</sup> Session in October 2018 and 47<sup>th</sup> Session in March 2019. The final version will be submitted for decision of the 48<sup>th</sup> Session in July 2019. If approved by EXCOM, it will be submitted for approval of the GEO 2019 Plenary. The timeline for the delivery of the strategy document is setup in Table 1 below.

**Table 1: Schedule for Development of a Strategy for a Results-Oriented GEOSS**

| Task   | Expected Completion Date |
|--|--------------------------|
| Initial meeting of expert group  | 6-7 Sept 2018            |
| First version of Strategy for a Results-Oriented GEOSS to be presented to EXCOM-45 and GEO-XV Plenary for discussion | October 2018             |
| Comments to be received from GEO community   | December 31 2018         |
| Second meeting of expert group   | Late January 2019        |
| Second version of Strategy presented to EXCOM for discussion   | March 2019               |
| Presentation at GEO Symposium and third meeting of expert group  | May 2019                 |
| Third version of Strategy presented to EXCOM for decision  | July 2019                |
| Proposed Strategy presented to GEO Plenary for approval  | October 2019             |

#### 4 MEETINGS

To prepare the versions of the document to be presented to the GEO Executive Committee, the Expert Group will have three meetings, held in Geneva in connection with meetings of the GEO Programme Board. The members of the Expert Group are expected to take part on these meetings and also contribute to the production of the Strategy document.

## Reference Document for Expert Group

### Realizing the Vision of a Results-Oriented GEOSS

*This document was submitted to the 44<sup>th</sup> Session of the GEO Executive Committee for decision, and the Plan for Action described in Section 7 has been approved*

#### 1 INTRODUCTION

The wide availability and accessibility of open data, coupled with the design of new technologies related to data processing systems and services, has changed the landscape of Earth observation (EO) applications. Studies that took months can now be done in days. These advances are particularly relevant to low- and middle-income countries, where EO information production now requires minimal infrastructure investment.

As stated in the *GEO Strategic Plan 2016-2025*, a central part of GEO's Mission is to build the Global Earth Observation System of Systems (GEOSS). GEOSS is expected to provide access to a diverse set of EO data and information for a broad range of users by linking EO observation, information and processing systems. This original vision of GEOSS as a "system of systems" continues to be essential to GEO. However, the GEOSS architecture – designed in the early 2000's – no longer matches what is possible and necessary with today's technology.

Given these challenges, this document outlines a strategy proposed to Executive Committee by the GEO Secretariat to redesign GEOSS, so that GEO Member states and Participating Organizations can utilize the latest technologies and thus increase the value of Earth observation worldwide.

#### 2 AN ILLUSTRATIVE EXAMPLE

GEO can help developing nations to increase the benefits they derive from Earth observation and provide support for decision-making. We consider the case where an expert in Cameroon is working for her government to assess tropical forest loss in her country, to support a system that complies with the best practices for Reducing Emissions from Deforestation and Forest Degradation (REDD+), and reports emissions to the United Nations Framework Convention on Climate Change (UNFCCC).

She then enters the GEOSS knowledge hub. After being recognized by the system, she has access to a large network of resources provided by the GEO community. In her case, the GEO Secretariat has facilitated access to Copernicus service that has put together Sentinel and Landsat data for Africa. She has also access to MODIS data in the African Data Cube, which also hosts a data set of ground-truth data for the African tropical belt. Due to some restrictions by the in-situ providers, the ground-truth data set is not yet public, but GEOSS and the African Data Cube have secured its use by GEOSS-authenticated users.

She then browses the GEOSS knowledge hub and uses a detailed report on best practices for forest monitoring using big EO data done by Brazil's National Institute for Space Research (INPE). INPE has also built a state-of-the-art algorithm that uses deep learning methods for forest monitoring. This algorithm is available on a GEOSS repository of trusted and curated methods. She then uses GEOSS programming environment to combine the ground truth data with the MODIS data set, using INPE's algorithm. The result is a 20-year time series of forest change for Cameroon for the period 2000-2010. Next, she refines the result for the period 2012 onwards using the combined Sentinel-Landsat mosaic. After testing the results, she then uses the tropical biomass map provided by the European

Commission (EC) Joint Research Centre to produce an emissions report that the government of Cameroon will submit to the UNFCCC.

### 3 GEOSS AS TRUSTED BROKER

The scenario described above is not futuristic. Rather, It could shortly become reality in different ways. However, we need to consider whether there is still a need for an intergovernmental GEOSS platform, given the expected profusion of EO data providers. If providers are already doing the work, is there still a need for GEOSS? We maintain that an intergovernmental platform is necessary to ensure fair access to EO data, methods and services to the widest number of decision-makers possible.

It is unlikely that a single data provider will ever be able to store all the satellite images, in-situ data and methods required to produce high quality applications. Data providers cannot foresee all different user needs. New methods and algorithms are developed independently by researchers and are more likely to be available in software repositories than in data providers' archives. GEO member states are particularly sensitive to storage of in-situ data in commercial providers. Given the need to combine different sources and the sensitive nature of in situ data, GEO is in the best position to provide an independent perspective in the role of a trusted broker. Thus, when different sources need to be combined, GEOSS will act as a *neutral, trusted platform* to support its Member States and Participating Organisations.

### 4 BUILDING A RESULTS-ORIENTED GEOSS

The current design of the GEOSS Portal assumes that users need to find out what kinds of Earth observation data are available, where they can get these data, and what are the associated intellectual property licenses. *This has changed.* Although data and services discovery facilities are still required for many GEO Member states and Participating Organizations, it is also true that many GEO members are already developing cloud technologies which provide analysis-ready data going beyond the capabilities of the GEOSS platform. Community-based initiatives such as Open Data Cube, coupled with private-sector services such as Copernicus DIAS, Google Earth Engine, and Earth on AWS, are enabling the GEO community to use data in ways not possible before. *Most users no longer need to find data.* The next generation of data providers allows users to interact with analysis-ready data, without downloading. Users will require an evolution of the current GEO Platform. GEO will focus on what should work for the users. Thus, *GEOSS needs a new design.*

The results-oriented approach will be particularly relevant to GEO Flagships and Initiatives. Much progress on the Flagships and Initiatives will result from finding a trusted and consistent set of methods that can be applied to the big data sets openly available. *Results must be policy-relevant along the three main engagement priorities of GEO.* These applications need to be carried out by Member States, with support from the GEO community.

Consider the Global Forest Monitoring Initiative (GFOI). In its initial phase, researchers were invited to showcase their work. These use cases were typically studies about forest areas in the developing world, carried out by researchers from developed nations. For example, the University of Wageningen in the Netherlands carried out a series of case studies in small areas in Brazil under the GFOI umbrella without the involvement of Brazilian institutions. This way of working was acceptable in early phases of the program, but brought limited benefits. These case studies did not allow the production of country reports to UNFCCC or Sustainable Development Goal (SDG) indicators. In a results-oriented approach, involvement of the concerned Member state is mandatory. Instead of having a large number of small-sized case studies, the GFOI Flagship needs to build country-relevant results. Instead of answering the question "*what data does forest monitoring need?*", GEO needs to respond to the

demand: "*what are the components of a successful forest monitoring application for GEO Member States and how can GEOSS organize the knowledge required to build it?*".

GEO and its collaborators should consider how knowledge about Earth observation is disseminated. This issue is best framed from the perspective of *reproducibility*. All successful EO applications have different components: satellite data, in situ observations, good quality methods and algorithms, and efficient deployment strategies. We need to be able to organize GEOSS to make sure that these components are visible and accessible, and that others can reproduce relevant work. Doing this, we will capture a significant portion of the knowledge embedded in each application. In so doing, *we will transform the GEOSS Platform from a discovery and access facility to a knowledge hub.*

## 5 REGIONAL COMPONENTS OF GEOSS

The emergence of GEOSS applications in regional contexts provides an opportunity to further tailor the requirements of a results-oriented GEOSS. These regional initiatives will have an important role aligning the activities of Member states and end-users. They can provide the opportunity to blend together, in different combinations, data provision, application development, and capacity building. GEO needs to fully embrace and support these initiatives in order to fine-tune GEOSS as a knowledge hub. The Secretariat also needs to work with the regional GEOSS components so that together, the adoption of GEO principles is increased globally. Furthermore, cloud technologies are likely to be an integral part of regional GEOSS initiatives. GEO needs to work with regional GEOSS components to ensure that all these initiatives follow the FAIR paradigm, where data and methods should be *findable, accessible, interoperable, and reproducible.*

## 6 IMPLEMENTING THE VISION

The vision presented here implies a change on how GEO is funded and operates. A results-oriented organization is better managed by having part of its work to be *project-driven*. In this context, we define projects as fixed-term activities which are properly financed and staffed so as to achieve policy-relevant results. Projects with fixed terms and clear objectives are effective to keep GEO focused on results and to ensure that those who finance them get what they expect. The main focus of the GEO projects will be to bring the benefits of EO to developing nations. To be successful on this mode of operation, GEO will provide strong scientific and technical expertise to its Member states, either directly by the Secretariat or by high-quality collaborators.

An important concern is ensuring that the spirit of cooperation which unites the GEO community is enhanced, as the new vision gets implemented. There are many worthy initiatives that are currently being carried out on a voluntary basis and that are part of the GEO Work Programme. These activities need to have the continued attention and support of the GEO Secretariat and governance. Some of these activities, given their level of maturity and their potential for producing high-impact results, may be singled out for being supported as projects. In these cases, the GEO Secretariat will work with the community to search for the additional funds that are necessary to produce policy-relevant outcomes. Therefore, the Secretariat will work with the GEO Programme Board to ensure that the transition from the current mode of operation to a results-based GEO will be done with full collaboration and participation of the GEO community.

Implementing the proposed vision will require technical decisions on the evolution of the GEOSS Platform. Under the scientific leadership of the Secretariat Director, the Secretariat and the Programme Board will work to reach a consensual view on the required actions. These actions will consider the proposals of the *GEOSSEvolve* Initiative, as well as the technical consensus to be reached in the "Plan for Action", as described below. The overall aim is that future implementations of the GEOSS Platform will be able to support a results-oriented GEO.

## 7 A PLAN FOR ACTION

The first step toward this Vision will be for the Secretariat, assisted experts from the inside and outside the GEO community, to develop a plan for how to make best use of the transformative technologies that have emerged in recent years. The following questions will be addressed:

- a) How best to evolve the GEOSS Platform into a knowledge hub?
- b) How can the GEOSS Platform evolve so that the community can use the existing and upcoming analysis-ready data sets?
- c) How can the GEOSS Platform bridge across the different public, community-based, and private data providers?
- d) How will the future GEOSS Platform interact with the proposed regional GEOSS initiatives?
- e) How can GEO support community-based initiatives of sharing infrastructures for processing big EO data, such as Open Data Cube and the proposed African Data Cube?
- f) How can GEO best interact with private data providers, such as Copernicus DIAS, Amazon Web Service (AWS), and Google Earth Engine, to help users make the most of them?
- g) What are the most promising innovative scientific results produced by the Earth observation research community and how can they be made available to GEO?
- h) What are the best practices of EO applications that should be highlighted in the GEOSS Platform, so that they follow the FAIR principles?
- i) How can GEO and the GEOSS Platform facilitate access to in-situ observations and analysis methods that are used in cutting-edge and best practice applications?
- j) How can development of the GEOSS Platform into a knowledge hub can be made in connection with existing structures?
- k) How can these initiatives be financed?

The intended product of this work will be a strategy for the future of the GEOSS Platform, to be presented to the GEO-XV Plenary in Kyoto.

## 8 IMPROVING THE LINKS TO THE SCIENTIFIC COMMUNITY

One of the major challenges in this transformation is to identify those innovations that are relevant to the GEO mission, while shortening the "time-to-market" these innovations can bring to the wider GEO community. Although the Secretariat comprises competent and qualified staff, no single person is capable of having the broad vision that encompasses all opportunities and challenges pertaining to the transformation of GEO.

To secure the future of GEO, the Secretariat Director will need to make informed and sound decisions. Thus, the Secretariat would like to have the support of the Executive Committee to set up a Scientific Advisory Committee (SAC), composed of experienced, top interdisciplinary scientists. The main task of the SAC will be to *provide advice* to the Secretariat Director on how best to use cutting-edge scientific advances. The rationale is that GEOSS needs to support innovative applications to meet its goals.

## **9 POINTS OF DECISION BY EXECUTIVE COMMITTEE**

This document has been prepared by the GEO Secretariat to outline the vision which the new director intends to carry out during his tenure. *This vision is consistent with earlier Executive Committee and Plenary decisions that GEOSS should become an applications-oriented organization.* The Executive Committee is asked to consider the following decisions:

- a) To approve the Vision stated on item (6) and Plan for Action presented in item (7) above;
- b) To consider that the proposal for establishing a Scientific Advisory Committee (SAC) be further explored, so that the Secretariat can prepare a document for the 45th meeting of Executive Committee.

## ANNEX A

### ADDITIONAL ELEMENTS PRESENTED DURING EXCOM-44

As part of the discussions held during the 44<sup>th</sup> Session of the Executive Committee, the Lead Co-chair (Stephen Volz from USA) brought to the attention of the committee the fact that the Vision proposed in the document 44.6 above had already been discussed in previous Executive Committee meetings. Specifically, in document 34.9, presented at the 34<sup>th</sup> Session of the GEO Executive Committee in July 2015, the Infrastructure Implementation Board laid out three levels of ambition for GEOSS, as outlined below.

#### ***“Level 0: GEOSS Silver***

*This is the minimum level of ambition where GEOSS is considered as a platform for international collaboration and coordination of EO activities, expanding the availability of datasets with full and open access (GEOSS Data CORE), but with limited goals with respect to the infrastructure, which could be as minimal as a catalogue of existing EO systems and global initiatives, and a discovery service to access the data “as is”.*

#### ***Level 1: GEOSS Gold***

*This level includes Level 0 but raises the level of ambition towards providing an increasing number of consistent and completed datasets with full and open access, and “ready to use” status. This requires the availability of a set of services to transform the data so they are in the same coordinate reference systems, projections, scale/resolution, geographic and time windows, plus a set of semantic mappings so that there is a degree of consistency on classifications, definitions, methods, and quality parameters to enable direct use of the data.*

#### ***Level 2: GEOSS Platinum***

*This level includes Level 1 but raises the level of ambition even further to focus not only on the delivery of ready-to-use data, but additionally on the supply of information. This requires linking the data to documented models, processes, and workflows and processing them, for example, in high- performance computing environments, to derive custom-made but reproducible information products in line with the current vision of Open Science.”*

In the discussions during the 44<sup>th</sup> Session of the Executive Committee, the GEO Secretariat pointed out that the Vision outlined in document 44.6 corresponds to the GEOSS Platinum level of ambition set out beforehand. The GEO Secretariat considers that the recent technological advances in scientific data and knowledge management and big Earth observation data allow GEO to be more ambitious and start developing the GEOSS Platinum vision as part of the proposed Plan for Action.