

Report on the Sixth and Summative Evaluation of GEOSS Implementation

This document is submitted to GEO-XII Plenary for information.

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1 INTRODUCTION

The overall approach to GEOSS Monitoring and Evaluation, approved by GEO-VI, is contained in the “GEOSS Monitoring and Evaluation Framework Document”, and constitutes the basis for the performance of yearly evaluations. The first evaluation, the “mid-term assessment”, took place in 2009-2010 and the process included a total of six evaluations, ending with the sixth and summative one, whose report is now submitted to Plenary.

The Sixth and Summative GEOSS Evaluation took place from July 2014 to June 2015 – a time period that coincides with the development of the post-2015 GEO strategy by the GEO Implementation Plan Working Group (IPWG).

2 SIXTH AND SUMMATIVE EVALUATION

The “Summative Evaluation of GEOSS Implementation” is an assessment of GEO’s key successes and shortcomings during the entire first 10-Year Implementation Plan (2005-2015) period and across the full range of Societal Benefit Areas (SBAs) and other GEO activities.

An Interim report on the Sixth and Summative Evaluation was previously submitted to the Executive Committee and discussed at its 33rd meeting on 19-20 March 2015. This Interim Report was undertaken for the first time with the specific aim, through a preliminary set of findings, of supporting deliberations by the IPWG on how better to address their needs in the development of the new GEO Strategic Plan 2016-2025.

The final Report of the Sixth and Summative Evaluation of GEOSS implementation, produced by the Evaluation Team in June 2015, was officially transmitted to the Executive Committee by the co-chairs of the Monitoring and Evaluation Working Group (transmittal letter in Appendix 1).

The Report was thoroughly discussed by the Executive Committee at its 34th meeting in July 2015. The Committee shared the report’s recommendations and agreed not to produce the customary Management response, based on its general view that these recommendations were well addressed for the next GEO decade by the “GEO Strategic Plan 2016-2025: Implementing GEOSS”, developed by the IPWG.

The document “GEOSS (2005-2015) Summative Evaluation Report” (Appendix 2) that is now submitted to Plenary is a revised version of the Report submitted to the Executive Committee in July. There have been no changes in the recommendations; a thorough editing has been completed.

3 CONCLUSIONS

The Plenary is requested to take note of the Report.

APPENDIX 1**TRANSMITTAL LETTER FROM THE M&E WORKING GROUP CO-CHAIRS TO THE
EXECUTIVE COMMITTEE**

Dear Members of the Executive Committee:

The Monitoring and Evaluation Working Group (M&E-WG) is pleased to provide you with the report of the 6th Evaluation of GEOSS Implementation. This is the last evaluation planned in the *GEOSS Monitoring and Evaluation Framework Document*. This evaluation included in its scope the entire period of the first 10-Year Implementation Plan (2005-2015) and the full range of SBAs and Transverse Areas.

We would like to take a moment to thank you for your support over the past seven years and six separate evaluations. The Executive Committee has contributed to all phases of the Monitoring & Evaluation effort by sponsoring Evaluation Team members, making time to sit for interviews, providing documentation, and carefully reviewing and initiating action on dozens of prior recommendations.

As with previous evaluations, the M&E-WG reviewed the process by which the Evaluation Team independently conducted the evaluation and we believe that the approach taken by the Evaluation Team is consistent with the requirements of the Monitoring and Evaluation Framework Document and the Evaluation Plan. Unlike previous evaluations, this work was conducted concurrently with efforts of the Implementation Plan Working Group (IPWG) to review and revision the strategy of GEO for the post-2015 period. These simultaneous efforts provided unique opportunities for each to complement the other.

In anticipation of the close of the current Work Plan in 2015, the 6th Evaluation avoided making detailed critiques and recommendations of current GEO tasks. Instead, they focused on the larger lessons learned over the course of the previous decade of GEOSS Implementation efforts. A few of the key findings and recommendations of the 6th Evaluation that have particular relevance to the ongoing development of the 2016-2025 strategy and implementation plan:

- The continued benefit of GEO as a forum and convening power for voluntary efforts interested parties,
- Support for a strategy document that identifies tangible, measurable intended outcomes,
- The importance of better communication both within and external to the GEO organizational structure,
- Creation of a high-level task force to promote the incorporation of in-situ data into GEOSS, and
- Better integration of monitoring & evaluation practices within contributed activities.

We recommend that the Executive Committee, with support from the GEO Secretariat, prepare a brief statement acknowledging receipt of this report. Such a response need not indicate whether the Executive Committee agrees, partially agrees, or disagrees with each of the Key Findings and Recommendations nor develop specific response actions. However, we encourage the Executive Committee to provide a general statement of support for consideration of the report findings in all levels of post-2015 planning.

Sincerely,



Craig F. Larlee
Co-Chair (Canada)



John R. Adamec
Co-Chair (United States)

APPENDIX 2**REPORT OF “GEOSS (2005-2015) SUMMATIVE EVALUATION REPORT, JUNE 2015”**



GROUP ON
EARTH OBSERVATIONS

GEOSS (2005–2015) Summative Evaluation Report

July 2015

Preface

The Summative and Sixth Evaluation of GEOSS implementation took place from July 2014 to June 2015—a time period that coincides with the development of the 2016-2025 GEO Strategic Plan by the GEO Implementation Plan Working Group. This Summative Evaluation Report is intended to inform decisions regarding many aspects of GEOSS implementation. This report presents key findings and recommendations based on evidence collected by the Evaluation Team through interviews, a web-based survey and a variety of documents.

As with many other elements of GEO, the Evaluation Team is comprised of volunteers from Member States and Participating Organizations. The Evaluation Team is co-chaired by Norway and the United States, and includes members from Canada, the European Commission, Germany, Greece, Japan and South Africa.

Sincerely,



Lars Ingolf Eide (Norway), co-chair



Matthew Druckenmiller (United States),
co-chair



Rima Ammouri (Canada)



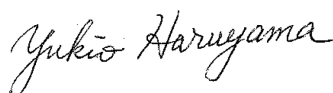
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Acknowledgements

The Sixth GEOSS Evaluation Team thanks the GEOSS Monitoring and Evaluation Working Group, especially co-chairs John Adamec and Craig Larlee, for their support and direction; the GEO Secretariat for hosting us during our meetings in Geneva in July 2014 and January 2015, with particular thanks to Giovanni Rum and Hendrik Baeyens for their secretariat and technical support; and the National Observatory of Athens, Greece, for hosting the Team's final meeting in its wonderful premises in May 2015. We are also grateful to all interviewees and survey respondents for providing insights into, and opinions on, the Global Earth Observation System of systems (GEOSS). The Federation of Earth Science Information Partners (ESIP) was especially helpful in advertising the web-based survey. A special thanks goes to Nadine D'Argent, Agnes Lane and others at the Australian Bureau of Meteorology for setting up and preparing statistics from the web-based survey.

Acronyms

ABE	Agriculture, Biodiversity and Ecosystems
ADB	Asian Development Bank
ADM	Architecture and Data Management
AGRICAB	GEO programme to develop increased EO capacity for better agriculture and forest management in Africa
AIP	Architecture Implementation Pilot
AfWCCI	African Water Cycle Coordination Initiative
API	Application Program Interface
AWCI	Asian Water Cycle Initiative
CEOS	Committee on Earth Observation Satellites
CIEHLYC	Comunidad para la Informacion Espacial e Hidrografica para Latin America y el Caribe, a programme framework for coordinating GEO-related capacity building activities in Latin America and the Caribbean
CMIP	Coupled Model Intercomparison Project
CoP	Community of Practice
COP	Conference of the Parties
CORE	Data Collection of Open Resources for Everyone
DAB	Discovery and Access Broker
DEH	Disasters, Energy and Health
DIAS	The Data Integration & Analysis System
DFID	UK Department for International Development
DG DEVCO	European Commission's Directorate-General for International Cooperation and Development
EBONE	European Biodiversity Observation Network
EC	European Commission
EO	Earth Observations
ESA	European Space Agency

ESIP	Earth Science Information Partners
ESRI	Environmental Systems Research Institute
ET	Evaluation Team
EU	European Union
FAO	UN Food and Agriculture Organization
FP7	EC Seventh Framework Programme for Research and Technological Development
G20	Group of Twenty (industrialized nations)
GCI	GEOSS Common Infrastructure
GCOS	Global Climate Observing System
GCW	Global Cryosphere Watch, a WMO programme
GDMP	Global Drought Monitor Portal
GEO	Group on Earth Observations
GEOCARBON	European FP7 project to lay the foundations for an operational Global Carbon Observing and Analysis System in support of science and policy
GEO BON	GEO Biodiversity Observation Network
GEOGLAM	GEO Global Agricultural Monitoring initiative
GEONetCab	GEO Network for Capacity Building
GEOSS	Global Earth Observation System of Systems
GEOWOW	GEOSS Water Oceans Weather
GFOI	Global Forest Observations Initiative
GHG	Greenhouse gases
GIFS	Global Interactive Forecast System
GOI	Government of Indonesia
GOOS	Global Ocean Observing System
GMES	Global Monitoring for Environment and Security
GMOS	Global Mercury Observing System
GSMaP	Global Satellite Mapping of Precipitation
GSNL	GEO Geohazard Supersites and Natural Laboratories
ICHARM	International Centre for Water Hazard and Risk Management
IGOS-P	Integrated Global Observing Strategy Partnership
IEEE	Institute of Electrical and Electronic Engineers
IFAS	Integrated Flood Analysis System
IPCC	Intergovernmental Panel on Climate Change
IPWG	GEO Implementation Plan Working Group
IPR	Intellectual Property Rights
IT	Information Technology
JAXA	Japan Aerospace Exploration Agency
JECAM	GEO Joint Experiment for Crop Assessment and Monitoring
JICA	Japan International Cooperation Agency
JRC	Joint Research Centre – European Commission
M&E WG	Monitoring and Evaluation Working Group
MEDINA	Marine Ecosystems Dynamics and Indicators for North Africa
MESA	Monitoring for Environment and Development in Africa
NASA	National Aeronautics and Space Administration – United States
NCAR	National Center for Atmospheric Research – United States
NOAA	National Oceanic and Atmospheric Administration – United States
NGO	Non-Governmental Organization

OGC	Open Geospatial Consortium
QA	Quality Assurance
QC	Quality Control
REDD/REDD+ Forest	UN-programme on Reducing Emissions from Deforestation and Degradation
SBA	Societal Benefit Area
S&T	Science and Technology
SDI	Spatial Data Infrastructure
SERVIR	USAID-NASA Regional Visualization and Monitoring System
SME	Small and Medium-sized Enterprise
SMS	Short Message Service
UN	United Nations
USAID	United States Agency for International Development
Web-DHM	Water and Energy Budget-Based Distributed Hydrological Model
WebGIS	Web-based Geographic Information System
WG	Working Group
WMO	World Meteorological Organization
WWC	Water, Weather and Climate

Executive Summary

Introduction and Purpose

This report—the Summative Evaluation of GEOSS Implementation—is an assessment of GEO’s key successes and shortcomings during the entire first 10-Year Plan (2005–2015) for implementing the Global Earth Observation System of Systems (GEOSS)—GEO’s primary effort to link and make available Earth observation resources world-wide for informed decision-making across multiple Societal Benefit Areas (SBAs). This evaluation addresses the full range of SBAs and GEO activities. An independent Evaluation Team (ET) completed the evaluation and this report, in consultation with the GEO Monitoring and Evaluation Working Group (M&E WG).

The evaluation process and the writing of this report took place at a critical time for GEO, as a simultaneous endeavor was underway by the GEO Implementation Plan Working Group (IPWG) to develop GEO’s 2016-2025 Strategic Plan. The co-occurrence of these complementary efforts, along with the interest of the general Earth observation community in seeing GEO evolve into the next decade, provided a unique opportunity to gather timely, diverse and enthusiastically-offered feedback on GEO’s first ten years.

Methodology

An analysis of feedback from 57 key informant interviews, 80 responses to a web-based survey, past GEOSS evaluation reports, case studies and a review of GEO-related documents provided the basis for key findings and recommendations. The evaluation of progress was made against the goals and objectives contained in two documents: the GEOSS 10-Year Implementation Plan and the Strategic Targets document.

Key Findings and Recommendations

Based upon analysis of the collected information and careful deliberation by the ET, the evaluation resulted in 16 key findings, 1 lesson-learned and 11 recommendations. In general, one of the main achievements and added-values of GEO is the creation of a common, yet flexible, framework and organizational structure for voluntary cooperation. As a result, GEO has fostered increased international and interdisciplinary collaboration, created opportunities for data sharing, and made new connections between researchers and governmental agencies. However, there remains room for improvement and better exploitation of the potential of GEOSS. The evaluation’s key findings are as follows:

Key Finding # 1: GEO's added-value to the Earth observation community of providing a common, flexible framework for international collaboration is widely recognized as a principal success.

Key Finding # 2: Insufficient strategic guidance and clarity within the GEO steering documents, the Strategic Targets document and the GEO Work Plan have led to

insufficient implementation of the Work Plan and only fair achievement of Strategic Targets.

Key Finding # 3: Cooperation across SBAs has been strengthened within the GEO community, but a lack of coordination has hampered full exploitation of the potential of GEOSS.

Key Finding # 4: Insufficient mechanisms to engage the global *in situ* data community have contributed to significant, enduring observational gaps within GEOSS.

Key Finding # 5: GEO lacks a clear process for identifying priorities, which limits the broader community's ability to strategically organize and leverage contributions to GEOSS.

Key Finding # 6: The GEO Global Initiatives are widely considered significant contributors to GEO's success, even though they were not initially included in the 10-Year Implementation Plan.

Key Finding # 7: The creation and advocacy of open data sharing principles for Earth observations are major accomplishments of GEO, but the open data approach has yet to be established and implemented in a number of countries in different regions.

Key Finding # 8: The GEOSS Common Infrastructure (GCI) has greatly advanced Earth observation data interoperability; however, user expectations regarding data discoverability, access and quality assurance have not been met.

Key Finding # 9: GEO has not fully achieved a “user-driven GEOSS” because users have not been adequately incorporated into the entire observation-to-information value cycle. The current user landscape includes: (1) the science community as the main user; (2) governmental/international organizations and (3) the non-profit private sector as moderate users; (4) the commercial sector as marginal users; and (5) laymen/citizens as non-users.

Key Finding # 10: GEO's engagement of the private sector¹ is stronger than generally recognized, as evident by the robust participation of non-profit entities and participation of a limited number of commercial sector entities. Strengthened, strategic engagement of the private sector is nonetheless recognized as a promising, and often necessary, avenue for GEO to pursue in the future.

Key Finding # 11: GEO has made well-recognized efforts to establish capacity building initiatives; however, the long-term impacts have not been monitored.

Key Finding # 12: GEO has made significant progress in establishing itself as a global reference in the domain of Earth observations, but has not adequately communicated its role and value to potential users of Earth observations and, therefore, has not capitalized on the breadth of potential users.

¹ “Private sector” in this report means any type of non-governmental organization.

Key Finding # 13: GEO has not yet realized its full potential to establish formal collaborations with global organizations (e.g., UN institutions) or regional and global observation systems (e.g., GCOS or GOOS). Such partnerships, which are reliant on identifying complementary goals, are broadly recognized as critical to GEO's future success.

Key Finding # 14: The GEO Societal Benefit Area (SBA) structure, which covered a broad range of societal challenges, has worked well to establish the GEO community. There is, however, a wish from throughout the GEO community to review and redefine the SBAs in the future to better align with targeted user groups.

Key Finding # 15: The GEO Communities of Practice (e.g., for Water) provided an efficient avenue for user engagement and a means to enhance cross-SBA activities.

Key Finding # 16: There is a recurrent shortage of resources, and irregular and uneven follow-up of commitments, for the tasks necessary to implement GEOSS.

In addition, the Evaluation Team identified the following lesson-learned:

Lesson Learned²: The GEOSS Evaluation process has been largely effective in generating responses from the GEO Executive Committee (98% of past recommendations received responses); however, the added-value from the process of reporting back to the broader GEO community has yet to be comprehensively assessed.

² This is based on: (1) a review of how recommendations from previous evaluations have been received and responded to; (2) discussions with the M&E Working Group; and (3) the experiences of the current ET Co-Chair (Ingolf Eide), who has co-chaired or served as a team member on all previous evaluation teams.

Recommendations with links to supporting findings and relevant sections of the report

Recommendation	Relevant Key Findings	Relevant Report Sections
#1: GEO should define GEOSS users, restructure SBAs to better reflect user domains, and communicate to users the benefits of GEOSS through specific use-cases.	• 9 • 14 • 15	• 4.2 User Engagement • 6. Organizational Structure and Resources
#2: GEO should revitalize the Communities of Practice (CoPs) and ensure that they have strong and engaged leadership and funding.	• 14 • 15 • 16	• 6. Organizational Structure and Resources
#3: GEO should develop a strategy for GEOSS 2016–2025 with more measureable targets, performance indicators, and strengthened and straightforward implementation mechanisms.	• 2 • 3 • 4 • 5	• 3. SBAs: Implementation and Strategic Targets
#4: GEO should capitalize on its success of developing and promoting data sharing principles by engaging political decision makers and potential users of GEOSS in the regions that lag behind in adopting the principles.	• 7	• 4.1.2 – subsection on Data Sharing
#5: Access to the GEOSS Common Infrastructure (GCI) should be more user-friendly, and data discovery and accessibility should be improved, using successful AIPs as models.	• 8	• 4.1.2 – subsection on Data Availability, Data Access and Interoperability • 4.1.2 – subsection on AIPs • C.3 (case study)
#6: GEO should develop a procedure for data quality control and quality assurance (e.g., by disseminating best practices) and promoting standards with potential data providers.	• 8	• 4.1.2 – subsection on Data Availability, Data Access and Interoperability
#7: GEO should develop and implement a communication and outreach strategy to fully advance user engagement and collaboration with international and donor institutions.	• 12 • 13	• 5. Communication and Visibility

#8: GEO should use the global initiatives to build strategic bridges to UN-related organizations by identifying common targets and complementary areas for collaboration.	• 6 • 12 • 13	• 3.3 Global Initiatives • 5. Communication and Visibility
#9: GEO should improve capacity building through comprehensively assessing regional capacity building needs, implementing monitoring and evaluation frameworks to systematically assess long-term results, and leveraging funding from international donors (e.g., for data infrastructure) to complement contributions from EO data providers.	• 11	• 4.3 Capacity Building
#10: GEO should identify a high-level task force with very strong representation from existing <i>in situ</i> Earth observation communities (e.g., similar to CEOS for satellite data) to make recommendations on how to incorporate the <i>in situ</i> community and its data into GEOSS.	• 4 • 5	• 3.4 Gaps
#11: GEO should establish a mechanism to ensure that task and project-related commitments have sufficient resources to be completed as expected.	• 16	• 6. Organizational Structure and Resources

1. Introduction

This report provides the results of the Summative Evaluation of the Global Earth Observation System of Systems (GEOSS). It assesses all aspects and activities of GEO during its first ten years 2005–2015. It is the sixth in a series of evaluations of progress towards implementation of GEOSS. The first evaluation—the mid-term assessment completed in 2010—assessed all aspects of GEOSS. The succeeding evaluations were concerned with Architecture and Data Management (ADM; the second evaluation completed in 2011), the Societal Benefit Areas (SBAs) of Agriculture, Biodiversity and Ecosystems (ABE; the third evaluation completed in 2012), the SBAs of Disasters, Energy and Health (DEH; the fourth evaluation completed in 2013) and the SBAs of Water, Weather and Climate (WWC; the fifth evaluation completed in 2014).

This Sixth and Summative Evaluation of GEOSS implementation took place from July 2014 to June 2015, during a time of transition for GEO. In January 2014, at the GEO-X Plenary and Ministerial in Geneva, the Members and Participating Organizations made a commitment to continue implementing GEOSS for a second decade beyond 2015. Planning for the 2016–2025 GEO strategy was already underway when the Sixth Evaluation Team (ET) started its work. The Implementation Plan Working Group (IPWG), charged with developing the 2016–2025 Strategic Plan, and the ET worked in parallel, but were completely independent of each other.

By the time this Evaluation was completed in June 2015, a draft outline for future directions in GEO and GEOSS had been made available to the community. This Evaluation provided an opportunity to inform decisions concerning many of the details of implementation.

1.1 Objective and Scope of the Evaluation

The objective of the evaluation is to present findings and recommendations that can be used to inform future plans for the implementation of GEOSS, including implementation goals, improving operations and governance, sharing best practices, avoiding common pitfalls, and setting priorities for effective achievement of strategic targets.

The GEO Monitoring and Evaluation Working Group (M&E WG) provided the following specific points as guidance to the ET regarding the scope of the Sixth Evaluation of GEOSS:

- The scope of the evaluation covers the entire period of the first 10-Year Implementation Plan (2005–2015) and the full range of SBAs and Transverse Areas.
- The evaluation should synthesize the findings of prior evaluations to the extent they continue to be relevant.
- The evaluation should continue to examine the "why" and "how" of successes and failures in order to suggest actions that can be taken by individuals to improve GEOSS implementation.
- Recommendations should be directed toward development of the next implementation plan rather than suggesting changes specific to the current plan.

- The evaluation should pay attention to discerning whether and how value-added progress is attributable to GEOSS. In particular, the evaluation should note where the interconnectivity developed in GEOSS has specifically contributed to achievement of scientific or technological outcomes, expanded capacity building, and assisted in meeting the needs of users within the SBAs.
- The evaluation should also examine in what ways GEOSS has improved data collection, data sharing and dissemination within and across the SBAs, and efforts within Work Plan Tasks or SBAs to track and ensure progress.

1.2 Approach and Organization of the Report

The Sixth Evaluation used 57 key informant interviews, a web-based survey (80 responses), case studies and a review of key documents, including past GEOSS evaluations, to collect evidence to support findings and recommendations. More details are provided in Annex A (interview questions³), Annex B (web-based survey questions, along with the statistics and free text responses), Annex C (case studies) and Annex D (past evaluations).

There are at least two factors that may have biased the interview and survey results and, as a result, contributed to different responses from these two response groups:

1. Survey responses were usually in the form of Yes/No answers or selected from a Likert-scale rating, whereas interviewees had the ability to explain and nuance their responses.
2. As groups, neither is completely representative of the GEO community. Interviewees were recruited from persons expected to have a broad view of GEO and GEOSS. They were/are Board Members or Co-chairs, Task Leads or Points of Contact, or persons engaged in GEO at national or regional levels. Task Points of Contact were the minority of those interviewed. On the other hand, the invitation to participate in the survey went to several thousand persons via the GEO distribution list and to members of Earth Science Information Partners (ESIP), and was announced at relevant scientific conferences. 49% of survey respondents were Task Leads or Contributors, 19% were data providers, 13% were members of GEO leadership or the Secretariat, 11% represented users of data or information, and 9% had no direct involvement in GEO.

The fact that most survey respondents were directly involved as contributors to GEOSS tasks, whereas only a minority of the interviewees had this background, may partly explain why the views and perceptions on the implementation of GEOSS vary between these groups.

The evaluation of progress was made against the goals and objectives contained in two documents: the GEOSS 10-Year Implementation Plan and the Strategic Targets document. When this report refers to Strategic Targets, it refers to those targets contained in the latter

³ A compiled version of interview notes, which were stripped of information that could identify specific individuals, can be found at: ftp://ftp.earthobservations.org/GEOSS_Summative_Evaluation/

document. During interviews, key informants identified several topics that were not part of the 10-Year Implementation Plan as missing or weak points in GEOSS and its Work Plans. In general, these comments were treated as suggestions for the future, rather than gaps in the present GEOSS.

Guide to reading this report:

- Analysis of findings is organized in Sections 2–6, according to the general themes of questions from both interviews and the survey. Section 2 summarizes feedback related to GEO’s overall added-value to the GEO and broader Earth observations (EO) communities. Sections 3 and 4 summarize feedback related to the SBAs and cross-cutting themes, respectively. Section 3 has one overarching synthesis sub-section, while Section 4 includes a separate synthesis for each cross-cutting theme. Sections 5 and 6 present feedback related to GEO’s communication and visibility, and GEO’s organizational structure and resources, respectively.
- Analysis sections (and sub-sections) begin with quotes from either the GEOSS 10-Year Implementation Plan or Strategic Targets document in order to highlight the main contextual factors used to analyze the data and produce findings.
- Most sections start with Key Findings from previous evaluations, where the two numbers preceding each finding refer to the evaluation where the finding was reported and the number of the finding within that evaluation. A summary of all previous evaluations is provided in Annex D with a complete list of past findings.
- Findings from the current evaluation are presented at the end of the analysis sections, when relevant.
- Section 7 lists all Key Findings and Recommendations and relates these in Table 1 to relevant sections in the report.

1.3 Audience

The primary audiences for this Summative Evaluation report are the GEO Executive Committee, the IPWG, the GEO Plenary and the Ministers of GEO member countries who will meet on the occasion of the GEO Ministerial Summit due to take place on 13 November 2015 in Mexico City. This report will be made available through the normal channels of distribution via the GEO Executive Committee and Plenary documents. The secondary audiences for this evaluation report are the various GEO bodies responsible for implementing GEOSS and individuals participating in the implementation of GEOSS. The Evaluation’s Key Findings and Recommendations are expected to inform future plans for the implementation of GEO and GEOSS during the 2016-2025 period and beyond, including the work of the GEO Executive Committee and the IPWG.

2. Overall Success and Added-Value

“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.

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 10-Year Implementation Plan*

2.1 Key Findings from Previous Evaluations

- 1.1 GEOSS represents an important new Earth observation community and network. GEOSS has raised visibility of the importance and need for integrated global Earth observations.
- 1.3 Stakeholders are generally positive about the foundation that has been established and optimistic that appropriate outcomes are being realized.
- 1.4 GEOSS implementation has brought together various organizations and governments to collaborate and support integrated global Earth observations.
- 1.5 GEOSS implementation has created a path to enable full and open data sharing and lowered discussion barriers.
- 1.6 GEOSS implementation has resulted in positive outcomes for the Earth observation community, such as Data Sharing Principles.
- 3.9 GEO and GEOSS are adding value to the work within Member States and organizations, mainly through collaborative initiatives, more so than adding value through contributing to increased use of Earth observations and institutional capacity building.
- 4.7 Participants and users perceive that networking and synergy will be the main value-adding elements.
- 5.2 There is good evidence of value-added by GEO in the Water, Weather and Climate (WWC) SBAs.

2.2 Evidence from Current Evaluation

Interviews clearly show that GEO having been established, recognized, and sustained is, in and of itself, a major accomplishment. Those interviewed acknowledge the value of GEO and GEOSS, and the contributions that can still be made around the globe. GEO has led to increased international and, to some extent, interdisciplinary collaboration around Earth observations by facilitating coordination, raising the visibility of the need for integrated global Earth observations and promoting open data exchange. GEO has created synergies and opportunities for cooperation among a diversity of relevant platforms. One respondent noted that GEO’s primary added-value stems from its ability to serve as a “convening body” and as a “commissioning entity”.

The survey results show that of the 80 survey responses, 44% rated GEO “Good” to “Very Good” in achieving its vision and purpose as defined in the 10-Year Implementation Plan and the Strategic Targets document. 39% indicated “Fair” achievement; 10% indicated “Poor” achievement; and 5% were “Unsure” (see Figure 1). No respondents indicated “Very Poor” achievement.

Regarding the perceived benefit of GEO or GEOSS to the respondents’ institutions, 44% indicated “Moderate” benefit; 24% “Little” benefit; 23% “Significant” or “Very Significant” benefit, and 5% “No Observable Benefit.” In response to the question concerning the added-value, almost 80% agreed that GEO/GEOSS has added value towards achieving the outcomes of the SBAs (see Figure 1).

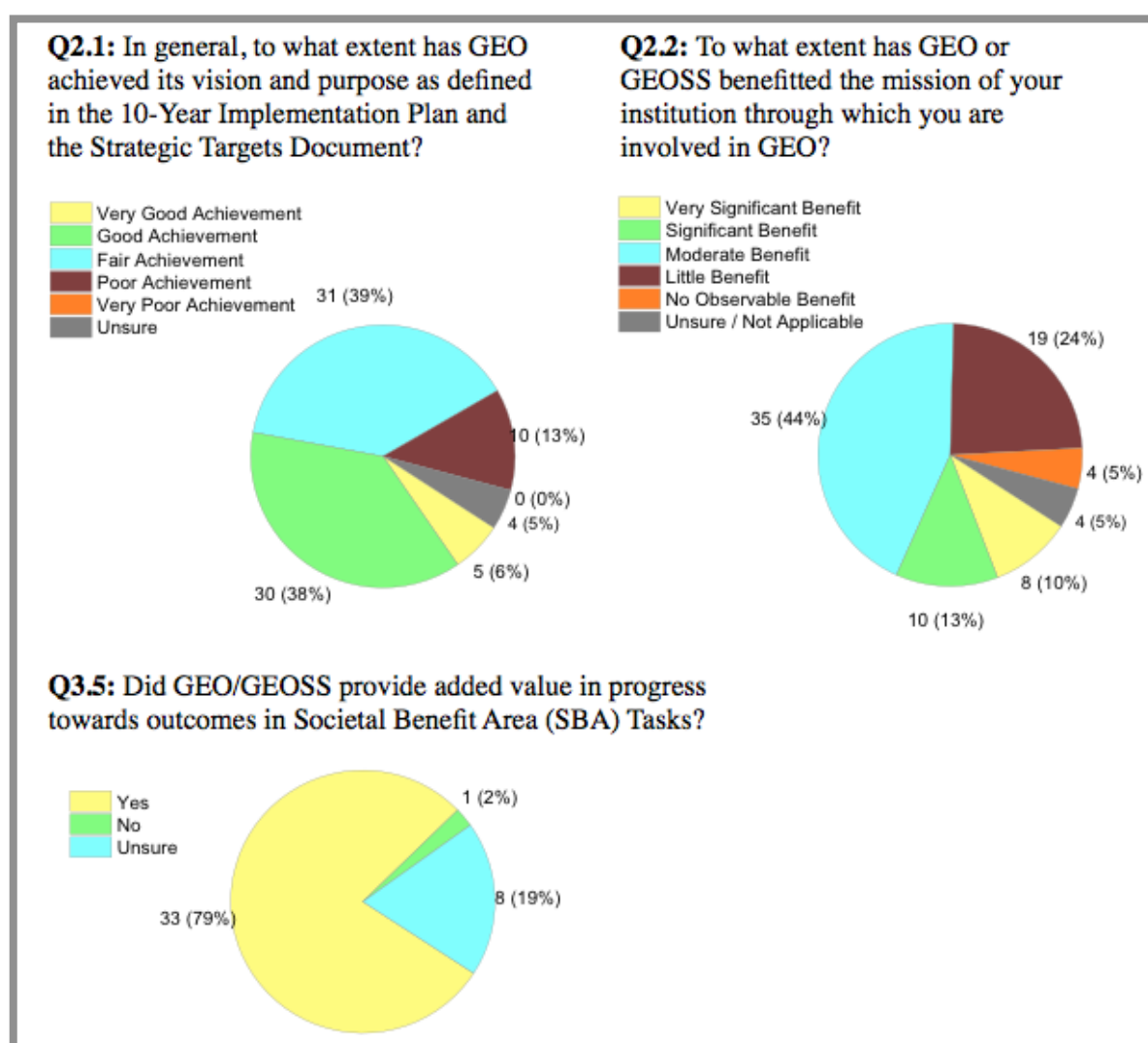


Figure 1. Survey responses related to achievements, benefits and the added-value of GEOSS.

The survey’s free text responses support the impression shared by interviewees that people working together on a voluntary basis, the data sharing principles, and the bringing together of major players in Earth observations with common goals have all been major achievements

and important success factors of GEO. The following example free text excerpts highlight perceptions of the types of individuals engaged in GEO:

"several enthusiastic persons ... highly motivated individuals ... people's enthusiasm and commitment ... participants working within the spirit of GEO/GEOSS ... people with energy and interest".

Special emphasis was also placed on the efforts of the GEO Secretariat and its staff for playing a very positive and pro-active role in GEOSS implementation.

2.3 Synthesis

In summary, one of the main achievements and added-values of GEO is the creation of a common, yet flexible, framework and governance for voluntary cooperation. GEO has fostered increased international and interdisciplinary collaboration, created opportunities for data sharing and made new connections between researchers and governmental agencies. However, both interviews and survey results indicate that there remains room for improvement and better exploitation of the potential of GEOSS.

Key Finding # 1: GEO's added-value to the Earth observation community of providing a common, flexible framework for international collaboration is widely recognized as a principal success.

3. SBAs: Implementation and Strategic Targets

The following relevant Strategic Targets are to be met by 2015⁴:

Agriculture: Improve the utilization of Earth observations and expanded application capabilities to advance sustainable agriculture, aquaculture, fisheries and forestry in areas including early warning, risk assessment, food security, market efficiency, and, as appropriate, combating desertification.

Biodiversity: Establish, in conjunction with a comprehensive ecosystem monitoring capability, a worldwide biodiversity observation network to collect, manage, share and analyze observations of the status and trends of the world's biodiversity, and enable decision-making in support of the conservation and improved management of natural resources.

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

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

Ecosystems: Establish, in conjunction with a comprehensive biodiversity observation network, a wide-ranging monitoring capability for all ecosystems and the human impacts on them, to improve the assessment, protection and sustainable management of terrestrial, coastal and marine resources and the delivery of associated ecosystem services.

Energy: Close critical gaps in energy-related Earth observations and increase their use in all energy sectors in support of energy operations, as well as energy policy planning and implementation, to enable affordable energy with minimized environmental impact while moving towards a low-carbon footprint.

Health: Substantially expand the availability, use and application of environmental information for public health decision-making in areas of health that include allergens, toxins, infectious diseases, food-borne diseases and chronic diseases, particularly with regard to the impact of climate and ecosystem changes.

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

Weather: Close critical gaps in meteorological and related ocean observations, and enhance observational and information capabilities for the protection of life and property, especially with regard to high-impact events, and in the developing world.

⁴ GEOSS Strategic Targets document (November 2009)

3.1 Target Achievements and Work Plan

3.1.1 Key Findings from Previous Evaluations

- 1.8 Survey respondents had an overall “neutral” feeling towards the status of GEOSS development and implementation at this point.
- 1.14 The GEOSS implementation approach does not explicitly describe an end-to-end process of how the application of resources supports the overall vision and goals of GEOSS, how or why benefits are expected, or when benefits will be achieved. Without this, it may be difficult for stakeholders to make well-informed decisions about supporting GEOSS.
- 2.7 There is no formal process by which gaps between Targets and Tasks are addressed.
- 3.2 There is moderate to low confidence that most outcomes of the Agriculture, Biodiversity and Ecosystems SBAs will be achieved by 2015. Where there is success it is mainly due to goals which are more broadly stated (e.g., increased use of EO or improved collaboration) or activities that are being done independent of direct GEO involvement. The degree to which outcomes will be achieved depends on levels of future funding.
- 3.10 There is no procedure for systematic progress reporting against targets and outcomes. The progress reporting so far is a listing of general progress of activities without mapping these to targets and outcomes.
- 4.1 The Disasters and Energy SBAs will not achieve their strategic targets unless new tasks/components are added.
- 5.1 There has been good progress in the WWC SBAs. This is confirmed by the interviews, the survey and GEO-X Document 7: *Assessment of Progress Target and Task*.
- 5.9 The Strategic Targets and related Outcomes are viewed by some interviewees as too easy to achieve, while others found them too ambitious.
- 5.12 Water: WA-01-C3, GEO Cold Regions, has made progress following a long period of inactivity. Currently the Secretariat is acting as Component Coordinator and Point of Contact⁵.

3.1.2 Evidence from Current Evaluation

As in earlier evaluations, interviewees for the Sixth Evaluation often described the Strategic Targets as vague, unrealistic and lacking baselines. In addition, the lack of quality performance indicators has reduced an ability to measure success. On the other hand, some interviewees suggested that the non-prescriptive nature of the Implementation Plan allowed for voluntary GEO contributions to be made in new directions.

The interviews revealed that the achievement of the Strategic Targets overall was fair, but that progress is considered significant given GEO’s limited resources. Some comments noted

⁵ This is no longer applicable; the Task has a Point of Contact in China.

that the GEO Work Plan (currently 2012–2015) has neither reflected nor properly articulated the goals of achieving the Strategic Targets and the means necessary to achieve them. Comments regarding the GEO Work Plan included:

- “It is a high-level document that lacks well-defined objectives and activities”.
- “The extent to which it has been completed is very variable.”
- “It may have been too rigid at the inception of GEO”.

According to 43 survey responses from GEO/GEOSS participants, 44% indicated that GEO has made “Fair” progress toward completing the Work Plans, and 26% indicated “Good” progress. “Poor” progress and “Very Good” progress were each reported by around 10% of responses. No one indicated “Very Poor” progress. 9% were “Unsure” about progress.

The survey also showed that 51% of 41 respondents rated achievement of the Strategic Targets as “Fair”, while 31% rated achievement as “Good” to Very Good”. Only 5% rated achievement as “Poor” and none rated it “Very Poor” (see Figure 2).

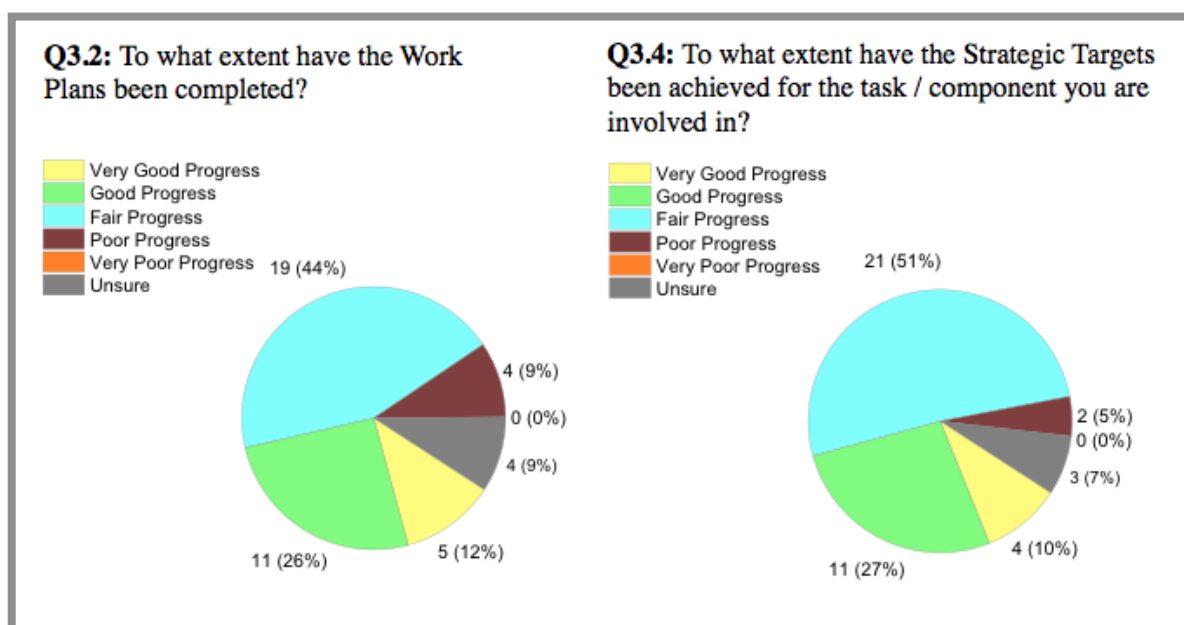


Figure 2. Survey responses regarding the Work Plans and Strategic Target achievements.

Interviews indicated that clearer Work Plans, together with input from stakeholder communities and improved interaction with Task Contributors, could help fill gaps in the Work Plan. It was noted that GEO documents have informed calls for proposals within the European Commission (e.g., FP7 and Horizon 2020), while there are few equivalents from other regions.

Although there is a general belief amongst interviewees that most activities in the Work Plan would exist in the absence of GEO, Work Plan collaboration is credited with activities being conducted across broader communities with greater productivity, expediency, potential and farther-reaching benefit than otherwise possible. However, the interviewees expressed an overall different view than survey respondents, as the survey showed that 55% of 42

respondents believe that it is “Unlikely” or “Very Unlikely” that activities in the GEOSS Work Plan would have occurred without GEOSS, and only 10% found it “Likely” or “Very Likely”.

Additional input from interviewees indicated that:

- Insufficient reporting and the absence of robust methodologies for assessing progress are obstacles for Work Plan completion and the evaluation of longer-term outcomes;
- The resources available for reporting and monitoring and evaluation are often too limited; and
- Improved and simplified reporting could allow for eliminating gaps in the Work Plan and the removal of tasks that are unsupported or show no progress.

The above evidence is generally in line with the conclusions of the report “Assessment of Progress – Targets and Tasks”⁶. The Assessment, prepared by the Societal Benefits Board, found that three of the nine SBAs (Agriculture, Energy and Water) were expected to be achieved with perhaps some actions/interventions being required (*green*), and six were at risk of not being achieved without additional actions/interventions (*yellow*). Since 2012, when the tracking system started, Agriculture has moved from *yellow* to *green* and Ecosystems from *red* (i.e., not expected to be achieved without significant actions/interventions) to *yellow*. Energy has been *green* throughout (although this was disputed in the 4th Evaluation), and Water moved from *green* in 2012 to *yellow* in 2013 and back to *green* in 2014. Only Biodiversity has shown worsening performance, changing from *green* in 2012 to *yellow* in 2013 and 2014.

3.2 Interconnectivity and Collaboration Across SBA's

3.2.1 Key Findings from Previous Evaluations

- 3.8 The Ecosystem task is fragmented, with most tasks within this SBA focusing on activities that straddle several SBAs (marine, forestry) or deal with regional ecosystems that are not represented explicitly in the GEO Targets and Outcomes.
- 3.15 Cooperation within the tasks is reported to be neutral to good, skewed towards the latter. It is unclear whether there is a shared understanding of what is to be achieved and how to get there.
- 4.3 Cross-SBA cooperation is unsatisfactory and must be improved. Tasks and Components consist of activities initiated and funded by sources external to GEO. Coordination of tasks within the SBAs is hardly visible.
- 5.4 Interaction between the WWC and other SBAs is presently limited. This is confirmed by interviews and the survey. There is some evidence that GEOSS has enabled the Weather SBA to focus on different users such as energy and ecosystems.

⁶ Document 9 (Rev1) GEO XI, 13 – 14 November 2014.

3.2.2 Evidence from Current Evaluation

The Work Plan is credited by interviewees with increasing general awareness within the GEO community of the work being performed within Tasks and leading to better linkages among Tasks. There appears to have been some improvement from earlier evaluations of cross-SBA cooperation and interconnectivity, as positive feedback indicated that people were satisfied with the SBA structure. The Water SBA, which has made, or tried to make, connections to other SBAs (e.g., Health and Disasters and the Water-Energy-Food Nexus), was mentioned as an example where efforts may have led to cross-SBA collaboration. On the other hand, several interviewees claimed that SBAs remain self-contained with little cross-collaboration. One respondent indicated that the lack of coordination within the GEO Secretariat (e.g., to support cross-cutting meetings) is at least partially responsible for inadequate collaboration across SBAs.

According to 41 survey responses: 41% indicated that GEO has made “Fair” progress in increasing collaboration between relevant projects and programmes within the GEO SBAs and Building Blocks. “Good” progress was reported by 32%; “Poor” progress by 20%; “Very Good” progress by 5%; and “Very Poor” progress by 2%. None were “Unsure” about progress.

Regarding the extent to which GEO has enabled and promoted cross-SBA cooperation, a slight majority indicated “Good” and “Very Good” progress, but a significant fraction of responses were “Unsure” (see Figure 3).

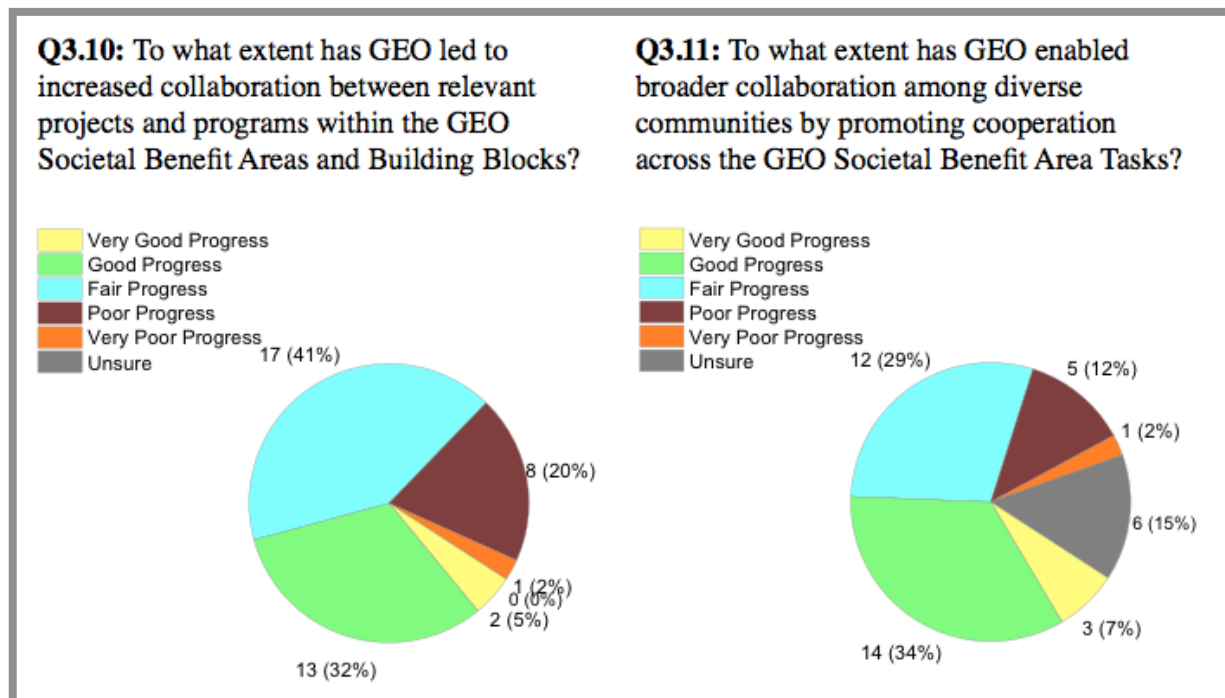


Figure 3. Survey responses regarding cross-SBA collaboration.

Examples of cross-SBA cooperation that were highlighted in the survey's free-text responses include:

- *Capacity building, Agriculture (food security), Climate (adaptation actions), Energy (substitutions energy), Water (integrated management)*
- *Climate – Energy Nexus*
- *Collaboration between the activities in the Biodiversity SBA with those of the Ecosystems and Water SBAs*
- *Cooperation and integration of data for CO₂ monitoring*
- *Discussions across Implementation Boards for the development of the GEOSS Community Portal*
- *Expansion of the agricultural component to grasslands*
- *FP7 projects (e.g., EuroGEOSS, GEOWOW, MEDINA, European Supersites); outcomes include: resources mobilization (e.g., data sharing) and their brokerage through the GCI*
- *Architecture Implementation Pilots (AIPs)*
- *GEOGLAM, JECAM - the community of practice has been created, joint FP7 projects have been fulfilled*
- *Geohazards Supersites and Natural Laboratories (GSNL); Global Urban Observation and Information (SB-04); and Informing Risk Management and Disaster Reduction (DI-01)*
- *The GEO broker initiative/project has brought several SBAs together, but needs more stimulus*

The GEOSS Implementation Plan calls for GEOSS to “*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*”, as well as “*information on drivers and consequences of change, including georeferenced socio-economic data and indicators.*” Such product facilitation was rarely or never mentioned within interviews as an approach of GEO toward increasing SBA interconnectivity, nor were such elements typically identified as key achievements of GEO. One exception is that GEO was largely credited in an interview with commissioning the US Geological Survey's (USGS) New Map of Global Ecological Land Units.

Some interviews indicated that insufficient SBA interconnectivity may, to some extent, be related to SBA definitions and the nature of the communities that comprise them. Some SBAs are knowledge-based, while others are more application-based. SBA definitions are often seen as arbitrary and not well articulated. For example, the weather and climate SBAs, to some extent, relate to all other SBAs.

3.3 Global Initiatives⁷

3.3.1 Key Findings from Previous Evaluations

- 3.3 Success has been reported for both GEO BON and GEOGLAM and their plans, but for these tasks, there is uncertainty in terms of resources and coordination. Thus the implementation of these programmes is more uncertain, and only partial implementation of these will be achieved by 2015.
- 3.7 Agriculture and Biodiversity are increasingly driven by cooperative initiatives like GEOGLAM and GEO BON and orienting their activities directly to the targets of stakeholders, like G20 for Agriculture and CBD for Biodiversity.
- 3.9 GEO and GEOSS are adding value to the work within Member States and organizations, mainly through collaborative initiatives, more so than adding value through contributing to increased use of Earth observations and institutional capacity building.

3.3.2 Evidence from Current Evaluation

As in the 3rd Evaluation, interviewees were positive regarding large initiatives in the context of achieving better collaboration at the regional level, exploitation of existing capacities and demonstration of GEO's potential. It was, however, pointed out that few initiatives are solely GEO initiatives. In the absence of GEO, the user justification for large initiatives would still exist. In other words, stakeholder communities, such as the agriculture community that is served by GEOGLAM or the forestry community served by GFOI, are relatively independent of GEO. However, the initiatives would not have started without GEO. In addition, GEO has significantly contributed to their content, improved their visibility and engagement, and heightened their purpose.

Although some of the global initiatives show linkages to other international initiatives⁸, some interviewees pointed out that GEO's Global Initiatives could take better advantage of key global initiatives or activities organized by other bodies (see also Section 5 on Communication and Visibility).

80 survey responses were received regarding GEO's progress in building partnerships with relevant organizations, projects or programmes that are not direct contributors to the GEO Work Plan. Of these, 68% indicated that GEO has made "Fair" or "Good" progress (equally divided), 11% indicated "Poor" progress, and 6% indicated "Very Good" progress. 15% were "Unsure" about progress.

Several interviewees suggested that GEO's collaboration with global organizations is critical, and that it should be possible to identify common targets and complementary areas in order to

⁷ The Global Initiatives were not included in the original GEOSS 10-Year Implementation Plan, but were created more or less spontaneously as part of the GEOSS Work Plan.

⁸ E.g., official websites show that GEOGLAM is recognized as contributing to Global Crop Prediction by FAO; GEOBON cooperates with international conventions like the Ramsar Convention and the Convention on Bio Diversity (CBD); and GFOI is responding to the requirements of the UN-programme Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD).

build strategic bridges for mutual benefit.

As an example of how well the GEO Global Initiatives have been received, it was suggested by one interviewee that a scheme of 8-10 key initiatives or flagships (such as GEOGLAM, AfriGEOSS and other successful examples) should be part of GEO's future, in parallel with the SBAs. It was also stressed by another interviewee that smaller initiatives should not be excluded, as they could reflect more regional priorities or issues that might be of unexpected importance in the future.

3.4 Gaps

“GEOSS aspires to encompass all areas of the world, and to cover *in situ*, airborne, and space-based observations”

– *GEOSS 10-Year Implementation Plan*

In the *GEOSS Strategic Targets* document, *in situ* observations are identified as a means to achieve or to demonstrate achievement for 7 of the 14 Strategic Targets (Architecture, Science & Technology, Biodiversity, Ecosystems, Health, Water and Weather).

3.4.1 Key Findings from Previous Evaluations

- 1.13 GEO has not conducted a comprehensive gap analysis of either their implementation approach (structural) or observation needs (observational).
- 2.7 There is no formal process by which gaps between Targets and Tasks are addressed.
- 3.4 There is no task for desertification.
- 3.5 Poor spatial resolution of most agricultural satellite Earth observations and insufficient coordination with space agencies for Biodiversity are gaps to achieving progress.
- 3.6 There are no established procedures for structural and domain-focused gap analysis. Gap analysis is critical to ensure that Targets and Outcomes can be achieved.
- 5.8 Concerns persist about gaps in observational data and the continuity and quality of datasets. These issues are most notable in Latin America, Africa and Central/Northern Asia, where there has been limited involvement and capacity building. There is a need to increase hydrological observations worldwide. River discharge and stream gauge networks have decreased and require maintenance. All evidence suggests a need to develop additional *in situ* networks (e.g., temperature, precipitation, carbon flux, soil moisture) and better maintain the current *in situ* and satellite networks.

3.4.2 Evidence from Current Evaluation

In this evaluation, key informants' interpretations of "gaps" fell within three different categories:

1. Elements missing from the Work Plan that were necessary to achieve Strategic Targets;
2. Missing observational data; or
3. Elements that were not included as Strategic Targets and/or never included in the Work Plans.

Within category 1 above, "combating desertification" is the only identified major gap among the Task Components that remains. Of 43 responses to the survey question "Were all Strategic Target outcomes addressed by the Work Plan?", only 5% said "No", but as many as 58% were "Unsure".

Within category 2 above, interviewees frequently mentioned insufficient *in situ* data, particularly from the oceans and hydrology, as a gap.

Some respondents indicated that observational gaps have occurred because there has been declining attention in GEO toward observations themselves. Rather, too much attention has been placed on data products for existing datasets. It was suggested that greater recognition of Participating Organizations may improve access to some datasets that have been absent from GEOSS. In addition, several interviewees referred to the Integrated Global Observing Strategy Partnership (IGOS-P; <http://www.eohandbook.com/igosp/>), which is frequently referenced in the GEOSS 10-Year Implementation Plan Reference Document, as an indication that the intentions of IGOS-P have been lost, and that too much emphasis has been placed on satellite observations. One interviewee suggested that GEO could make greater progress toward integrating *in situ* and satellite-based data if greater focus is placed on doing so in the context of specific applications, and less so from an over-arching strategic standpoint.

One survey respondent pointed out that space-based remote sensing has less value for oceans and biodiversity than for some other GEO areas, and that GEO has not fully embraced observation systems that are not controlled by space agencies.

Within category 3 above, some respondents identified the need for a thorough gap analysis for global Earth observations and infrastructure. Some interviewees noted that GEO lacks activities related to mineral resources, transportation, safety and security, and acknowledged that these represent missed opportunities to engage new stakeholders and regional partners.

Information Services for the Cold Regions was identified as a gap within GEOSS, especially given that there are a lot of "Cold Regions" observations performed globally, but no interdisciplinary framework or institutional relationships (e.g., with WMO's Global Cryosphere Watch, GCW) to support their integration within GEOSS. Such responses, however, acknowledged recent progress with Sustaining Arctic Observing Networks (SAON) joining GEO as a Participating Organization in 2014.

In general, discussions of gaps identified concerns that key tasks were too bottom-up, too voluntary and not supported by top-down funding and direction. Voluntary activities are often seen as having been accepted within the Work Plan without clear and explicit links being made to the needs and priorities of GEOSS. Similarly, interviewees have observed a lack of solicitations for projects that would meet Strategic Targets.

3.5 Synthesis

The overall achievement of Strategic Targets has been rated as “Fair”, but progress is considered significant given GEO’s limited resources. The Work Plan and the Strategic Targets document have not provided sufficient guidance and clarity on how to implement the Tasks in order to achieve the Targets. The extent to which Work Plans have been completed is variable across SBAs. Between 2012 and 2014, there has been moderate improvement in how the progress towards the Targets is rated.

The Targets and outcomes are perceived as neither concrete, focused nor measurable, and simple reporting requirements are lacking. Also, there is no real requirement of resources or deliverables for volunteered contributions, thus making prioritization difficult.

The general impression gained from interviews is that cooperation and facilitation within GEO is insufficient. In contrast, the 41 survey responses are more positive and provided examples of existing cross-SBA cooperation (e.g., the Water-Food-Energy Nexus).

Key Finding # 2: Insufficient strategic guidance and clarity within the GEO steering documents, the Strategic Targets document and the GEO Work Plan have led to insufficient implementation of the Work Plan and only fair achievement of Strategic Targets.

Key Finding # 3: Cooperation across SBAs has been strengthened within the GEO community, but a lack of coordination has hampered full exploitation of the potential of GEOSS.

Key Finding # 4: Insufficient mechanisms to engage the global *in situ* data community have contributed to significant, enduring observational gaps within GEOSS.

Key Finding # 5: GEO lacks a clear process for identifying priorities, which limits the broader community's ability to strategically organize and leverage contributions to GEOSS.

Key Finding # 6: The GEO Global Initiatives are widely considered significant contributors to GEO’s success, even though they were not initially included in the 10-Year Implementation Plan.

4. GEOSS Cross-Cutting Activities

4.1 Architecture and Data Management

Regarding 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.”

– *GEOSS 10-Year Implementation Plan*

Regarding data availability, data access 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.
- 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.

– *GEOSS 10-Year Implementation Plan*

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

– *GEOSS Strategic Targets*

4.1.1 Key Findings from Previous Evaluations

- 1.5 GEOSS implementation has created a path to enable full and open data sharing and lowered discussion barriers.
- 1.6 GEOSS implementation has resulted in positive outcomes for the Earth observation community, such as Data Sharing Principles.
- 1.9 Stakeholders perceive that architecture developed by GEO does not yet meet their needs for data, information and tools.
- 2.1 There is no clear evidence that the ADM Strategic Targets will be met by 2015
- 2.2 The User Interface is difficult to use because it does not follow good human factors engineering practices.
- 2.3 Although the implementation of the GCI provides a standard infrastructure and platform, there is not a uniform, consistent way that data are registered, stored and accessed.
- 2.5 Technology employed by GEOSS is not current.
- 2.6 Data may exist, but it is difficult to find.
- 2.10 Commercial and intellectual property rights are perceived as a barrier to publishing data in GEOSS.
- 4.4 Data must be made more accessible over the GEOSS Portal. Today it is difficult and time consuming to locate data and information.
- 4.5 There is not a clear understanding of the difference between the GEOSS Portal and the GCI.
- 5.10 User experiences with accessing data from the GEOSS Portal are diverse. In the web survey, as many users describe their experience as “Good” as say it is “Poor” to “Very Poor”. In the survey, the Climate SBA reports more negative experiences than Water or Weather.

4.1.2 Evidence from Current Evaluation

Data Sharing

The GEOSS Data Sharing Action Plan, adopted in 2010, builds upon the concept of full and open exchange of data. Its agreed upon guidelines for implementation state that “...*data, metadata and products made available through the GEOSS are made accessible on a non-discriminatory basis with minimal time delay and with as few restrictions as possible, at minimal cost and, in any case, no more than the cost of reproduction and distribution.*”

Interviewees and survey respondents’ free text replies expressed that GEO has helped in advocating full and open access to data, which has increased collaboration. GEO has increased availability of open data and is better off at the end of its first 10 years than its beginning, in terms of *in situ* and satellite data. Thus, the establishment of the GEOSS Data Sharing Principles is considered one of the major achievements of GEO, regarding both the development of these principles and their technical implementation. A subset of all data registered in GEOSS is now available on a free, full and open basis through the GEOSS Data-CORE (GEOSS Data Collection of Open Resources for Everyone).

Several interviewees, however, indicated the need to extend these achievements to the national level in some countries by assisting individual governments advance their open data policies. Some noted that implementation of data sharing principles varies between countries due to political willingness, as well as technical and economic barriers. Thus, there is need for continued advocacy and assistance at both global and regional levels in advocating full and open access to data. Open data sharing is viewed as especially important for the support it provides to developing countries that lack data generation and data access capabilities. Identified areas for improvement include, bringing data sharing to the political level, having more data openly available for use at low cost, and increasing discussions on how to leverage GEOSS data in decision-making.

Data Availability, Data Access and Interoperability

Several Information Technology (IT) components have been deployed and interconnected by GEO experts to constitute the main IT architecture of the GEOSS information system, referred to as the GEOSS Common Infrastructure (GCI). The heart of the system, the GEOSS Discoverability and Access Broker (DAB), is generally described as a success of GEOSS in terms of enabling interoperability (i.e., the ability of a system to communicate and exchange data using open standards and specified formats between systems). The extent to which retrieval of exchanged data for specific applications is user friendly will depend on the structure of the specific systems in question.

A recurrent and clear finding from the interviews is that the GCI is not user-friendly and does not provide effective discoverability and access to quality data. Despite a vast number of data and information resources that an average user should be able to discover, only highly specialized users are able to find their way through the GEOSS Portal. As in the 4th Evaluation, it appears that the general user does not possess a clear understanding of the differences between the GCI and its components. Therefore, it should be made clear that several key informants had difficulties distinguishing the different components of the GCI, and as a result, it is difficult to judge which parts of the GCI were criticized.

The inclusion of the DAB has resulted in a significant expansion of available information sources, including the GEOSS Data-CORE (free, full and open resources). In December 2014, the number of GEOSS Data-CORE open resources (data, products and services) that could be discovered using the GEOSS Discovery and Access Broker exceeded 1,200,000 for data sets and 51,000,000 for individuals records. The foundation of this success was a new approach to interoperability and continuous development of the GEO data policy. One interviewee indicated, however, that progress must be made to increase awareness of GEO and GEOSS by data providers.

There is still no consensus on the objective of the GEOSS data infrastructure. On one hand, some interviewees claim that GEOSS should deliver products and services, and that GEOSS users are not interested in basic Earth observation data. On the other hand, there are views that GEO should focus on the provision of the necessary observational data at different scales to address important issues within the different SBAs.

The development and maintenance of a GEOSS data infrastructure are perceived as very ambitious efforts requiring sustainable resources. There are some worries that the present operators may not continue beyond a certain period.

Finally, several interviewees mentioned the challenge of ensuring and promoting data quality. Presently, quality assurance of data is left to the data provider, thus, there is no guarantee that this is performed consistently, or at all, within GEOSS.

Of the 80 survey responses received regarding use of the GEOSS Portal, 52% said they “Rarely” or “Never” use the Portal, while 15% claimed to be familiar or very familiar with its use. 39% believe that the extent to which the GEOSS Portal has created new users of Earth observations is “Fair” to “Good”, but 30% are “Unsure”. To questions related to data availability, accessibility and efficiency, the majority identified “Fair”, “Good” or “Very Good” progress, while only around 20% indicated “Poor” or “Very Poor” progress. However, the fraction indicating “Poor” or “Very Poor” progress was largest for the specific question related to the comprehensiveness of the data available (see Figure 4).

According to survey respondents, the data most sought online are related to climate (20%) and biodiversity (18%), followed by disasters and water (both 14%). Importantly, as many as 64% said that the GEOSS Portal is not their preferred means of searching for Earth observations data (Figure 4). Among the preferred sources are freely available Internet search engines, direct data providers, and other servers or portals.

Survey respondents were also asked how the GEOSS Portal can be improved. The suggestions include⁹:

- *More direct access to data; complete metadata; more access to free, processed imagery; access to real primary data; free data and available Very High Resolution data; less global and scientific products and more products and services tailored and down-scaled for real users; more social services;*
- *More links to additional information; better inclusion of community portals; dedicated links to FP7 research projects; a clearer link between various brokers and the GEOSS Portal;*
- *Reduce intermediate stops; get rid of redundant and outdated data; systematic verification and validation of each dataset; better overview of data and more search and compilation functions; aligning dataset descriptions with the most recognized standards;*
- *More interactive, more modern interface; powerful free-text search (as search engines); making joint ventures with commercial entities; one-stop access trying to address requests coming at least from one of the main category of users; ability to retrieve/download data directly via a basket and checkout approach, as used by internet shopping sites;*
- *GEOSS portal should better rely on existing portals and provide opportunities to integrate the existing data sources; and*

⁹ These are listed here without the ET knowing how well the respondents understand the GCI and its different components, or the associated roles and responsibilities. The ET has also not considered the feasibility of implementing these suggestions.

- *Better coordination and liaison with the resources of Participating Organizations in order to address gaps and avoid unnecessary duplication.*

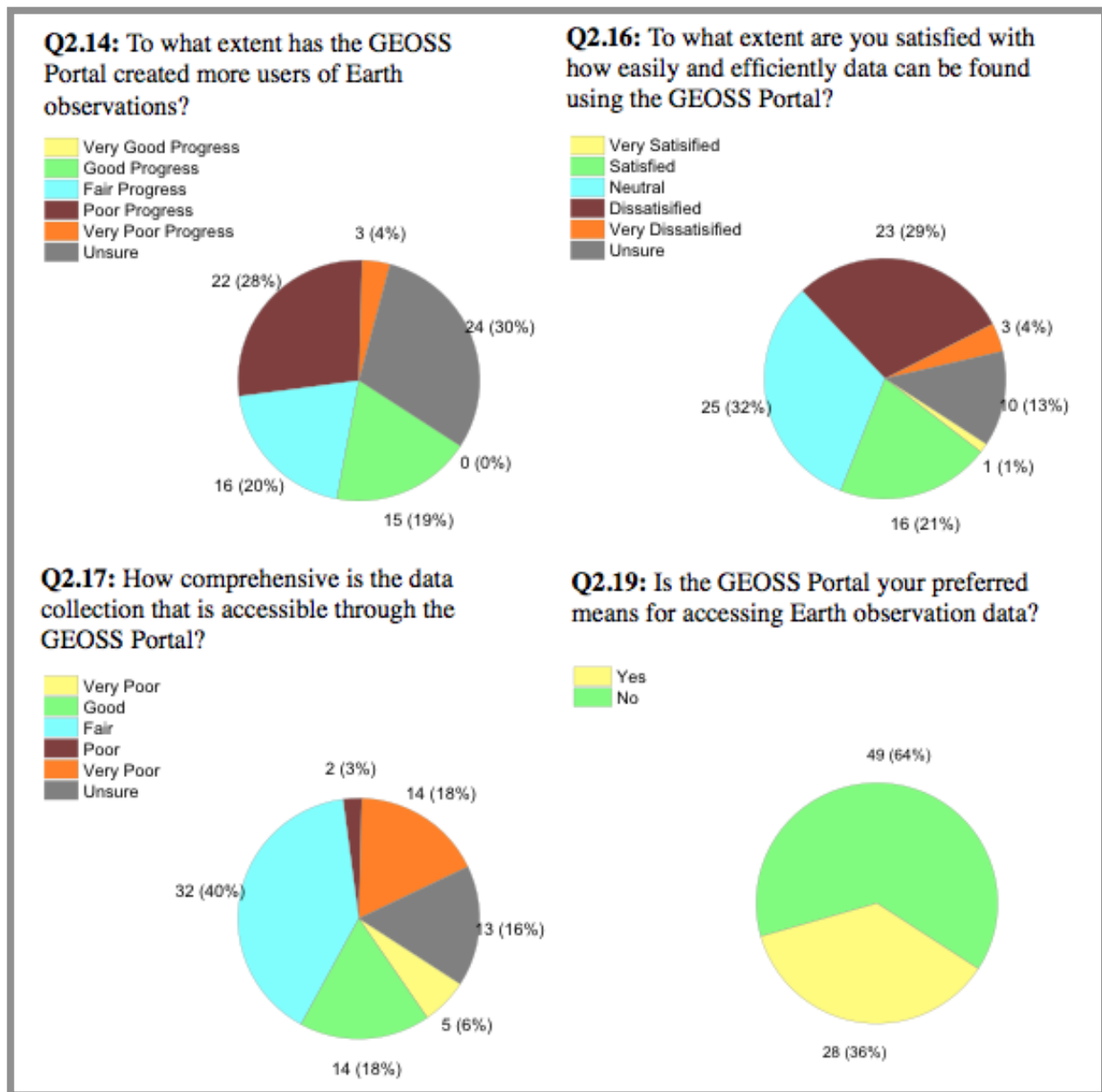


Figure 4. Survey responses related to the GEOSS Portal.

Architecture Implementation Pilots (AIPs)

The GEOSS Architecture Implementation Pilots (AIPs) develop and deploy new processes and infrastructure components for the GEOSS Common Infrastructure (GCI) and the broader GEOSS architecture under Task IN-05 “GEOSS Design and Interoperability.” The main aims of AIPs are to reach consensus on Interoperability Arrangements and to register operational components and services that carry forward into persistent operations of GEOSS. Until now, seven phases of AIPs have been completed (AIP-1, completed in November 2007, through AIP-7, completed in November 2014). The 8th AIP will be completed in November 2015.

AIPs were mentioned in the 2nd Evaluation, where one interviewee stated: *“The Architecture Implementation Pilot (AIP) methodology is good, but lack of funding makes it difficult to implement it properly. Involved parties usually bring to the AIP what they have developed in other contexts, without the possibility of dedicating efforts to tailor them to the AIP and GEOSS objectives”*.

One finding in the 2nd Evaluation was: “The Architecture Implementation Pilot (AIP) does not seem to be a sufficiently open process to be of value to a larger audience. There are differences between what is reported to the GEO Secretariat against plans and what was found by the evaluation as substantive performance measures, outputs and outcomes.” AIPs were not mentioned in the 3rd Evaluation, but they were mentioned in the 4th and 5th as accomplishments by the Energy SBA and Water SBA, respectively.

In this Sixth Evaluation, AIPs were hardly mentioned by interviewees, except by one who indicated that the successes of the AIPs have not been properly presented and highlighted to the broader GEO community. In a case study (see Annex C.3), one team member made a cursory review of a limited number of results, which are in the form of demonstration videos and engineering reports. The deliverables were found to contain highly variable information. Those Pilots deemed most useful, in particular within the Water and Energy SBAs, have developed their own portals that are accessible via the GEOSS Portal, and have undoubtedly contributed to building the GCI and increasing information accessibility.

While outcomes of AIPs should be aligned with GCI development, and the GCI should take up results from the AIPs, it appears that the AIP and GCI processes are somewhat disconnected. Despite AIPs being a specific item on the GEO home page, the ET believes that more can be done to make the AIPs known and available outside the SBA communities. The most successful AIPs could perhaps serve as models for further work on the GCI. Similar to GEO’s potential to learn from the results of the AIPs, GEO may also be informed from lessons derived from other, similar efforts to exploit data available through GEOSS, such as the GEO Appathon 2014 (see the case study in Annex C.4).

4.1.3 Synthesis

Interviews and the document review show that GEO has advocated and agreed to full and open access to data by creating an open data sharing policy and fostering an environment for data sharing. GEO has communicated and made increasingly visible its role as a data and service provider. Over the course of the last 10 years, GEOSS has increased the availability of open data, which is widely viewed as one of GEO’s greatest achievements.

There is opportunity to build on this success, as there are nations and regions that lag behind in implementation of the open data principles. Thus, there is need for continued political advocacy and assistance at both the global and regional levels. Open data sharing is viewed as especially important for developing countries that lack data generation and data access capabilities.

Key Finding # 7: The creation and advocacy of open data sharing principles for Earth observations are major accomplishments of GEO, but the open data approach has yet to be established and implemented in a number of countries in different regions.

Much has been achieved in developing a common infrastructure. The heart of the system—the GEOSS Discoverability and Access Broker (DAB)—is generally perceived as a success that has advanced the interoperability of GEOSS. Although survey respondents appear more positive than interviewees, the general impression is that there is much progress needed before the GEOSS Portal, which is the primary entry point for GEOSS users, can be called user-friendly.

Key Finding # 8: The GEOSS Common Infrastructure (GCI) has greatly advanced Earth observation data interoperability; however, user expectations regarding data discoverability, access and quality assurance have not been met.

The above findings may be in line with the conclusions of the report “Assessment of Progress – Targets and Tasks” (Document 9, Rev1 to GEO XI, November 2015), where both Architecture and Data Management targets were found to be at risk of not being achieved without additional actions/intervention (*yellow*), which is the same rating they have had since 2012. However, the conclusions are not directly comparable, as the report does not point specifically to the GEOSS Portal as a weak spot. Furthermore, the report marks IN-05, GEOSS Design and Interoperability, as *green* (i.e., expected to be achieved with perhaps some actions/interventions being required) due to emphasis on AIPs, apps, guidance papers on community portals and a GEOSS tutorial.

4.2 User Engagement

“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.”

– *GEOSS 10-Year Implementation Plan*

“Before 2015, GEO aims to: Ensure critical user information needs for decision making are recognized and met through Earth observations.”

– *GEOSS Strategic Targets*

4.2.1 Key Findings from Previous Evaluations

- 3.13 Users and stakeholders are not always well understood by task leaders and participants, but there is a general feeling that the tasks are aligned with stakeholders’ priorities.
- 3.14 Tasks are primarily focused on establishing collaboration and developing data products, with less focus on the involvement of users.

- 4.6 Users' response was too low to judge if they are sufficiently involved and their needs are taken properly care of.
- 5.13 Climate: Interaction with users is currently limited in the GEO context and there are few feedback mechanisms where users can comment on their climate data needs. This is confirmed by interview evidence.
- 5.15 There is very limited evidence of direct user involvement in definition of task activities and the daily execution of them. Surveys and interviews show that user engagement occurs through national committees, by e-mails asking for input to needs, and by invitations to workshops/seminars.

4.2.2 Evidence from Current Evaluation

The above quote from the GEOSS 10-Year Implementation Plan sets the scene for the engagement of GEOSS users. Some interviewees expressed the view that GEO should be more specific in how users are defined, for example, by separating institutional end-users, value adding or intermediary users, and individual citizen end-users. One interviewee offered the following categories, which have been adopted by the ET:

- *Intermediate users* who take EO data or information and tailor it for a specific end-use (e.g., commercial sector);
- *End-users* whose activities or businesses benefit from EO data and information in terms of better scientific understanding of the Earth, improved safety, economic efficiency gains or more effective environmental protection. The end-users fall into four main types:
 - *Science end-users* who undertake research activities that rely in whole or in part on sustained measurement and EO;
 - *Policy end-users* who require sustained EO and information to support policy formulation, monitoring of policy compliance and assessment of policy effectiveness;
 - *Operational end-users* who make use of EO and information to support operational needs related to safety, economic efficiency and protection of the environment; and
 - *Civil society and citizens* who can use a broad range of products (e.g., high resolution imagery or EO-based maps).

During this Sixth Evaluation, the achievement of user engagement was perceived differently by the above user groups. In general, GEO is perceived by interviewees as having been critical in informing users of Earth observations of specific products, tools and methodologies. The European Union (EU) Copernicus program, and the United States National Aeronautics and Space Administration (NASA) Applied Sciences Program are two examples identified as benefiting from GEO in their efforts to engage users.

Although significant efforts were made through the Communities of Practice (CoPs) to reach broader user communities, the general perception of interviewees is that the scientific community dominates involvement in GEO, and that GEOSS is often characterized as a "science initiative", since a significant number of GEOSS users are found within the research community. However, the engagement of the scientific community within GEOSS was

considered to have improved the scientific understanding of complex Earth observation data through CoPs and SBAs.

The involvement of the private sector is not a prioritized target in the 10-Year Implementation Plan. Therefore, the interviews were not designed to address GEO-private sector issues, *per se*. However, interviewees spontaneously commented on the private sector, especially in regard to user engagement. Throughout the interviews, the private sector stood out as an emerging user of GEOSS. User engagement in general and, in particular, the engagement of the private sector, is not considered satisfactory. This is considered one of GEO's weaknesses. However, the fact that GEO intends to involve the private sector in the future is generally welcomed.

Increased private sector engagement in Earth observations could, in particular, support and inform more efficient uses of resources. There is an opportunity to increase engagement toward the delivery of new systems that may create business opportunities through access to Earth observation datasets. One interviewee suggested the creation of more public-private partnerships to showcase the daily usefulness of Earth observation data. Others, however, see GEO/GEOSS as a governmental framework for contributing to governmental decision makers. Therefore, they do not see benefits from partnerships with the private sector, industries and UN organizations, except in specific instances (e.g., Forests or Disasters).

As an inter-governmental entity, GEO did not initially plan to engage the private sector; however, the private sector is already present to some extent in GEO (see Annex C.2.3). Private, non-profit entities, such as the Open Geospatial Consortium (OGC), which is a Participating Organization in GEO, contribute to standards and provide links to the research and private sectors. Several private sector Small and Medium sized Enterprises (SMEs) contribute to the implementation of GEO tasks, for example, through their involvement in European projects. GEO participants are not always fully aware of these contributions, which is frustrating for those private sector entities involved. Regardless, it appears that the commercial sector is not well aware of GEOSS and rarely uses it, except upon request of governmental agencies. An indication of this is that only a few of the survey responses came from the private sector.

During its first 10-year phase, GEO has focused mostly on the engagement of institutional users involved in the management of the environment at local, national, regional and global levels (e.g., civil protection, climatic issues and weather forecasts). Earth observation user groups remain rather limited in size and conventional in terms of applications (e.g., mapping, surveillance and scientific applications). The engagement of these groups has taken place within CoPs in compliance with the original requirement for creating GEOSS user fora. Input to the ET indicated that the user fora concept has functioned well and should be developed further on a broader scale.

There is a strong sentiment amongst interviewees that user engagement should be strengthened. Several interviewees indicated that GEO must do a much better job at demonstrating use cases, while defining and investing in a more user-focused communication strategy. Interviewees also mentioned that during the next GEOSS implementation period (2016-2025) there should be more focus on actively engaging policy and decision makers, as well as the private sector, in areas of mutual benefit.

The survey responses show mixed views on user engagement. Equal numbers (27%) rated progress on user engagement as “Poor” or “Very Poor”, and “Good” or “Very Good”. 30% of respondents found that GEO has made “Good” or “Very Good” progress toward making GEOSS user-driven, and about the same percentage reported “Fair” progress and “Poor/Very Poor/Unsure” in this area (see Figure 5). 25% said they have identified users that have significantly benefitted from GEOSS, while 31% said they can identify users that have not benefitted.

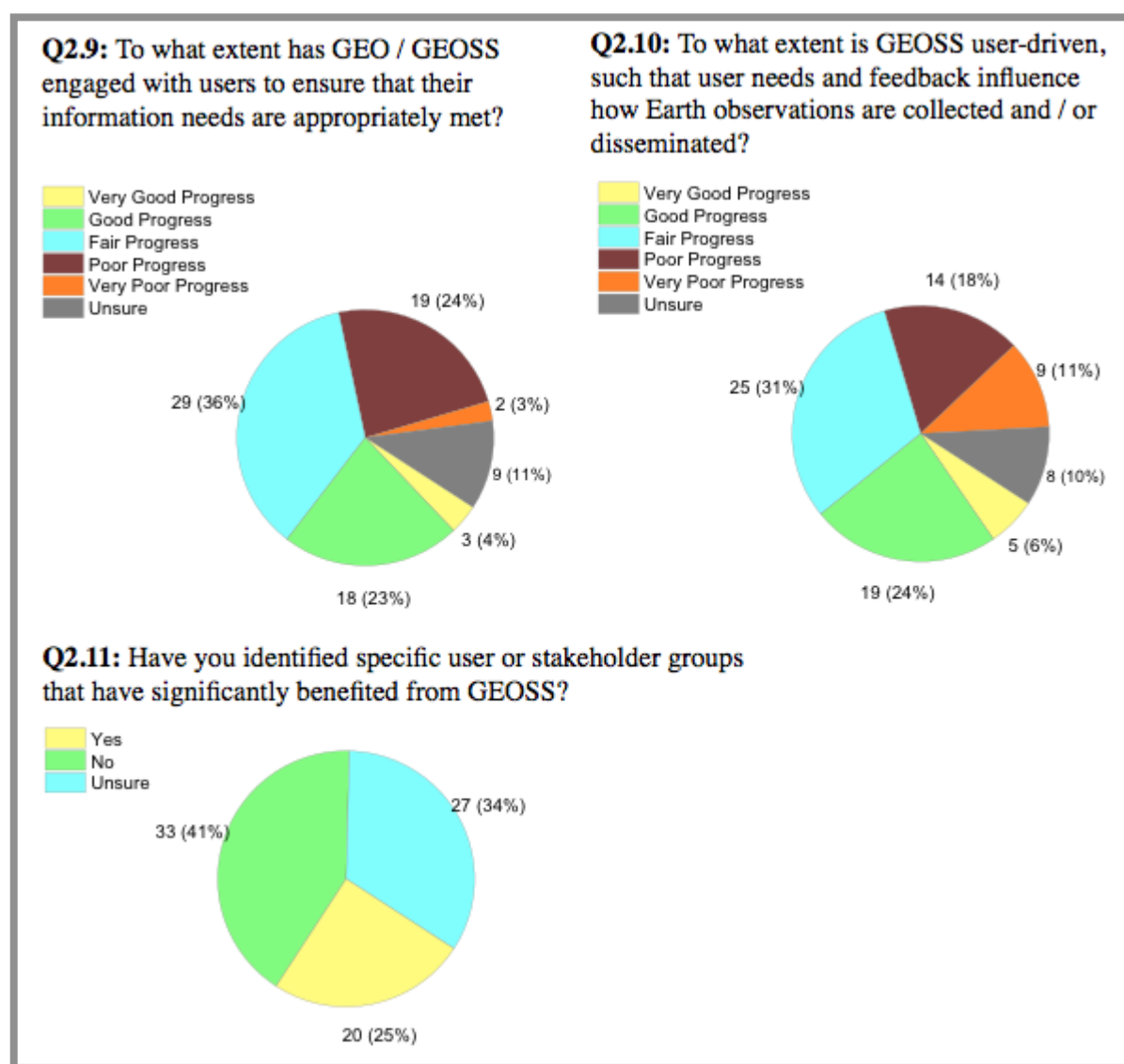


Figure 5. Survey responses to related to User Engagement.

4.2.3 Synthesis

GEO has not fully succeeded in engaging users beyond the scientific community. Policy makers, governmental and non-governmental organizations show moderate engagement. Although the private profit sector is often characterized as being absent, non-profit entities

and SMEs are present to a larger extent than is usually recognized. User fora have proven to have merit for engaging users, and are a promising venue for improving engagement through greater demonstration of EO data use-cases.

Key Finding # 9: GEO has not fully achieved a “user-driven GEOSS” because users have not been adequately incorporated into the entire observation-to-information value cycle. The current user landscape includes: (1) the science community as the main user; (2) governmental/international organizations and (3) the non-profit private sector as moderate users; (4) the commercial sector as marginal users; and (5) laymen/citizens as non-users.

Key Finding # 10: GEO’s engagement of the private sector is stronger than generally recognized, as evident by the robust participation of non-profit entities and participation of a limited number of commercial sector entities. Strengthened, strategic engagement of the private sector is nonetheless recognized as a promising, and often necessary, avenue for GEO to pursue in the future.

4.3 Capacity Building

“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.”

“Within 6 years GEO will...produce monitoring and evaluation mechanisms for GEO capacity building efforts.”

– *GEOSS 10-Year Implementation Plan*

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

– *GEOSS Strategic Targets*

4.3.1 Key Findings from Previous Evaluations

- 3.12 The limited capacity in developing countries and the inclusion of those countries systematically across the activities is a major organizational challenge.
- 5.7 Capacity building in terms of technical competence and resources appears limited. There is very little evidence that implementation at the national level is occurring after capacity building workshops.

4.3.2 Evidence from Current Evaluation

Capacity building has been broadly defined within GEO. In 2006, the GEO Capacity Building Committee developed the GEO Capacity Building Strategy¹⁰ and outlined three

¹⁰ GEO Capacity Building Committee (2006) GEO Capacity Building Strategy. GEO-III, Document 13.

types of capacity building: *human/individual*, *institutional* and *infrastructure*. The GEO Strategic Target for capacity building identified the coordination of these three elements as critical to producing and using Earth observations and derived information products across all SBAs. Achievement of the GEO Strategic Target was to be demonstrated by:

- Networking activities that specifically built individual, institutional and infrastructure capacity.
- Leveraged resources for Earth observation capacity building efforts.
- Increased use of Earth observation in policy and decision-making.
- Enhanced participation of developing countries in GEO and GEOSS.

Evidence collected during the Sixth Evaluation shows that there has been progress in engaging developing countries and that GEOSS has contributed to capacity building in developing countries through mobilizing the research community. Asia Pacific GEO, AfriGEOSS, and GEOSS for the Americas are a direct result of GEO, and are now vehicles for reaching developing countries. Other initiatives that were indicated as significant capacity building successes were the Asian Water Cycle Initiative (AWCI), the African Water Cycle Coordination Initiative (AfWCCI), and Centre of Hydrologic and Spatial Information for Latin America and the Caribbean (CIEHYLC). These were also positively mentioned in the 5th GEOSS Evaluation Report. CIEHYLC, for example, has helped to build technical capacity in the Americas and has led to the development of new projects (e.g., through the NASA DEVELOP program), investments (e.g., in GEONETCast antennas) and new forms of monitoring (e.g., high frequency radars in Colombia). Specific examples of successful projects led by international development agencies within the AWCI are provided in Annex C.5. These include the Asian Development Bank (ADB) project *Applying Remote Sensing Technology in River Basin Management* in Bangladesh, the Philippines and Vietnam, and the Japan International Cooperation Agency (JICA) project for *Assessing and Integrating Climate Change Impacts into Water Resources Management Plans* in Indonesia.

Several interviewees identified the SERVIR program, a joint USAID-NASA initiative, as both a success in its own right and an effort that significantly benefitted from GEO. It was within the Capacity Building Committee that the idea for a SERVIR hub in East Africa was born. SERVIR, which partners with regional institutions to deliver Earth observation-based information products to decision makers in developing countries, has four hub locations around the world – Mesoamerica, East Africa, the Himalayas and the Lower Mekong Region in South East Asia.

Some interviewees indicated that for developing nations, capacity building needs to move away from the model of 1-2 day workshops toward longer training sessions for people involved with EO, and should expand to address infrastructure related issues. The longer training sessions are necessary for users to learn how to develop data and knowledge products from available GEOSS data and information. Also, several people indicated the need for new capacity building approaches beyond technical trainings, including, for example, guiding people in developing countries to make Earth observations part of a business model or strengthening their ability to maintain observing systems.

In addition, several interviewees mentioned that capacity building must be sustainable, which requires increased follow-up for success to be maintained. Workshops and training for selected people alone may not be sufficient from a long-term perspective. It is important to

identify the relevant institutions and follow-up and assist with advancing their institutional and technical capacities. Joint implementation approaches between the training institution and local or regional institutions are better than simply targeting individuals.

Some interviewees stated that capacity building progress has been slow in developing countries, in part due to reasons mostly beyond GEO's control. The receiving countries are often simply unable to sustain activities due to resource constraints. There is an evident lack of commitment by several developing-country Member States that both prevents them from benefiting from GEOSS and hampers the deployment of GEOSS to huge geographical areas without adequate observational coverage. Interviewees highlighted the need for solutions to overcome these issues, in particular, by strengthening GEO's engagement with developing countries by focusing on sustainable development, regional cooperation and new approaches for funding GEO projects. Despite progress in engaging developing countries, some interviewees expressed that many developing countries do not have access to data or the capacity to use it; therefore, there remains room for improvement in GEO's capacity building activities.

The GEO Capacity Building Strategy also highlighted the need to monitor and evaluate capacity building by tracking appropriate indicators. The Strategy stated that: "Indicators to measure progress in capacity building for Earth observations should be defined by integrating elements of new and existing international and global capacity development indicator concepts and frameworks, tailored to the purpose of GEO."

Interviews revealed that GEO progress in capacity building has been difficult to measure because of the lack of monitoring and evaluation. Informants identified several reasons, all of which have been identified previously (e.g., in the GEONETCAB Capacity Building Strategy). These reasons include the absence of a baseline from which to assess progress, the complementary and/or overlapping nature of GEO activities with those of other initiatives, and the lack of monitoring and evaluation (M&E) at the project level to track results. The latter is likely due to the lack of resources and the voluntary nature of GEO, as well as the absence of a focus on M&E as a matter of best practice, despite an early recognition of that need within the GEO community.

In addition to tracking indicators that quantify capacity building implementation, some interviewees have expressed the need for future indicators that are capable of tracking the long-term impacts of capacity building, for example, the continued operational use of Earth observations one year after a training workshop. Such indicators would advance GEO's definition of capacity building toward greater recognition of capacity building as an endogenous process, where donors play a facilitating or supporting role but are not necessary for long-term sustainability. The SERVIR program is one example of a capacity building effort that has made M&E central to its operations. SERVIR conducts internal monitoring guided by a logical framework for tracking results, supports external assessments of progress and even works with its partner institutions in developing countries to develop their own M&E capacities.

In a multitude of contexts, the GEO community has prioritized engagement with developing countries and, toward that end, has widely recognized the need to engage international donor communities. For approximately the last 10 years, the international donor community has increasingly institutionalized M&E as common and necessary practice. At least one

interviewee suggested that GEO's ability to engage and partner with donor organizations will strengthen with a greater shift toward M&E programs to track results against identified baselines.

The following are results from the web-based survey regarding GEO capacity building (see Figure 6):

- 23% of respondents agreed that capacity building efforts to strengthen current users or create new users of Earth observations have been “Good” to “Very Good”.
- 28% of respondents agreed that the capacity building efforts of GEO to appropriately address the needs of developing countries have been “Good” to “Very Good”.
- 19% of respondents identified important gaps in GEO's capacity building efforts, while the majority (53%) was “Unsure” if such gaps exist.

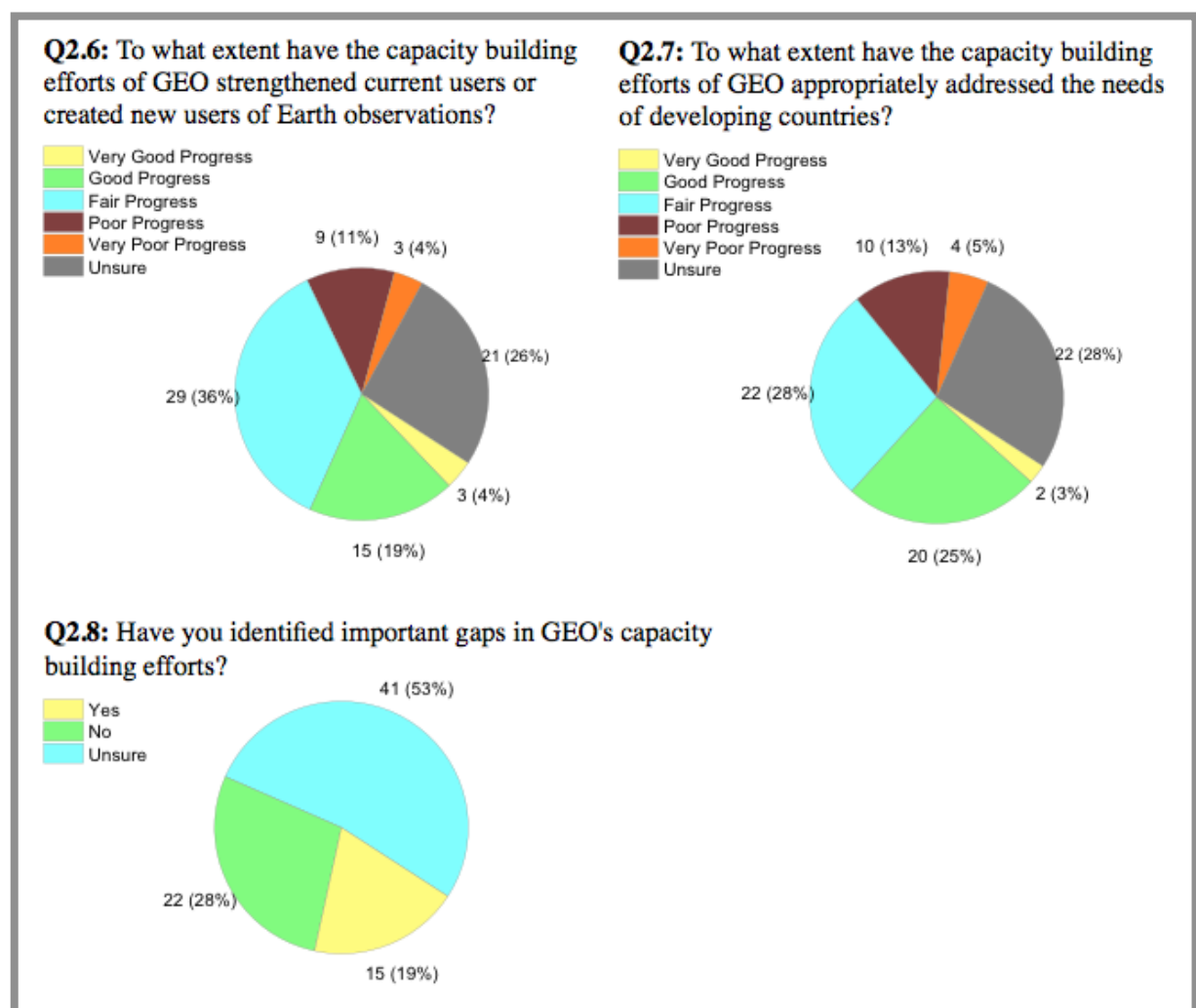


Figure 6. Survey responses to related to Capacity Building.

4.3.3 Synthesis

Asia Pacific GEO, AfriGEOSS and GEOSS for the Americas are direct results of GEO and are now vehicles for reaching developing countries. Despite connections being made, developing countries significantly lack both access to data, particularly *in situ* data, and the capacity to use it. Interviewees highlighted the need for solutions to overcome these challenges, in particular through strengthened engagement of developing-country Member States within the GEO governance structure to both address the need for more diverse funding mechanisms and enhance regional cooperation in the developing regions. Although GEO has made significant progress in capacity building for individuals through workshops and trainings, evidence suggests that GEO needs to place greater effort in institutional and infrastructure capacity building during its next decade of implementation, as well as to implement tools to track and monitor progress in capacity building.

Key Finding # 11: GEO has made well-recognized efforts to establish capacity building initiatives; however, the long-term impacts have not been monitored.

4.4 Science and Technology

“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.”

– *GEOSS 10-Year Implementation Plan*

“Ensure full interaction and engagement of relevant science and technology communities such that GEOSS advances through integration of innovations in Earth observation science and technology, enabling the research community to fully benefit from GEOSS accomplishments.”

– *GEOSS Strategic Targets*

For the purpose of this evaluation, the S&T communities are defined as the research community. It should be noted that the ET did not focus heavily on S&T through our interviews and survey. This section is focused on elements of the research community’s engagement in GEO and their derived benefits from GEOSS accomplishments that are not covered elsewhere in this report, particularly in Sections 4.1 and 4.2.

4.4.1 Key Findings from Previous Evaluations

- 2.3 Although the implementation of the GCI provides a standard infrastructure and platform, there is not a uniform, consistent way that data are registered, stored and accessed.
- 2.4 Lack of Systems Engineering rigor.
- 2.5 Technology employed by GEOSS is not current.
- 2.10 Commercial and intellectual property rights are perceived as a barrier to publishing data in GEOSS.

4.4.2 Evidence from the Current Evaluation

Surveys confirmed that Science and/or Research (56%) best characterize the category of people involved within GEO strategic areas, with Information Technologies second (20%), and that Academic and Research institutions dominate participation in GEO strategic areas (43%; see Figure 7). Despite this, there was no clear message regarding the usefulness of GEOSS to the scientific and/or information technologies community. Although previous

evaluations showed that there was good participation by the research community in the earlier phases of GEO, some interviewees indicated that the enthusiasm no longer exists. Data is now available or accessible through GEOSS, but not at the appropriate quality or resolution to drive technological research and technology development. For part of the scientific community, the benefits of freely sharing their high resolution and/or real-time data are not yet clear.

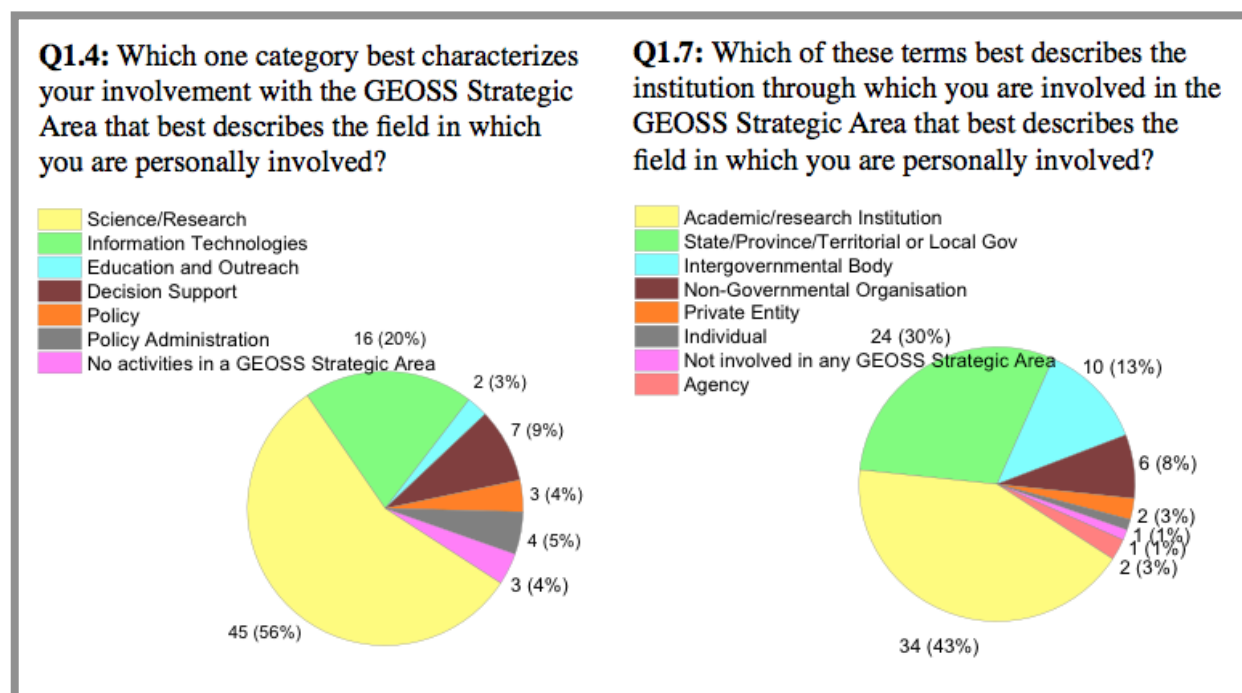


Figure 7. Application area and affiliation of survey respondents.

A number of interviewees expressed that post-2015 research work in GEOSS should build on existing science community initiatives, including the established CoPs that are already producing and making data available in a well-organized manner.

Input from the EC and Japan indicates that political support to GEO has enabled part of the research community to receive support from funding agencies and facilitated the appropriate governmental connections. For example, the EC-funded research programme Horizon 2020 may serve as an example of how science and technology within GEO may be developed further. Horizon 2020 aims to ensure the delivery of the long-term data and information required to address the GEO-identified societal challenges and the implementation of GEOSS. Activities focus on the capabilities, technologies and data infrastructures necessary for Earth observations and monitoring to continuously provide timely and accurate information, forecasts and projections. Horizon 2020 provides support to enhance the structure of EU research and innovation activities that are related to Earth observations, including addressing gaps in data and capabilities. Free, open and unrestricted access to interoperable data and information is encouraged and supported via Horizon 2020.

Horizon 2020 addresses:

- The need for Earth observation data on a global scale, necessary to underpin the research and innovation activities under the societal challenges of climate, environment protection, resource efficiency and raw materials;
- EU's commitment at the international level to contribute to GEO datasets and, in particular, to implement GEOSS, including through the Copernicus Programme and other GEO-relevant initiatives; and
- The need to increase engagement towards the delivery of new systems that can create business opportunities; the domain of Earth observations is strongly linked to new technologies and making full and open access to Earth observation datasets will support the creation of new services.

Regarding S&T, major concerns from the research community include the following:

- There are weak links between GEO strategic areas and Science and Technology.
- There is a lack of service orientation and involvement of the private sector, for example, to establish agreements with private high-resolution data providers.
- Decision makers can access data via GEOSS, but they are still waiting for derived information and knowledge products. In most cases, the value-added information derived from data is the critical requirement for users, and not the data itself.
- There is a mismatch between the requirements of researchers and the data supplied by the GEOSS Portal, as researchers usually require data of high resolution and frequency. Furthermore, key applications for Science and Technology require data in real time or near real time—conditions that are not often met by the data available through the GEOSS Portal.

4.4.3 Synthesis

The research and S&T communities best characterize the category of those involved in GEO, yet there remains uncertainty regarding progress toward ensuring the relevance of GEOSS to scientific and/or information technology communities, or toward developing information for users. There remains significant potential for research funding agencies to support GEOSS-associated initiatives (e.g., Horizon 2020) so that the research and S&T communities can continue progress toward transforming GEOSS data into information for specific users. S&T also has a clear role to play in capitalizing on the data that is now available or accessible by improving quality and resolution to meet the requirements of technological research and technology development.

5. Communication and Visibility

“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.”

– *GEOSS 10-Year Implementation Plan*

5.1 Key Findings from Previous Evaluations

- 1.7 GEO has not adequately communicated evidence of progress to show value-added results unique to the implementation of GEOSS and to unequivocally prove a positive return on investment.
- 1.14 The GEOSS implementation approach does not explicitly describe an end-to-end process of how the application of resources supports the overall vision and goals of GEOSS, how or why benefits are expected, or when benefits will be achieved. Without this, it may be difficult for stakeholders to make well-informed decisions about supporting GEOSS.
- 2.9 The capabilities of GEOSS are not well communicated to the global community.
- 3.1 The recognition of GEO work by international entities like the G20 for the Agriculture SBA and the UN Convention of Biological Diversity for the Biodiversity SBA and the establishment of cooperative initiatives are major accomplishments, strategically as well as with respect to cooperation and data sharing.
- 5.6 There are unclear interfaces between GEO and intergovernmental and national organizations.

5.2 Evidence from Current Evaluation

Since the beginning of GEO, communicating the value of EO, which is to a large degree the very definition of GEO outreach, has been considered an essential part of user engagement. Yet despite GEO success in asserting itself as a global leader, it is widely recognized that GEO has not adequately communicated its role and value to potential users of EO and, therefore, is not fully aware of the full range of potential users. The interviews repeatedly highlighted that GEO’s communication strategy needs clear and powerful examples of how EO have been used in decision-making across the SBAs. Furthermore, several interviewees stressed that GEO needs good examples of EO being used by everyday, non-expert users. Toward this aim, one specific interviewee noted that GEO should promote the seamless integration of EO into information products such that users may not even know that EO’s are

being used. More specifically, there is need for GEO to more clearly and thoroughly communicate its mandate and value to international development-focused organizations (e.g., USAID, The World Bank, UK Department for International Development and other international development agencies) in order to link GEO Tasks with international development funds so that GEO can be a well-supported technical partner.

A couple of interviewees indicated that the visibility of GEO has been undervalued in part because the GEO Executive Committee has not embraced an engagement strategy. The result is that “*GEO doesn’t know what it wants to be*”. It was suggested that the lack of decisive action regarding an engagement strategy is why there was previously no strategy for involving the private sector.

Some interviewees indicated that the international role of GEOSS is to serve as the leading global facility for EO data and information, but despite continued progress, GEO must continue to strengthen efforts to fulfill this role. GEOSS is often viewed (or on its way to be seen) as a brand label for EO. This is, in part, due to GEO’s website, maintained visibility and presence at conferences and meetings of the EO community, and word-of-mouth communication (see Survey Question 2.23 in Annex B). Some respondents observed that institutions that were once critical of GEOSS are now hosting conversations with GEO. Collaboration between the European Commission and GEO was offered as an example of high-level success. On the contrary, other interviewees see very limited awareness and communication about GEOSS at the international level, which has resulted in inadequate collaboration with international organizations.

Interviewees specifically discussed the visibility of GEO in the context of collaboration with the UN or other organizations with global mandates. According to the Implementation Plan, “*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,*” and the functions of GEO include “*consulting, coordinating, and liaising with relevant UN Specialized Agencies and Programmes, and international scientific organizations.*” For example, GOOS and GCOS were identified as global observing systems where cooperation with GEO is lacking.

Mixed feedback, as was found in previous evaluations, indicates the controversial debate around the potential benefits of GEO becoming more closely linked to the UN. While highlighting the importance of this topic, interviewees mentioned that some related UN initiatives have been launched independent of GEO (e.g., UN Data Revolution and UN Geospatial Information Management). Although some of the GEO global initiatives show linkages to other international initiatives, GEOSS has not always taken advantage of such initiatives, or the initiatives have not involved or recognized GEO. Interviewees suggest several possible reasons for limited recognition and collaboration, including: (1) GEO’s lack of independent legal status; (2) insufficient understanding by potential partners of how GEO can add value to their operations; and (3) GEO’s lack of clear messaging and professional communication regarding the services that it can offer to the UN and other international initiatives in a noncompetitive environment. Despite difficulties and the mentioning of specific cases where there may be conflict (e.g., World Meteorological Organization), the overall conclusion was that it should be possible to identify common targets and complementary focus areas in order to build strategic bridges with the relevant organizations.

In all cases, either regarding internal or external GEO collaboration, global relationships were identified as crucial, despite the identified challenges (e.g., language barriers to engagement with developing countries).

The need for improved GEO communication was not limited to external communication; several interviewees highlighted a need to improve internal communication. Within the GEO community, there is a clearer understanding of GEO's mandate at the Task Lead level, but much less so at the lower working levels within projects. According to the survey (see Question 2.21), the majority opinion is that GEO has had only fair progress communicating its role and mandate to GEO participants and/or users of EO.

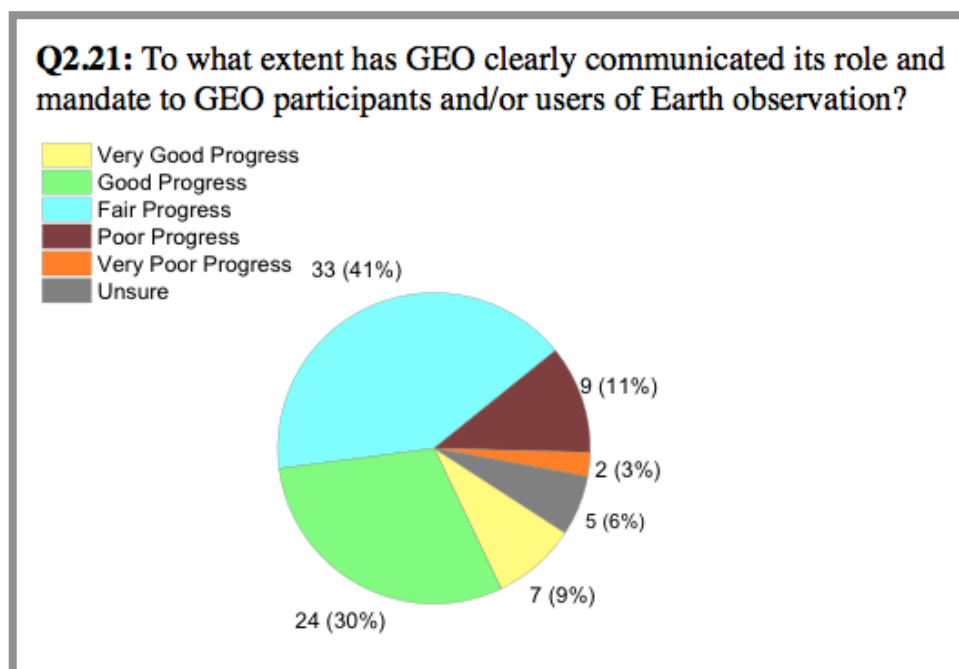


Figure 8. Survey responses related to GEO's communication of its role and mandate.

5.3 Synthesis

GEO has made broadly recognized success in asserting itself as a global leader in EO, but has not adequately communicated its role and value across the full breadth of potential users and strategic partners. A primary reason for GEO's limited collaboration with strategic global partners is GEO's lack of clear messaging and professional communication, which has resulted in an insufficient understanding by potential partners of how GEO can add value to their operations. A GEO communication strategy that includes clear and powerful examples of how EO can inform decision-making would help to build stronger collaboration with under-engaged partners, such as UN institutions, global Earth observing organizations and international development-focused organizations. There is general consensus from within the GEO community that it should be possible for GEO to make significant progress post-2015 toward engaging new partners as the new implementation strategy is undertaken. There was less consensus around whether this will require GEO obtaining legal status.

Key Finding # 12: GEO has made significant progress in establishing itself as a global reference in the domain of Earth observations, but has not adequately communicated its role and value to potential users of Earth observations and, therefore, has not capitalized on the breadth of potential users.

Key Finding # 13: GEO has not yet realized its full potential to establish formal collaborations with global organizations (e.g., UN institutions) or regional and global observation systems (e.g., GCOS or GOOS). Such partnerships, which are reliant on identifying complementary goals, are broadly recognized as critical to GEO's future success.

6. Organizational Structure and Resources

Regarding resources:

“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.”

– *GEOSS 10-Year Implementation Plan*

6.1 Key Findings from Previous Evaluations

- 1.10 Stakeholders are concerned about the sustainability of GEOSS with regard to: (a) the voluntary nature of GEOSS implementation, which has been beneficial up to this point for engaging partners; and (b) the lack of sufficient resources, both financial and human, to sustain efforts into the future.
- 3.11 Limited funding and availability of dedicated staff is an obstacle to full implementation of the ambitious targets and outcomes.
- 3.16 While some policy barriers exist, most barriers are related to funding to support GEO activities, including travel.
- 3.17 Communities of Practice and associated workshops have been effective ways of bringing together practitioners and stakeholders to establish communication, consensus and take advantage of emerging initiatives from international institutions. Communities of Practice that emerged through GEO have been able to establish more outcome-oriented initiatives, such as GEO BON and GEOGLAM.
- 3.18 Roles and responsibilities within a GEO as a voluntary organization are unclear to many participants.

6.2 Evidence from Current Evaluation

6.2.1 Organizational Structure

Regarding the management structure of GEO, interviewees were asked whether the current organizational structure is considered optimal. Discussion was mainly driven by the different existing approaches adopted in GEO, namely SBAs and larger initiatives.

In general, interviewees positively commented on GEO’s structure in terms of SBAs. From the survey, 73% of respondents reported “Fair” to “Very Good” progress in terms of how the SBA structure benefitted implementation (see Survey question 3.12). In most cases, the lack of constant funding has been pointed out as a main drawback for the SBA structure to fully achieve targets. Several weaknesses and approaches for improvement were suggested, including:

- A more flexible and "light" coordination structure capable of mobilizing resources;
- A better definition of SBAs (some based on a body of knowledge and others on applications);
- Inclusion of more SBAs that reflect societal sectors and applications, but not too much dilution since they should still adequately represent the different science networks within GEO;
- A more interdisciplinary and cross-SBA approach; and
- Better articulation of specific Targets and the means to achieve them.

The interviews show that the operation of the Boards was generally not considered entirely successful. The main drawbacks highlighted included minimum visibility, low representation of Tasks, an absence of power to make decisions, misrepresentation of users and "outsiders", and a lack of verification mechanisms to both filter out inactive participants and monitor implementation. There was a specific recommendation that the previous Committee-based structure could probably create more enthusiasm than the present Board-based structure. Regarding capacity building, it was mentioned by one interviewee that when the Committees transitioned into Boards, coordination became more difficult given the restricted membership of the Boards. Under the Committee structure, anyone with an interest could join a particular committee.

The survey respondents had a more positive view of the Boards than the interviewees. 43% indicated that the Boards' progress toward fulfilling their purposes was "Good", with the rest indicating "Fair", "Poor" or "Unsure" progress (see Figure 9).

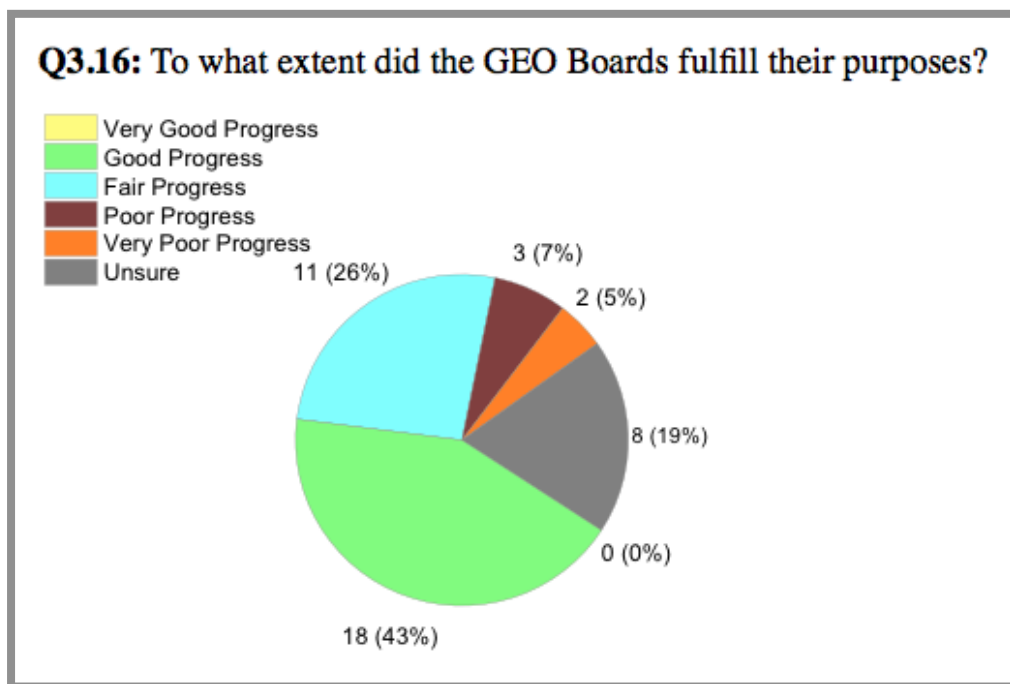


Figure 9. Survey responses related to the GEO Boards.

A number of interviewees stated that "*the voluntary nature of GEO has been a headache*", though, at the same time, they recognize that this is one of GEO's main assets. It was widely accepted that individuals within GEO really matter and can make a difference through their enthusiasm and commitment. In cases where Boards or Committees are comprised purely of

scientists, user benefits are not always easy to discern. Some interviewees expressed a need for GEO to identify more leaders possessing a vision and interested in assuming responsibilities. At the same time, there should be a controlling mechanism to check that contributors deliver when they make commitments. In this context, one interviewee characteristically stated: *"If there is no control, why do we need all the formality, for example, the approval by ExCom?"*

In regards to CoPs, the overall perception was that some worked quite well, while others were not very active. In the successful cases, like the Biodiversity and Water CoPs, there has been a tradition and history of members working together to help them succeed. There were also diverse opinions about whether CoPs are clear about whom they serve. One interviewee suggested that reorganization into market sectors could be more efficient. Another indicated that CoPs, similar to other structures within GEO, are too heavy with scientists (i.e., too academic) and have a difficult time convincing users to join. It was felt that there is a need for a new generation of CoPs with diverse membership that are more active and explicit regarding their purpose and whom they serve. Overall, the conclusion was that, even though CoPs were not always very active and some changed into Task teams, they may provide the best avenue for user engagement and enhancing cross-SBA activities. In the survey, 55% of respondents indicated that CoPs contributed to GEO's success, while the rest were "Unsure". No respondent said that CoPs hindered success (see Figure 10).

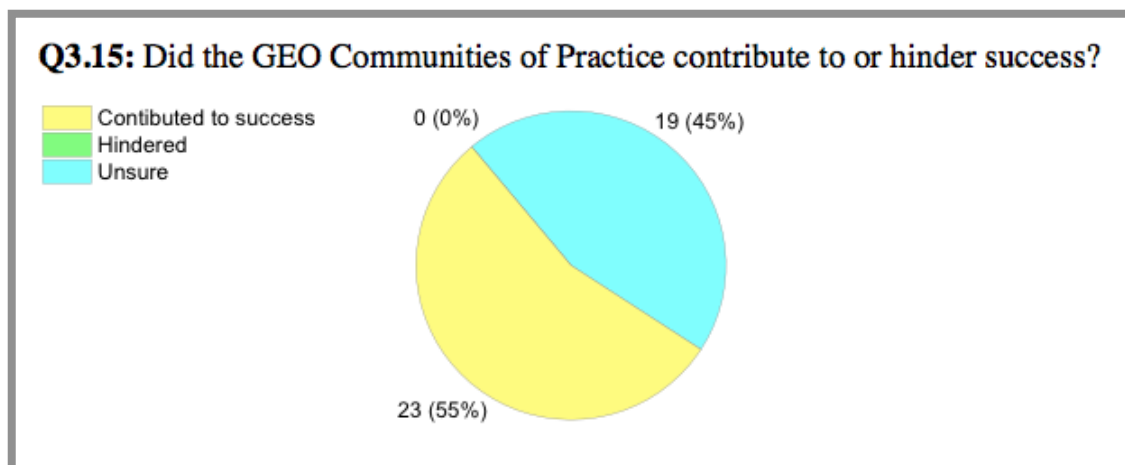


Figure 10. Survey responses on whether CoPs contributed to or hindered success.

In the interviews, the Water SBA was often referred to as one SBA that has showed good progress. Some interviewees indicated that this has mainly been due to the efforts of the Chair of the Water CoP. In comparison, one interviewee pointed out that the Energy CoP lost momentum when their Chair stepped down, supporting the idea from the Water SBA that a champion (with the some funding support) is needed to drive the SBA and its components.

Interviewees also expressed opinions on the present organization of GEO and the ability to set priorities. Some examples are:

1. Too much is being added to the Work Plans without sufficient resources or commitments.

2. GEO should refuse un-solicited proposals if they do not fit well within the Work Plan or cannot document sufficient resources.
3. A better combination of bottom-up and top-down processes, in which the former should dominate, would be of great benefit.
4. Clear, higher-level mandates should be passed to all levels, especially to the Task level.
5. The voluntary basis of GEO necessitates better planning, accountability for commitments and greater efforts to build coalitions based on common interests.

The lack of prioritization and a clear prioritization process is also identified as a weakness of GEO. According to the Implementation Plan, “*setting and addressing priorities for filling gaps*” is a function of GEO. In this context, better clarification of the roles of the GEO Secretariat, the Executive Committee and the Plenary were highlighted. While GEO’s current lack of prioritization may be the result of intentional political decisions aimed at striking the right balance between prioritization and the necessary diversity within an initiative that involves nearly 100 countries, several interviewees indicated that a clear prioritization process should at least exist. Among the opinions expressed, it was stated that the GEO Secretariat should be empowered to collect and compile priorities from the science communities, and then to pass final decision-making to the Executive Committee. Alternatively, it was suggested that the GEO Plenary needs to be more focused on making decisions and deciding on priorities. Another major point raised by interviewees was related to the need to decrease the bureaucratic development of the GEO/GEOSS organization.

6.2.2 Resources

GEO Members and Participating Organizations voluntarily contribute resources from their respective Earth monitoring systems to GEOSS and interlink them to enhance their performance. However, the voluntary nature of GEO may lead members to perceive their offered contributions as not necessarily true commitments. There is a recurrent lack of resources for the implementation of GEOSS and an uneven commitment from GEO Members, which has consequences for both the expertise and financial resources that are essential for GEO to reach its Strategic Targets. One example of uneven commitments is the GEOSS information systems where most of the investment comes only from Europe and the US. GEO’s lack of human resources in many Tasks highlights a perceived need for greater prioritization of work within GEO; yet there is no clear strategy for prioritizing or an understanding of who would be responsible for setting priorities.

6.3 Synthesis

The present SBA structure of GEO worked reasonably well during 2005–2015 and, to a large extent, served its purpose. Successful SBAs had strong and engaged CoPs. However, overall, few CoPs have persisted. A particular concern is the lack of an ability and process to prioritize activities, for example, through a stronger top-down process. The lack of human resources in the Tasks was, as reported in previous evaluations, identified as a hindrance to success.

Key Finding # 14: The GEO Societal Benefit Area (SBA) structure, which covered a broad range of societal challenges, has worked well to establish the GEO community. There is, however, a wish from throughout the GEO community to review and redefine the SBAs in the future to better align with targeted user groups.

Key Finding # 15: The GEO Communities of Practice (e.g., for Water) provided an efficient avenue for user engagement and a means to enhance cross-SBA activities.

Key Finding # 16: There is a recurrent shortage of resources, and irregular and uneven follow-up of commitments, for the tasks necessary to implement GEOSS.

7. Key Findings and Recommendations for Post-2015

Based upon analysis of the collected information and careful deliberation by the ET, this Sixth Evaluation has resulted in 16 Key Findings, 1 Lesson Learned and 11 Recommendations.

7.1 Key Findings and Lesson Learned

The Evaluation's key findings are as follows:

Key Finding # 1: GEO's added-value to the Earth observation community of providing a common, flexible framework for international collaboration is widely recognized as a principal success.

Key Finding # 2: Insufficient strategic guidance and clarity within the GEO steering documents, the Strategic Targets document and the GEO Work Plan have led to insufficient implementation of the Work Plan and only fair achievement of Strategic Targets.

Key Finding # 3: Cooperation across SBAs has been strengthened within the GEO community, but a lack of coordination has hampered full exploitation of the potential of GEOSS.

Key Finding # 4: Insufficient mechanisms to engage the global *in situ* data community have contributed to significant, enduring observational gaps within GEOSS.

Key Finding # 5: GEO lacks a clear process for identifying priorities, which limits the broader community's ability to strategically organize and leverage contributions to GEOSS.

Key Finding # 6: The GEO Global Initiatives are widely considered significant contributors to GEO's success, even though they were not initially included in the 10-Year Implementation Plan.

Key Finding # 7: The creation and advocacy of open data sharing principles for Earth observations are major accomplishments of GEO, but the open data approach has yet to be established and implemented in a number of countries in different regions.

Key Finding # 8: The GEOSS Common Infrastructure (GCI) has greatly advanced Earth observation data interoperability; however, user expectations regarding data discoverability, access and quality assurance have not been met.

Key Finding # 9: GEO has not fully achieved a "user-driven GEOSS" because users have not been adequately incorporated into the entire observation-to-information value cycle. The current user landscape includes: (1) the science community as the main user;

(2) governmental/international organizations and (3) the non-profit private sector as moderate users; (4) the commercial sector as marginal users; and (5) laymen/citizens as non-users.

Key Finding # 10: GEO's engagement of the private sector is stronger than generally recognized, as evident by the robust participation of non-profit entities and participation of a limited number of commercial sector entities. Strengthened, strategic engagement of the private sector is nonetheless recognized as a promising, and often necessary, avenue for GEO to pursue in the future.

Key Finding # 11: GEO has made well-recognized efforts to establish capacity building initiatives; however, the long-term impacts have not been monitored.

Key Finding # 12: GEO has made significant progress in establishing itself as a global reference in the domain of Earth observations, but has not adequately communicated its role and value to potential users of Earth observations and, therefore, has not capitalized on the breadth of potential users.

Key Finding # 13: GEO has not yet realized its full potential to establish formal collaborations with global organizations (e.g., UN institutions) or regional and global observation systems (e.g., GCOS or GOOS). Such partnerships, which are reliant on identifying complementary goals, are broadly recognized as critical to GEO's future success.

Key Finding # 14: The GEO Societal Benefit Area (SBA) structure, which covered a broad range of societal challenges, has worked well to establish the GEO community. There is, however, a wish from throughout the GEO community to review and redefine the SBAs in the future to better align with targeted user groups.

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Key Finding # 16: There is a recurrent shortage of resources, and irregular and uneven follow-up of commitments, for the tasks necessary to implement GEOSS.

In addition, the Evaluation Team identified the following Lesson Learned:

Lesson Learned: The GEOSS Evaluation process has been largely effective in generating responses from the GEO Executive Committee (98% of past recommendations received responses); however, the added-value from the process of reporting back to the broader GEO community has yet to be comprehensively assessed.

This is based on: (1) a review of how recommendations from previous evaluations have been received and responded to; (2) discussion with the M&E Working Group; and (3) the experiences of the current Evaluation Team Co-Chair (Ingolf Eide), who has co-chaired or served as a team member on all previous evaluation teams. Annex D summarizes the results and the follow-up from previous recommendations.

7.2 Recommendations

The Key Findings provided the majority basis for developing the Evaluation's Recommendations, which are provided in Table 1. These Recommendations were deliberated at an in-person meeting of the ET in May 2015 in Athens, Greece, where the M&E WG was present to offer guidance. The primary audiences for these recommendations, as well as for the entirety of this report, are the GEO Executive Committee, the IPWG, the GEO Plenary and the Ministers of GEO Member States. The ET intends for these recommendations to inform the decisions to be made at the November 2015 GEO Ministerial Summit in Mexico City, and therefore, ultimately inform future plans for the implementation of GEO and GEOSS during the 2016-2025 period and beyond.

Table 1. Recommendations with links to supporting findings and relevant sections of the report

Recommendation	Comments	Relevant Key Findings	Relevant Report Sections
#1: GEO should define GEOSS users, restructure SBAs to better reflect user domains, and communicate to users the benefits of GEOSS through specific use-cases.	There are many different opinions of who GEO's users are. More user-oriented SBAs and CoPs would remedy this problem. Development of specific cases that illustrate to users the value of GEO and GEOSS are needed. Successful SBAs and CoPs appear to have dedicated champions and sufficient funding.	9 14 15	4.2 User Engagement 6. Organizational Structure and Resources
#2: GEO should revitalize the Communities of Practice (CoPs) and ensure that they have strong and engaged leadership and funding.	There is a need for a new generation of CoPs (e.g., organized by market sectors) with diverse memberships that are more active and explicit regarding their purpose and whom they serve. CoPs provide a good avenue for broader user engagement.	14 15 16	6. Organizational Structure and Resources

#3: GEO should develop a strategy for GEOSS 2016–2025 with more measureable targets, performance indicators, and strengthened and straightforward implementation mechanisms.	• The strategy should enable priority-setting using a more top-down approach and allow voluntary contributions to fit within a strategic framework, while still encouraging participants’ creativity, innovation or ability to seize new opportunities through GEO (i.e., a bottom-up approach). The vision/purpose should be user-focused and show benefits to users.	• 2 • 3 • 4 • 5	• 3. SBAs: Implementation and Strategic Targets
#4: GEO should capitalize on its success of developing and promoting data sharing principles by engaging political decision makers and potential users of GEOSS in the regions that lag behind in adopting the principles.	• Some governments are reluctant to release data. It may be necessary to work directly at the political level to convince decision-makers of the importance and mutual benefits of an open data policy, particularly for developing countries. Europe may serve as a good example.	• 7	• 4.1.2 – subsection on Data Sharing
#5: Access to the GEOSS Common Infrastructure (GCI) should be more user-friendly, and data discovery and accessibility should be improved, using successful AIPs as models.	• Successful SBA-specific portals developed in AIPs for Water and Energy may serve as models for improved access to the GCI. Development of a portal by the private sector was mentioned as an alternative. The GCI and the role of its components must be communicated better to the GEO community.	• 8	• 4.1.2 – subsection on Data Availability, Data Access and Interoperability • 4.1.2 – subsection on AIPs • C.3 (case study)
#6: GEO should develop a procedure for data quality control and quality assurance (e.g., by disseminating best practices) and promoting standards with potential data providers.	• Quality assurance of data is left to the data provider, thus, there is no guarantee that this is performed consistently, or at all, within GEOSS.	• 8	• 4.1.2 – subsection on Data Availability, Data Access and Interoperability

#7: GEO should develop and implement a communication and outreach strategy to fully advance user engagement and collaboration with international and donor institutions.	• The visibility of GEO has been undervalued in part because GEO has not embraced an engagement strategy. The result is that “<i>GEO doesn’t know what it wants to be</i>”. GEO should more clearly and thoroughly communicate its mandate and value to international development-focused organizations. The need for improved GEO communication is not limited to external communication; there is a need for improved internal communication as well.	• 12 • 13	• 5. Communication and Visibility
#8: GEO should use the global initiatives to build strategic bridges to UN-related organizations by identifying common targets and complementary areas for collaboration.	• There may be several reasons for limited recognition and collaboration, including: (1) GEO’s lack of legal status; (2) insufficient understanding by potential partners of how GEO can add value to their operations; and (3) GEO’s lack of clear messaging and professional communication regarding the services that it can offer to the UN and other international initiatives in a noncompetitive environment.	• 6 • 12 • 13	• 3.3 Global Initiatives • 5. Communication and Visibility
#9: GEO should improve capacity building through comprehensively assessing regional capacity building needs, implementing monitoring and evaluation frameworks to systematically assess long-term results, and leveraging funding from international donors (e.g., for data infrastructure) to complement contributions from EO data providers.	• GEOSS is perceived to have contributed to capacity building in developing countries through mobilizing the research community, but progress in capacity building has been difficult to measure. Stronger focus is needed on sustaining the involvement of key institutions and individuals from receiving countries in GEOSS activities, and less on short-term workshops.	• 11	• 4.3 Capacity Building

#10: GEO should identify a high-level task force with very strong representation from existing <i>in situ</i> Earth observation communities (e.g., similar to CEOS for satellite data) to make recommendations on how to incorporate the <i>in situ</i> community and its data into GEOSS.	• <i>In situ</i> observations have not been prioritized relative to satellite observations. Reference was made to the importance of <i>in situ</i> observations in IGOS-P, and that GEO can learn from its approach to engage the relevant <i>in situ</i> communities.	• 4 • 5	• 3.4 Gaps
#11: GEO should establish a mechanism to ensure that task and project-related commitments have sufficient resources to be completed as expected.	• It appears that some contributors do not feel obligated to fulfill their commitments within GEO's voluntary framework. This leads to uneven implementation of Tasks and of Target achievements.	• 16	• 6. Organizational Structure and Resources

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Annex A: Key Informant Interviews

An interview protocol was developed with input from the GEO M&E WG. Interviews were conducted with a sample of members from GEO Communities of Practice (CoPs), leads for GEO Tasks, non-lead participants in GEO Tasks and members of user communities. The interviews were analyzed for the qualitative identification of issues and themes, rather than as the basis for statistical inference.

The interview topics and questions are included in Annex A.2. All interviewees received the questionnaire in advance of the interview being conducted.

A compiled version of notes from the 57 interviews can be found at the following FTP site: ftp://ftp.earthobservations.org/GEOSS_Summative_Evaluation/

A.1 Interviewees by Region

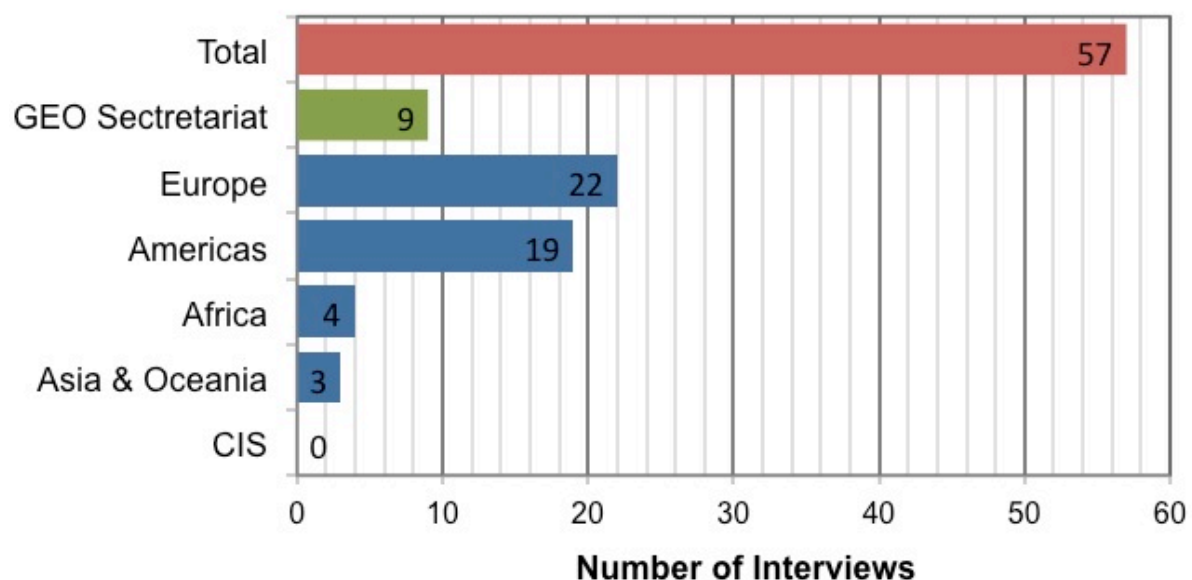


Figure A1. Number of persons interviewed sorted by region and whether they were from the GEO Secretariat.

A.2 Interview Guide

GEOSS SIXTH EVALUATION INTERVIEW GUIDE

An Evaluation Team has been tasked with conducting the sixth and final GEOSS evaluation. This evaluation will cover all aspects of the implementation of GEOSS since 2005 and will include interviews with key players in GEOSS, like you.

You will find below a list of topics of interest to the evaluation. Your input is crucial to this evaluation, but some of these topics might not be relevant to your situation, so please feel free to skip those during the interview.

Any information you provide will remain anonymous and none of your responses will be associated with you in our evaluation report.

The final evaluation report will be presented to the GEO Executive Committee and then to GEO Plenary.

Your contribution to this evaluation is very appreciated.

Topics and/or questions of interest to the Evaluation and examples of questions to be addressed during the interview

- Personal situation
 - How long have you been part of / engaged in the GEO / GEOSS implementation?
 - What has been your role in the implementation of GEOSS (e.g. task point of contact, task lead, task contributor, member of a board, etc.)?
 - What was your intention to take part at GEO / to engage in GEOSS?
 - How did you become engaged in the implementation of GEOSS (made the initiative yourself, recruited by someone else, other)?
 - What has been your feeling / impression about your engagement in GEO?: more positive – more negative (why?)
- To what extent has GEO demonstrated success during its first 10 years of implementing GEOSS?
 - Has GEO achieved its vision and purpose as defined in the 10-Year Implementation Plan and the Strategic Targets Document ¹¹?
 - To what extent have the Work Plans been completed?
 - Were all Strategic Target outcomes addressed by the Work Plans? If not, what was missing?
 - To what extent were the Strategic Target outcomes (“To be demonstrated by...” bullets) achieved?
 - To what extent did GEOSS provide added value in progress toward outcomes in SBA Tasks?
 - What did GEOSS do to add value? How effective was it?
 - To what extent would activities in the GEO Work Plans have occurred in the absence of GEO?
 - To what extent do participants in activities below the task component level see any benefit from participation in GEO/GEOSS? How are these participants connected to counterparts in other activities?

¹¹ The 10-Year Implementation Plan and the Strategic Targets Document can be found at https://www.earthobservations.org/docs_key.shtml

- Were there gaps in the way the Implementation Plan was implemented?
 - What were these gaps?
 - Why did these gaps occur?
 - How should these gaps be addressed in the next Implementation Plan?

- Has GEOSS effectively engaged users of EO?
 - Have the appropriate common standards or equivalent documents been developed and demonstrated?
 - To what extent has GEOSS engaged users in an adaptive manner by taking a value cycle approach?
 - What new users of EO, if any, has GEOSS created?
 - Which specific user or stakeholder groups have significantly benefited from GEOSS?
 - Which specific users or stakeholder groups have not benefitted from GEOSS but that have significant potential to benefit?
 - To what extent have users been involved in the planning and execution of the task/component (e.g. is there a (national) forum to gather stakeholder's ideas, needs, and suggestions about the execution of the task/component)?

- Has the GEOSS Portal made data available and accessible?
 - Can data be sufficiently found in the Portal?
 - Is the Portal user friendly?
 - Is the Portal preferred to other sources? Why or why not?

- To what extent did GEOSS add to capacity building?
 - Is capacity building being adequately addressed?
 - What has GEOSS done to increase capacity building?
 - i. How effective was it and what were the results of increased capacity building?
 - ii. To what extent has progress been made toward engaging and creating new users in developing countries?

- To what extent has GEOSS led to increased collaboration between relevant projects and programs within the GEOSS Building Blocks and SBAs? To what

extent has GEOSS built partnerships with relevant organizations, institutions, projects, or programs that were not direct contributors to the GEO Work Plans?

- How has any increased collaboration or outside partnerships led to reaching EO users on a wider scale?
- How has GEOSS enabled broader collaboration among diverse communities by establishing cross-SBA cooperation?
 - What outputs have emerged from these collaborations?
 - What examples are there of good working relationships between such related tasks?
- Which identifiable factors (organization, people, resources, relationships, etc.) have contributed to or hindered achievement of success toward the implementation of GEOSS?
 - Was the organizational structure of GEO optimal?
 - Did the defined SBAs contribute to or hinder success? To what extent would different definitions have improved cooperation between communities and user engagement?
 - To what extent would GEO benefit if more SBAs were organized in larger initiatives, similar to what has been done with GEO BON?
 - Did the Communities of Practice contribute to or hinder success? How could they be improved?
 - To what extent did the Boards fulfill their purposes?
 - To what extent are participants in activities below the task component level familiar with their contributions to GEO/GEOSS?
 - What do these participants do to spread awareness of GEOSS?
 - To what extent have these participants received useful communications (directly or via networks) from GEO/GEOSS?
 - To what extent has GEO articulated a clear role and mandate and to what extent do GEO participants and EO users understand this?
 - To what extent has GEO/GEOSS maintained visibility and articulated its mission by maintaining a presence at conferences and meetings of the earth observation community and by being acknowledged in scientific literature related to earth observations?
 - During the implementation of GEOSS, have any positive or negative lessons been learned, surprises encountered, or systemic issues identified?
 - What common or systemic issues related to GEO/GEOSS as identified in this or previous evaluations should be addressed in the next GEOSS Implementation?

Annex B: Web-Based Survey

B.1 Survey Questions



Summative Evaluation for GEOSS Implementation

July 2014- May 2015

SURVEY

Introduction and Instructions

This survey is part of the Sixth (Summative) Evaluation for the first 10 years of the Global Earth Observation System of Systems (GEOSS). The overall objective is to assess the extent of GEO's success in implementing GEOSS from 2005-2015. Results will be reported to the GEO Monitoring and Evaluation Working Group and later to the GEO Executive Committee and GEO Plenary. Contributions from members of the broader Earth observation community are essential to the success of this evaluation.

This survey has four parts:

- Part 1 - Background Information (Everyone must complete)
- Part 2 - Assessing GEO Success (Everyone must complete)
- Part 3 - Assessing GEO Success (GEO/GEOSS Participants Only)
- Part 4 - Assessing GEO Success (Expanded write-in questions; Open to everyone)

We estimate that this survey will take approximately 20-30 minutes to complete. Please do your best to answer all questions. All information you provide will remain anonymous. As needed, please refer to the summary of GEO's Strategic Targets and Outcomes in the appendix. Thank you for agreeing to complete this survey!

Questions or feedback may be directed to Evaluation Team co-chairs:

Lars Ingolf Eide (l-ingo-e@online.no) &
Matthew Druckenmiller (mdruckenmiller@usaid.gov).

Part 1 - Background Information

(Everyone must complete)

1.1 How familiar are you with GEO or GEOSS?

I have never heard of GEO/GEOSS	I am somewhat familiar	I know the basic structure and mission of GEO/GEOSS	I am familiar and have been active in the GEO/GEOSS community	I am very familiar as a result of deep involvement with GEO/GEOSS

1.2 What is or has been your primary involvement with GEO and/or GEOSS?

- ☐ GEO leadership and/or administration
(GEO Secretariat staff, country ministers, others above the Task Lead or Contributor levels)
- ☐ GEO/GEOSS Participant (Task Lead or Contributor)
- ☐ Provider of data or information to GEOSS [Skip Part 3]
- ☐ User of GEOSS data or information [Skip Part 3]
- ☐ I have no involvement. [Skip Part 3]

1.3 The list below represents the GEOSS Strategic Areas. Even if you are unfamiliar with GEO or GEOSS, please select the one Strategic Area that best describes the field in which you are personally involved? Please select only one. (Involvement could include, but is not limited to, such things as research, management, policy-making, education, etc.)

- ☐ Agriculture
- ☐ Biodiversity
- ☐ Climate
- ☐ Disasters
- ☐ Ecosystems
- ☐ Energy
- ☐ Health
- ☐ Water
- ☐ Weather
- ☐ Earth Observation Architecture
- ☐ Earth Observation Data Management
- ☐ Earth Observation Capacity Building
- ☐ Earth Observation Science and Technology
- ☐ Earth Observation User Engagement
- ☐ Other, please specify: _____
- ☐ I do not conduct any activities in a GEOSS Strategic Area.

1.4 Which one category best characterizes your involvement with the GEOSS Strategic Area you identified in Question 1.3? Please select only one.

- ☐ Science/Research
- ☐ Research Administration
- ☐ Policy
- ☐ Information Technologies
- ☐ Education and Outreach
- ☐ Decision Support
- ☐ Other, please specify: _____
- ☐ I do not conduct any activities in a GEOSS Strategic Area.

1.5 In which region are the primary beneficiaries of the activities you identified in Question 1.3? In other words, where do the people live who most benefit from your activities? Please select only one.

- ☐ Sub-Saharan Africa
- ☐ Middle East and North Africa
- ☐ Caucasus region, Russia and Central Asia
- ☐ East and Southeast Asia
- ☐ South Asia
- ☐ Australia/Oceania
- ☐ Europe
- ☐ North America
- ☐ South America
- ☐ The beneficiaries are global.
- ☐ Other, please specify: _____
- ☐ I do not conduct any activities in a GEOSS Strategic Area.

1.6 In which country (and/or region, if a regional institution) is the institution through which you are involved in the activities you identified in Question 1.3?

1.7 Which of these terms best describes the institution through which you are involved in the GEOSS Strategic Area you identified in Question 1.3? Please select only one.

- ☐ State / Province / Territorial or Local Government
- ☐ Private Entity
- ☐ Non-Governmental Organization
- ☐ National Government
- ☐ Intergovernmental Body
- ☐ Individual
- ☐ Academic Institution
- ☐ Other, please specify: _____
- ☐ I am not involved in any GEOSS Strategic Area

1.8 How are your current activities funded in the GEOSS Strategic Target Area you identified in Question 1.2? Please select only one.

- ☐ Entirely public funds
- ☐ Entirely private funds
- ☐ Mostly public funds
- ☐ Mostly private funds
- ☐ A mix of public and private
- ☐ Other, please specify: _____

1.9 For how long have you been involved with GEO and/or GEOSS?

- ☐ Since before 2005
- ☐ 6-10 years
- ☐ 3-5 years
- ☐ 1-2 years
- ☐ < 1 year
- ☐ I have no involvement.

1.10 What is your age? (Please skip if you prefer not to answer.)

- ☐ < 25 years
- ☐ 25-34
- ☐ 35-44
- ☐ 45-54
- ☐ 55-65
- ☐ > 65

Part 2 - Assessing GEO Success

(Everyone must complete)

2.1 In general, to what extent has GEO achieved its vision and purpose as defined in the 10-Year Implementation Plan and the Strategic Targets Document?

Very Poor Achievement	Poor Achievement	Fair Achievement	Good Achievement	Very Good Achievement	Unsure

2.2 To what extent has GEO or GEOSS benefitted the mission of your institution through which you are involved in GEO?

No Observable Benefit	Little Benefit	Moderate Benefit	Significant Benefit	Very Significant Benefit	Unsure / Not Applicable

2.3 Have you identified important gaps in the 2005-2015 Implementation Plan?

- ☐ Yes
☐ No
☐ Unsure

If yes, please identify these gaps, and if possible explain why

they occurred: _____

2.4 To what extent has GEOSS built partnerships with relevant organizations, institutions, projects, or programs that were not direct contributors to the GEO Work Plans?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

2.5 Have you participated in capacity building activities related to GEO/GEOSS?

- ☐ Yes
☐ No

If yes, describe the activity and the associated results:

2.6 To what extent have the capacity building efforts of GEO strengthened current users or created new users of Earth observations?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

2.7 To what extent have the capacity building efforts of GEO appropriately addressed the needs of developing countries?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

2.8 Have you identified important gaps in GEO's capacity building efforts?

- ☐ Yes
☐ No
☐ Unsure

If yes, please identify these gaps, and if possible explain why they occurred:

2.9 To what extent has GEO/GEOSS engaged users to ensure that their information needs are appropriately met?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

2.10 To what extent is GEOSS user-driven, such that user needs and feedback influence how Earth observations are collected and/or disseminated?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

2.11 Have you identified specific user or stakeholder groups that have significantly benefited from GEOSS?

- ☐ Yes
- ☐ No
- ☐ Unsure

If yes, please identify these groups:

2.12 Have you identified specific users or stakeholder groups that have not benefitted from GEOSS but that have significant potential to benefit?

- ☐ Yes
- ☐ No
- ☐ Unsure

If yes, please identify these groups:

2.13 How often have you used the GEOSS Portal and what is your level of familiarity?

I have never used or visited the Portal.	I have visited the Portal at least once but rarely use it.	I am moderately familiar with the Portal and have used it on several occasions.	I am quite familiar and have used the Portal many times.	I am very familiar and use the Portal on a regular basis.

2.14 To what extent has the GEOSS Portal created more users of Earth observations?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

2.15 To what extent has the GEOSS Portal made Earth observation data more available and/or accessible?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

2.16 To what extent are you satisfied with how easily and efficiently data can be found using the GEOSS Portal?

Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied	Unsure

2.17 How comprehensive is the data collection that is accessible through the GEOSS Portal?

Very Poor	Poor	Fair	Good	Very Good	Unsure

2.18 Please identify the GEOSS Strategic Area that corresponds to the type of data you typically access online, either using the GEOSS Portal or other type of portal.

- ☐ Agriculture
- ☐ Biodiversity
- ☐ Climate
- ☐ Disasters
- ☐ Ecosystems
- ☐ Energy
- ☐ Health
- ☐ Water
- ☐ Weather
- ☐ Weather
- ☐ Other, please specify: _____

2.19 Is the GEOSS Portal your preferred means for accessing Earth observation data?

- ☐ Yes
- ☐ No

If no, please identify your preferred portal and the reason why it is preferred over the GEOSS Portal:

2.20 How could the GEOSS Portal be improved?

2.21 To what extent has GEO clearly communicated its role and mandate to GEO participants and/or users of Earth observation?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

2.22 To what extent has GEO/GEOSS achieved and maintained visibility within the Earth observation community?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

2.23 Please rate the following based on the importance of their contributions to the visibility of GEO/GEOSS?

GEO website

Very Little	Little	Fair	Much	Very Much	Unsure

GEO brochures or reports

Very Little	Little	Fair	Much	Very Much	Unsure

GEO participation at conferences, workshop, or meetings

Very Little	Little	Fair	Much	Very Much	Unsure

Grey literature

Very Little	Little	Fair	Much	Very Much	Unsure

Peer-reviewed literature

Very Little	Little	Fair	Much	Very Much	Unsure

Word of mouth (person to person) communication

Very Little	Little	Fair	Much	Very Much	Unsure

Part 3 - Assessing GEO Success (GEO/GEOSS Participants Only)

3.1 What Strategic Target is associated with the task/component you are involved in? Please refer to the Appendix for a list of Strategic Targets.

3.2 To what extent have the Work Plans been completed?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

3.3 Were all Strategic Target outcomes addressed by the Work Plans?

- ☐ Yes
☐ No
☐ Unsure

If no, what was missing? _____

3.4 To what extent have the Strategic Targets been achieved for the task/component you are involved in?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

3.5 Did GEO/GEOSS provide added value in progress toward outcomes in Societal Benefit Area (SBA) Tasks?

- ☐ Yes
☐ No
☐ Unsure

If yes, please identify the added value, and if possible explain how GEO/GEOSS was effective:

If no, why not?

3.6 How likely is it that activities in the GEO Work Plans would have occurred in the absence of GEO/GEOSS?

Very Unlikely	Unlikely	Neutral	Likely	Very Likely	Unsure

3.7 How likely are participants in GEO activities, who are not task or component leads, to be familiar with their contributions to GEO/GEOSS?

Very Unlikely	Unlikely	Neutral	Likely	Very Likely	Unsure

3.8 To what extent do participants in activities below the task component level receive useful communications (directly or via networks) from GEO/GEOSS?

Very Rarely	Rarely	Occasionally	Frequently	Very Frequently	Unsure

3.9 Do participants in activities below the task component level see any benefit from participation in GEO/GEOSS?

- ☐ Yes
☐ No
☐ Unsure

3.10 To what extent has GEO led to increased collaboration between relevant projects and programs within the GEO Societal Benefit Areas and Building Blocks?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

3.11 To what extent has GEO enabled broader collaboration among diverse communities by promoting cooperation across the GEO Societal Benefit Area Tasks?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

Please identify any specific collaborations that resulted from cooperation across the GEO Societal Benefit Area Tasks, and if possible, identify specific outputs.

3.12 To what extent did organizing GEO/GEOSS across the nine Societal Benefit Areas benefit GEOSS implementation?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

3.13 Would a different organizational structure (for example, different definitions for the Societal Benefit Areas) have improved cooperation between communities and user engagement?

- ☐ Yes
- ☐ No
- ☐ Unsure

If yes, please explain: _____

3.14 Would GEO benefit more if it were organized according to large initiatives, such as GEO-BON or GEO-GLAM, as opposed to by Societal Benefit Areas?

- ☐ Yes
- ☐ No
- ☐ Unsure

If yes, please elaborate: _____

3.15 Did the GEO Communities of Practice contribute to or hinder success?

- ☐ Contributed to success
- ☐ Hindered success
- ☐ Unsure

If they hindered success, please explain how they could be improved:

3.16 To what extent did the GEO Boards fulfill their purposes?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

3.17 To what extent has any increased collaboration within the GEO community, or with external partners, led to reaching Earth observation users on a wider scale?

Very Poor Progress	Poor Progress	Fair Progress	Good Progress	Very Good Progress	Unsure

Part 4 - Assessing GEO Success

(Expanded write-in questions; Open to everyone)

- 4.1 Please identify any factors (organization, people, resources, relationships, etc.) that have contributed to success toward the implementation of GEOSS.

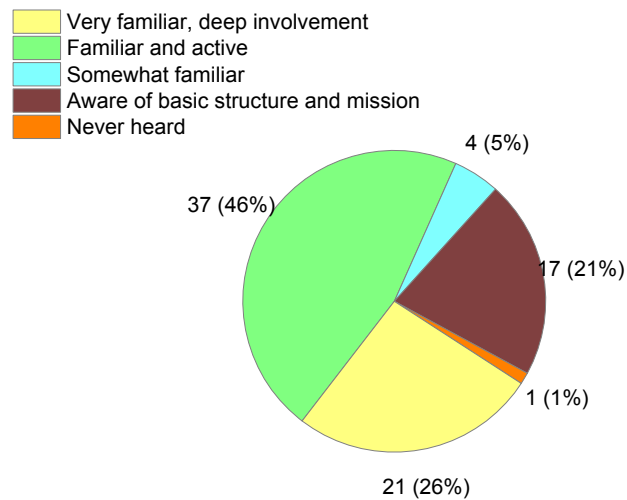
- 4.2 Please identify any factors (organization, people, resources, relationships, etc.) that have hindered success toward the implementation of GEOSS.

- 4.3 Please list any positive or negative lessons learned, encountered surprises, or systemic issues that you have identified during the implementation of GEOSS.

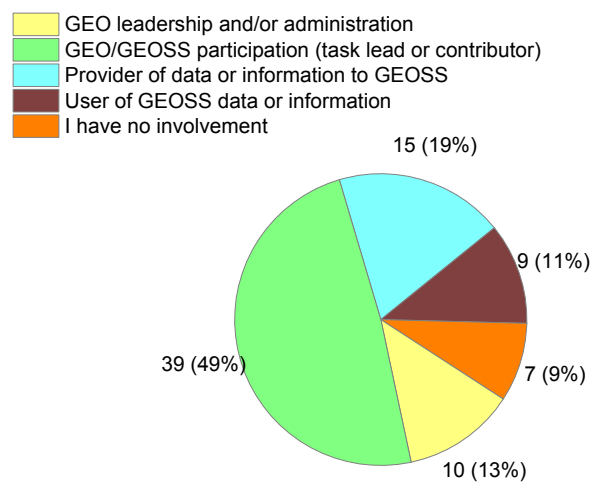
B.2 Survey Results

Part 1 – Background Information

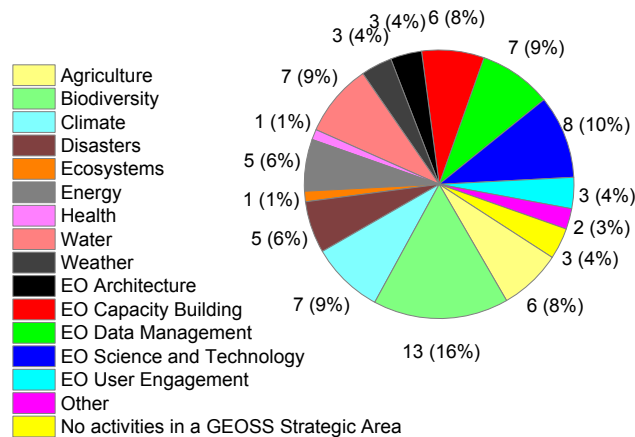
Q1.1: How familiar are you with GEO or GEOSS?



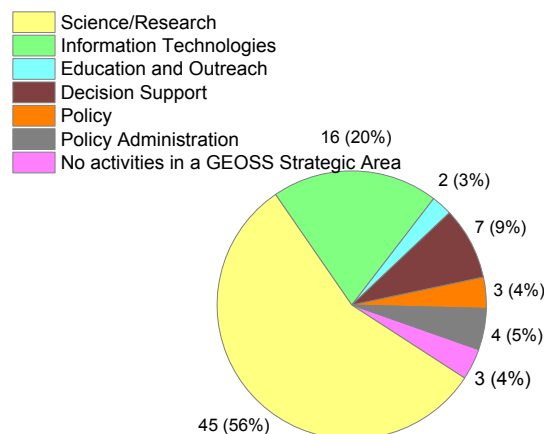
Q1.2: What is or has been your primary involvement with GEO and/or GEOSS?



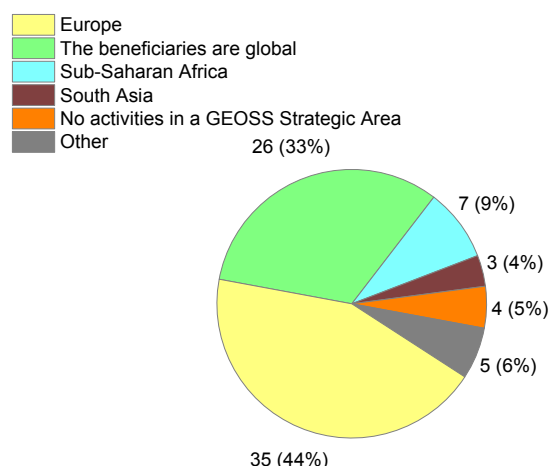
Q1.3: Even if you are unfamiliar with GEO or GEOSS, please select the one Strategic Area that best describes the field in which you are personally involved? (Involvement could include, but is not limited to, such things as research, management, policy-making, education, etc.)



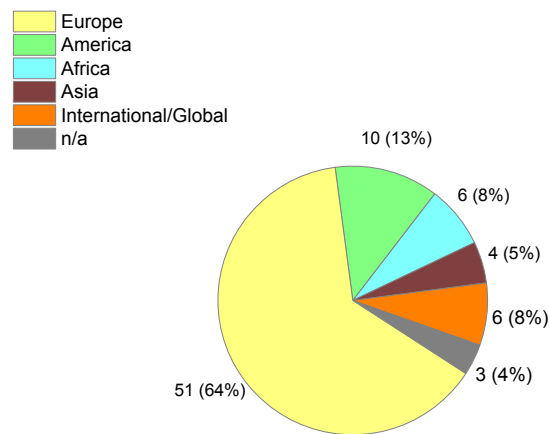
Q1.4: Which one category best characterizes your involvement with the GEOSS Strategic Area you identified in Question 1.3?



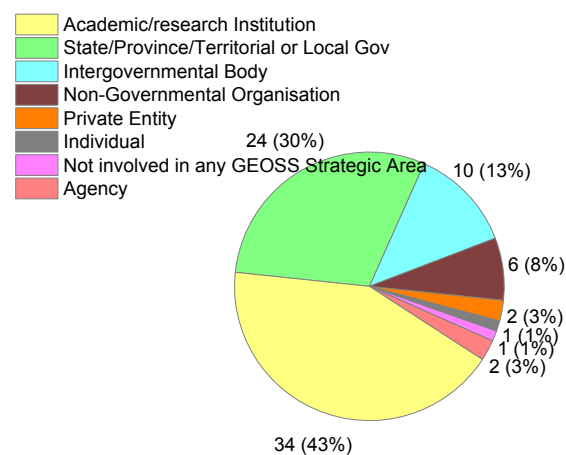
Q1.5: In which region are the primary beneficiaries of the activities you identified in Question 1.3? In other words, where do the people live who most benefit from your activities?



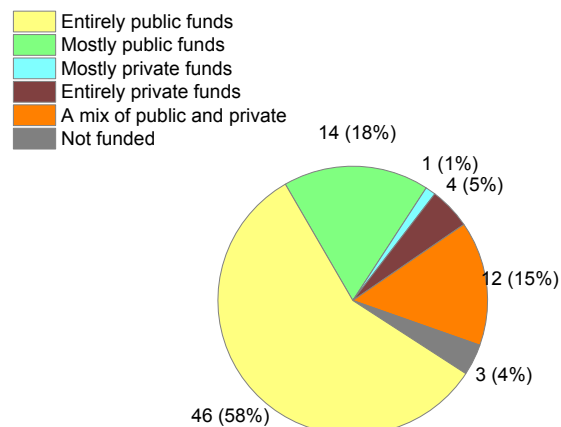
Q1.6: In which country (and/or region, if a regional institution) is the institution through which you are involved in the activities you identified in Question 1.3? (Answers were grouped by continent)



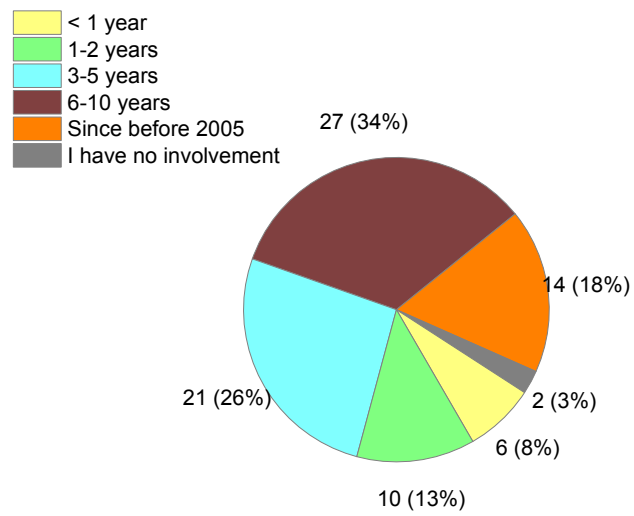
Q1.7: Which of these terms best describes the institution through which you are involved in the GEOSS Strategic Area you identified in Question 1.3?



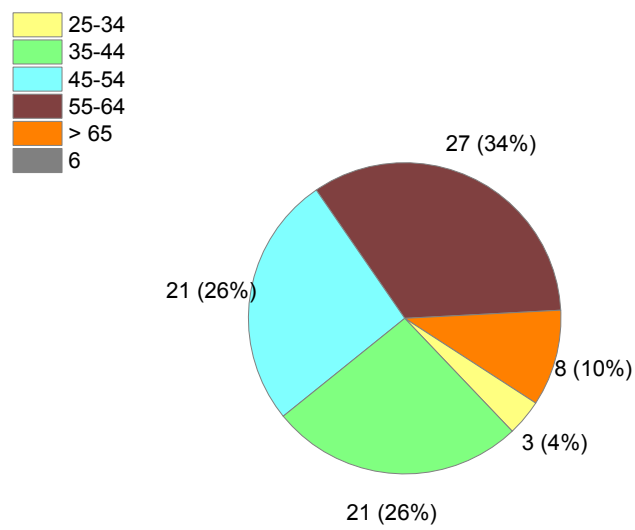
Q1.8: How are your current activities funded in the GEOSS Strategic Target Area you identified in Question 2?



Q1.9: For how long have you been involved with GEO and/or GEOSS?



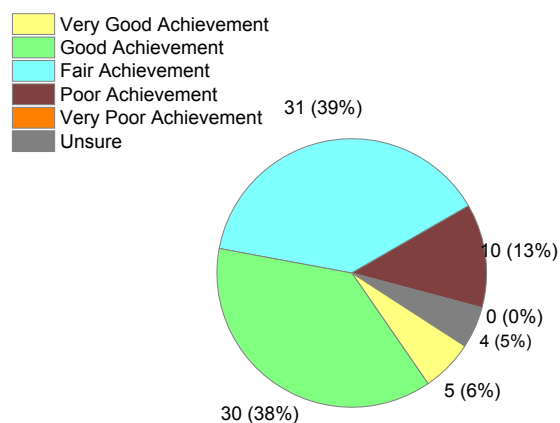
Q1.10: What is your age?



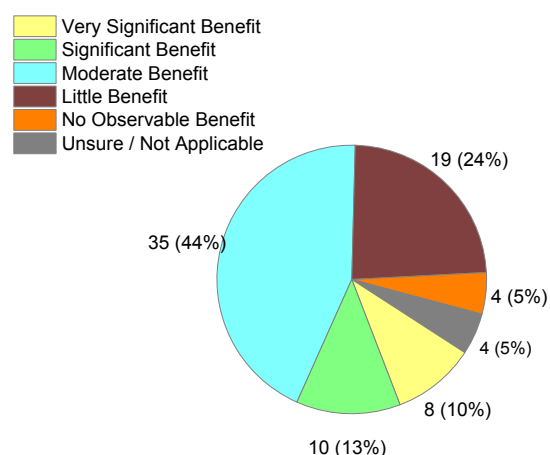
Part 2 – Assessing GEO Success

General questions

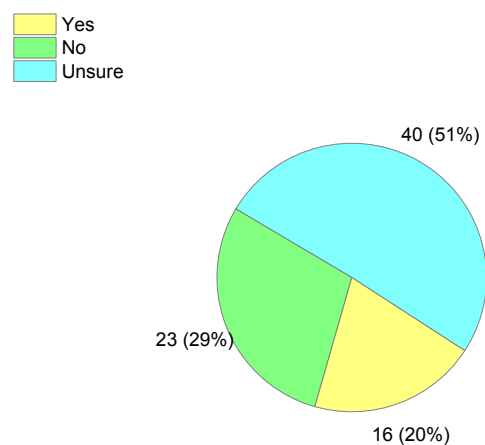
Q2.1: In general, to what extent has GEO achieved its vision and purpose as defined in the 10-Year Implementation Plan and the Strategic Targets Document?



Q2.2: To what extent has GEO or GEOSS benefitted the mission of your institution through which you are involved in GEO?



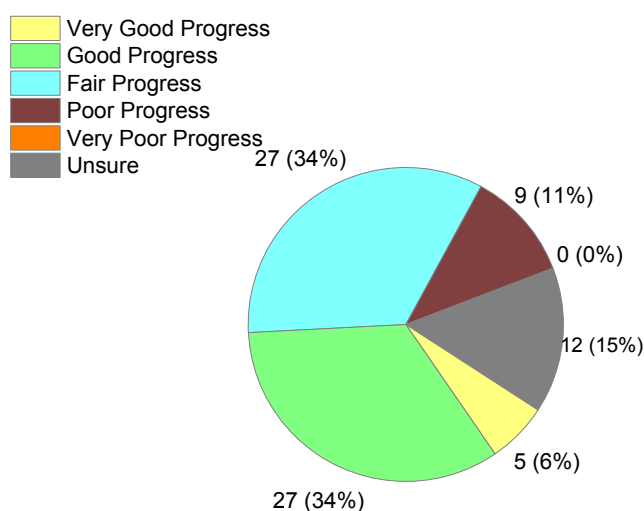
Q2.3: Have you identified important gaps in the 2005-2015 Implementation Plan?



Grouping of identified gaps:

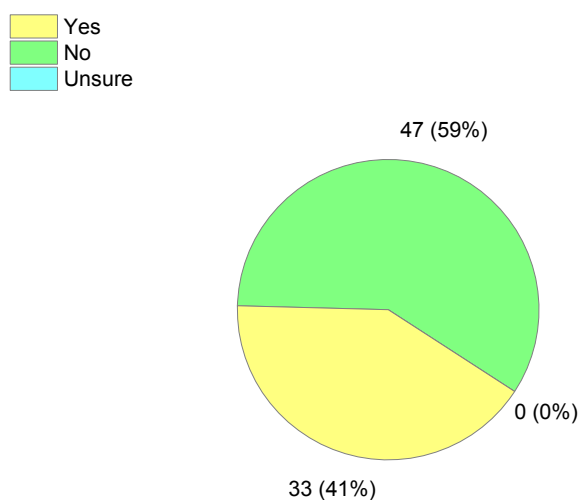
- Not clear that the implementation plan has actually impacted what has been done in the Work Programmes.
- Insufficient focus on benefits to the economic empowerment through EO in order to ensure wide policy makers support
- Capacity readiness for GEOSS implementation and poor awareness of stakeholders
- Weak links with Science and Technology; lack of service orientation and involvement of the private sector; need to establish agreements with private very high resolution data providers; address real user requirements
- Decision Makers can access data via GEOSS, but they are still waiting for information and knowledge
- No deforestation, not enough oceans, new strategic to conserve biodiversity
- Accessibility of GEOSS data is not what was envisioned; lack of products or services accessible through GEOSS, GEOSS Portal not quite useful
- Insufficient leverage of pre-existing programmes; duplication, lack of knowledge

Q2.4: To what extent has GEOSS built partnerships with relevant organisations, institutions, projects or programs that were not direct contributors to the GEO Work Plans?



Capacity Building

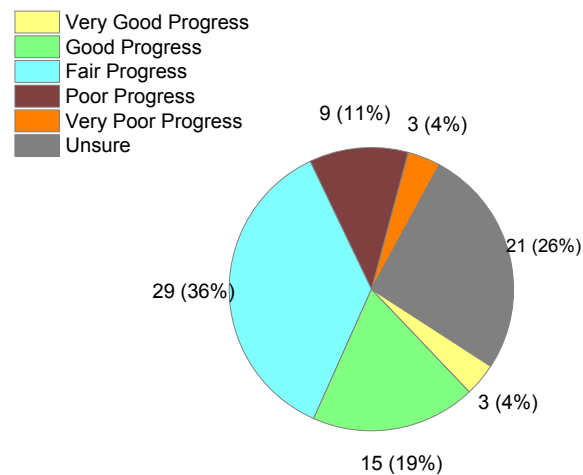
Q2.5: Have you participated in capacity building activities related to GEO / GEOSS



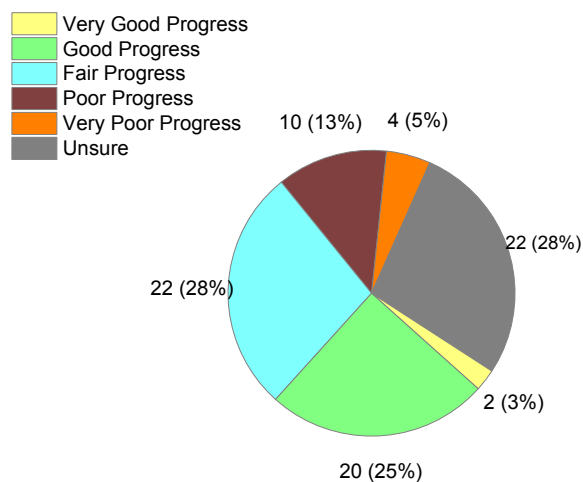
Grouping of Capacity Building examples and results:

- AIP; GeoViQua FP7; EU-BON; EGIDA FP7; GFOI; WCRP and GCOS; ENERGEO fp7; JECAM Site in Ukraine, CRAFT.LF center in Morocco within TASONI E-power; Architecture: GEOSS Community Portal Development Team; GEO Capacity Building Brother (GEO-CAB)
- Workshop Morocco, Al-Jadeeda, African Water Cycle, 2013; info Conferences on GEO/GEOSS EU funded projects, CIEHLYC Cartagena 2011, 2015; 2nd South-Eastern Europe GEO Workshop
- Working with other groups, encouraging participation, local meetings; awareness raising on data sharing in Europe and Latin America; exchange of files, user, workshops & international trainings; participation in all reflections and meetings of the Working Group; young researchers access to international cooperation programmes; travel for a standards development meeting for a GEO task; participation to capacity building meetings, improved participation in NL, FP7 funded projects to reach out to African and Balkan countries; capacity building in Africa for agricultural monitoring; Madagascar could enter 5 activities in GEO Workplan 2012-2015; permanent Networking Activities, training on EO topics; training on economic empowerment through EO; creation of an excellence center, concentration of critical mass, EO data/products; increasing use of oceanographic radars; interoperability test conducted with Mediterranean Countries

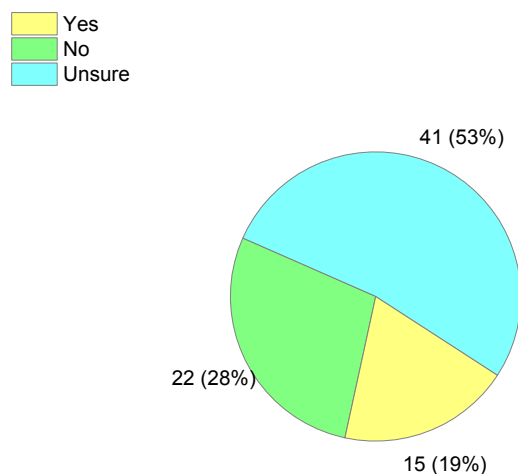
Q2.6: To what extent have the capacity building efforts of GEO strengthened current users or created new users of Earth observations?



Q2.7: To what extent have the capacity building efforts of GEO appropriately addressed the needs of developing countries?



Q2.8: Have you identified important gaps in GEO's capacity building efforts?

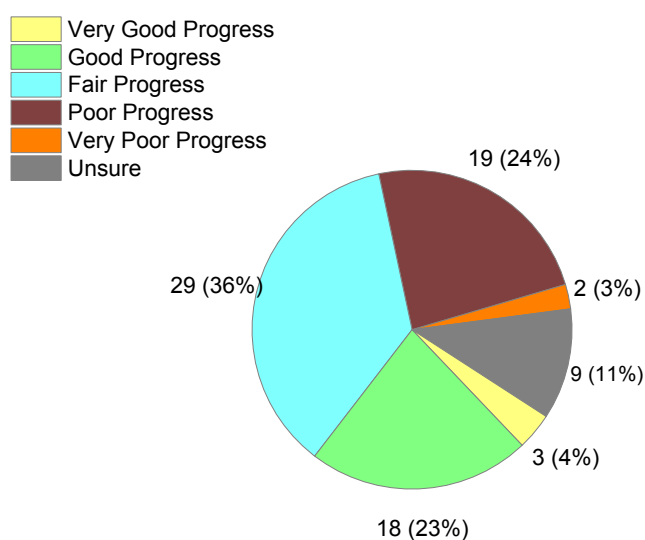


Identified gaps:

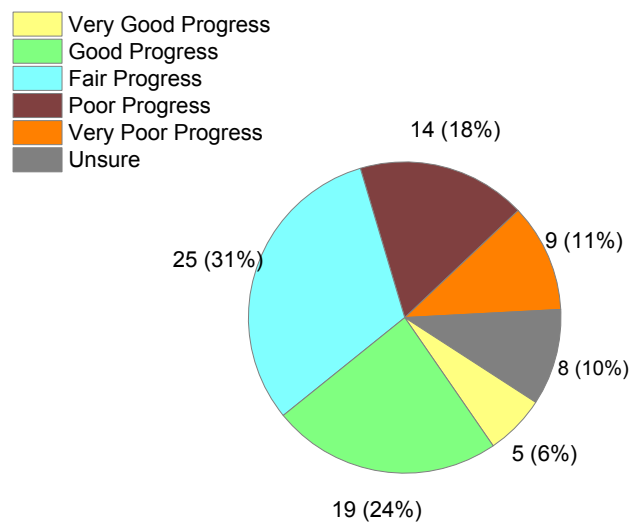
- Lack of funds
- More benefits, grants, research from private companies.
- Capacity building has not led to a closing of gaping holes in key observational networks. This has been one of the drivers behind GEO initially, though.
- Impairment of educational programmes and job opportunities for multidisciplinary BSc and MSc degrees; training, human resources
- GEO relies on voluntary help from organisations and this makes capacity building uncontrolled; volunteer efforts difficult to implement, however, common goals are advancing
- Lack of coordination with other intergovernmental organizations
- Very difficult to practically get hold of and utilize the collective GEO assets if one is not directly involved
- Data integrity, Ease of access/use
- Fragmented actions across different caucus. For Europe: funds and thus the majority of efforts in the past 5 years focused on neighboring regions (see Middle East Africa)
- We do not cover enough of the in situ community in biodiversity and ecosystems

Users Engagement

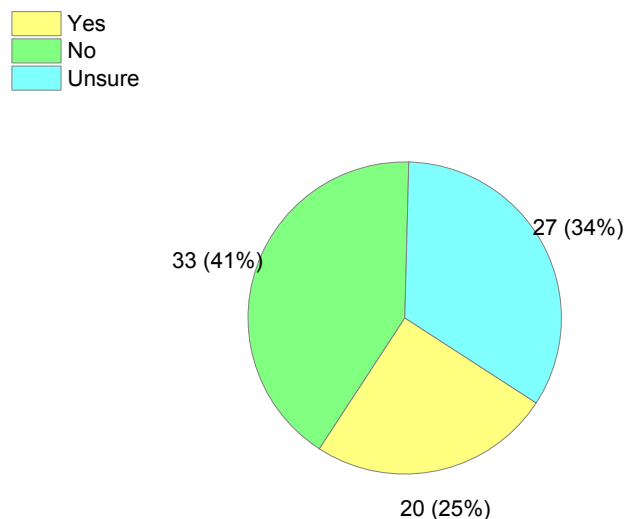
Q2.9: To what extent has GEO / GEOSS engaged with users to ensure that their information needs are appropriately met?



Q2.10: To what extent is GEOSS user-driven, such that user needs and feedback influence how Earth observations are collected and / or disseminated?



Q2.11: Have you identified specific user or stakeholder groups that have significantly benefited from GEOSS?

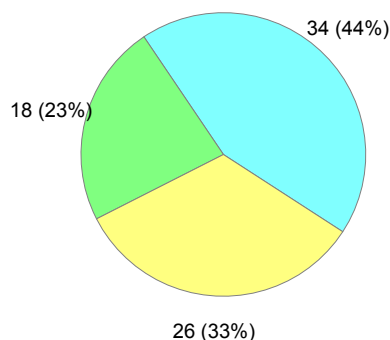


Identified specific users or stakeholders:

- Poorer developing countries, dispersed agencies within countries or regions, regional public services, bodies or authorities dealing with natural disasters
- Private companies, SMEs, clusters of end-users
- Decision makers and Earth System scientists
- The renewable energy community, forestry, solar energy in the Middle East for dust/aerosols monitoring, users of remote sensing data, agriculture, hydrology, biodiversity community, CBD, early warning services and disaster management
- The earth science IT community, IT Architecture: definition of standards and architecture choices
- Management Authorities of NATURA 2000 sites

Q2.12: Have you identified specific users or stakeholder groups that have not benefitted from GEOSS but have significant potential to benefit?

■ Yes
■ No
■ Unsure



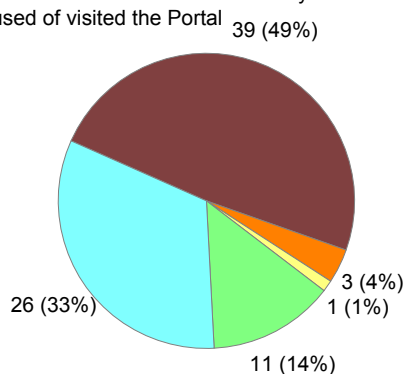
Identified specific users or stakeholders:

- General public, governments, agencies, communal public service providers
- Private sector, environmental NGOs, private sector users of climate information
- Some UN programmes, UNEP-MAP
- Real users of data/info, decision makers, science and technology users, researchers (e.g. EO, biodiversity) and academic users
- Any of the societal benefit areas
- General Directorate of Natural Resources, Safety and Maritime Services, Coastal managers needing real-time ocean currents data, civil protection and national health agencies, CMS

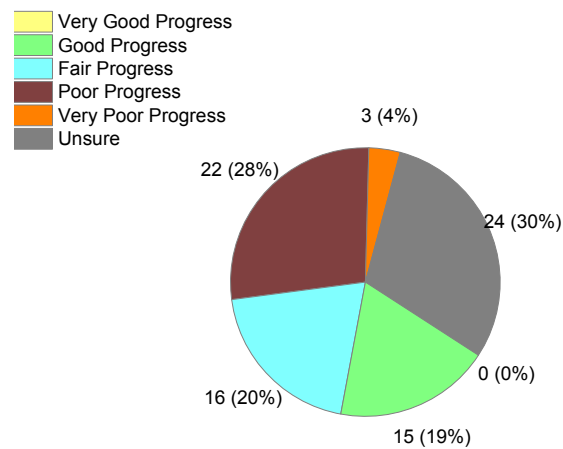
GEOSS Portal

Q2.13: How often have you used the GEOSS Portal and what is your level of familiarity?

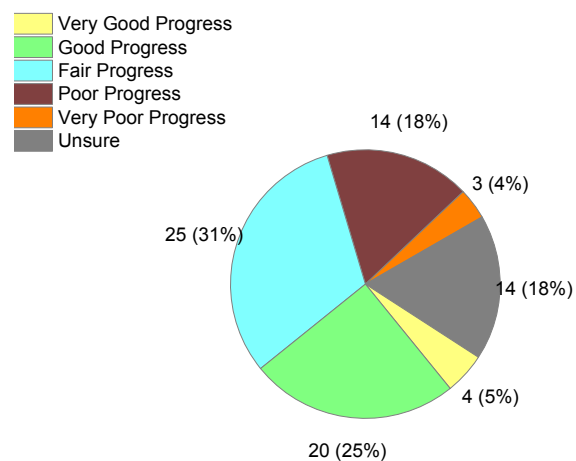
■ I am very familiar and use the Portal on a regular basis
■ I am quite familiar and have used the Portal many times
■ I am moderately familiar with the Portal and have used it on several occ;
■ I have visited the Portal at least once but rarely use it
■ I have never used of visited the Portal



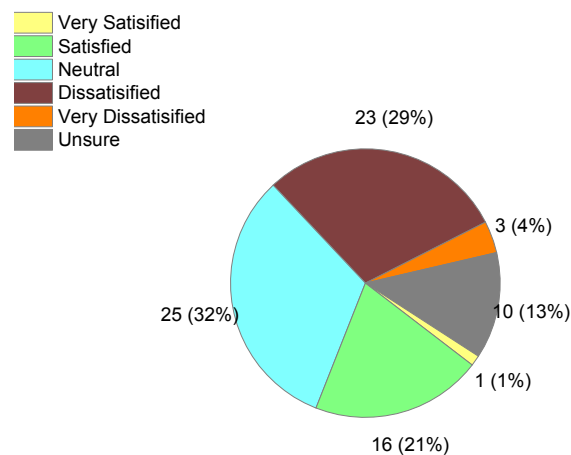
Q2.14: To what extent has the GEOSS Portal created more users of Earth observations?



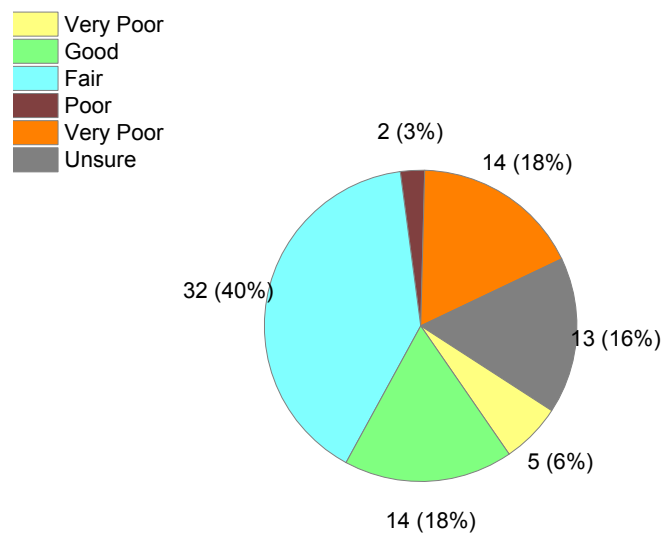
Q2.15: To what extent has the GEOSS Portal made Earth observations data more available and / or accessible?



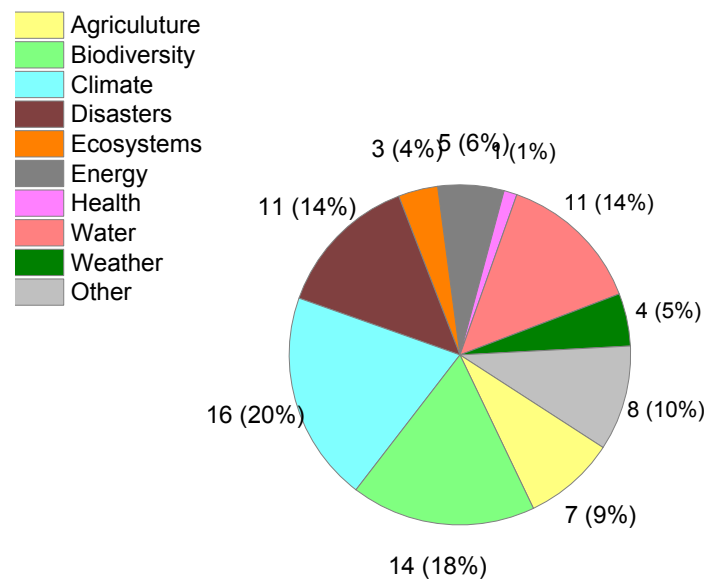
Q2.16: To what extent are you satisfied with how easily and efficiently data can be found using the GEOSS Portal?



Q2.17: How comprehensive is the data collection that is accessible through the GEOSS Portal?



Q2.18: Please identify the GEOSS Strategic Area that corresponds to the type of data you typically access online, either using the GEOSS Portal or other type of portal:

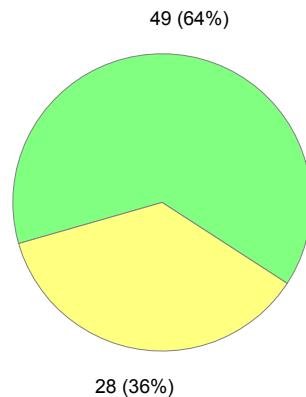


Other areas identified:

- Sustainability, urban, land use/cover, ocean
- Delivery of GEOSS DATA, capacity building resources

Q2.19: Is the GEOSS Portal your preferred means for accessing Earth observation data?

Yes
No



Preferred portals:

- Google
- Directly from data owners/primary sources, domain specific portals, public data portals, national portals, from the satellite data providers directly, mobile devices, specific provider or community portals close to the data/information source, portals with datasets having been peer-reviewed, on an ad hoc basis, divers, e.g.: EOLI-SA, own systems
- USDA's pecad portal (GEOGLAM), NCAR Climate Data Guide, Soda (special arrangement), US gov. servers, USGS, GBIF, FAO, NASA, ESA, INPE, OBIS, NOAA, EOSIS ESGF, NOMADS server portals, www.gebco.net, climate.gov, ARGO, Spanish Geographic Institute, EM-DAT,
- GEOSS portal has no unique datasets and is as complex to use as the original sources from which primary data can be downloaded, not just metadata.

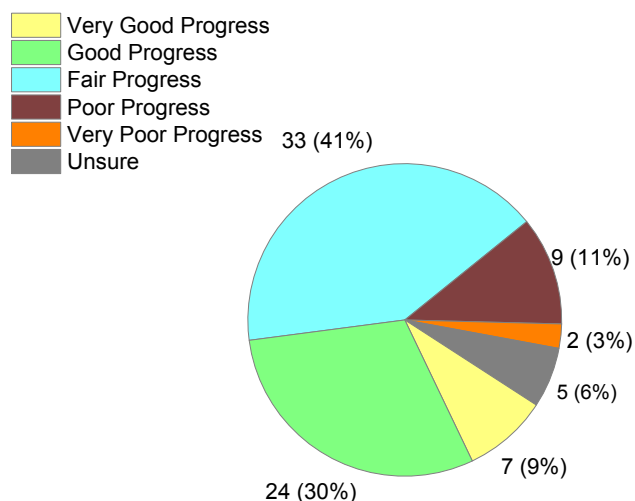
Q2.20: How could the GEOSS Portal be improved?

- More direct access to data; complete metadata; more access to free, processed imagery; access to real primary data e.g. from ecosystems community; Web service (WMS etc) access to bioclimatic and habitat layers; access to LANDSAT free data and available Very High Resolution data; less global and scientific products and more products and services tailored and down-scaled for real users; more social services; basis for dissemination of scientific literature related to GEO
- More links to additional information; better inclusion of community portals; dedicated links to FP7 research projects; a clearer link between various brokers and the GEOSS Portal
- Reduce intermediate stops; get rid of old outdated data; systematic verification and validation of each dataset; deal with redundancy of records; deal with granularity issues; better overview of data and more search and compilation functions; aligning dataset description with the most recognised standards

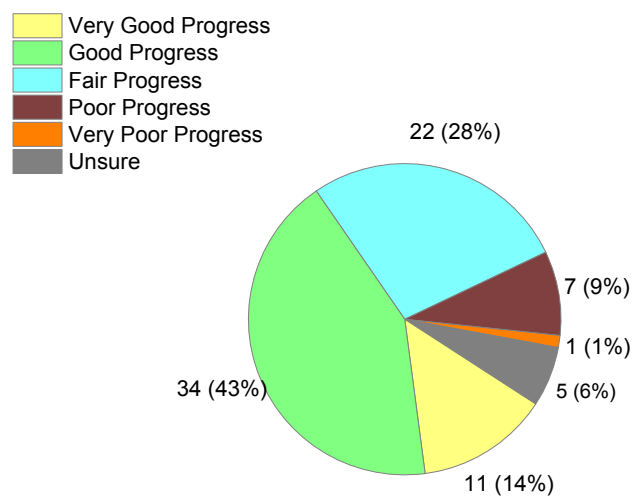
- More interactive, more modern interface; powerful free-text search (as search engines); making joint-venture with Google; one-stop access trying to address requests coming at least from one of the main category of users; additional meta-information (e.g. ratings, user feedback), sorting by relevance (e.g. quality, trusted sources); different layers of searching criteria e.g. thematic, geographic, case studies; smart branding and traceability/provenance of data sources; ability to retrieve/download data directly via a basket and checkout (cf. Amazon and similar shopping sites); include more movies about the state of the earth and blue planet
- Generic users want: to know what data are available for a specific place/period of time and to have easy access to data. For operational use and/or for added value developer SMEs: to have access to the data timely and with continuity also for the future; GEOSS portal should not aim at being the central portal for all observation data but should better rely on existing portals and provide opportunities to integrate the existing data sources; GEOSS portal would better serve GEO if it were to provide unique value (datasets are not unique, so perhaps focus on integrative applications would be useful to demonstrate a unique contribution); better coordination and liaison with the resources of participating organizations, in order to address gaps and avoid unnecessary duplication

Visibility

Q2.21: To what extent has GEO clearly communicated its role and mandate to GEO participants and / or users of Earth observation?

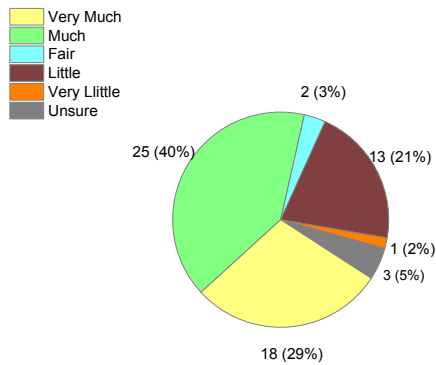


Q2.22: To what extent has GEO / GEOSS achieved and maintained visibility within the Earth observation community?

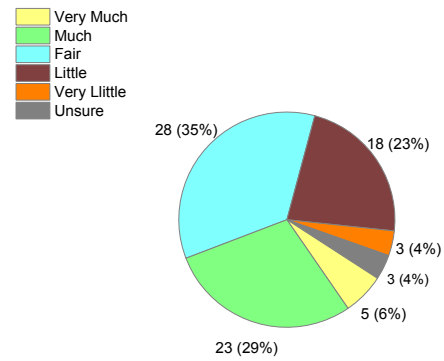


Q2.23: Please rate the following based on the importance of their contributions to the visibility of GEO/GEOSS

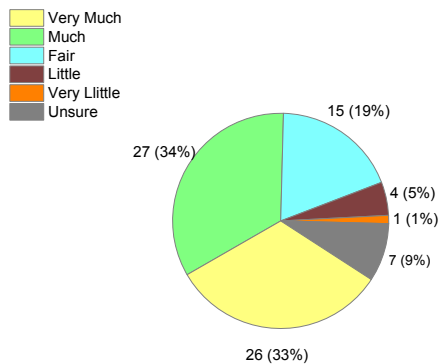
GEO website



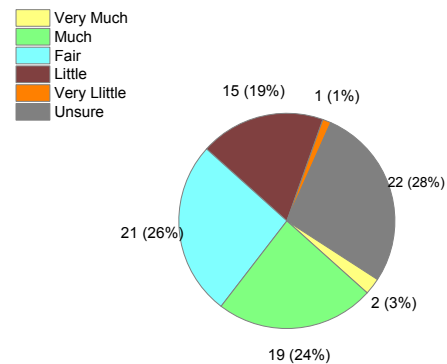
GEO brochures or reports



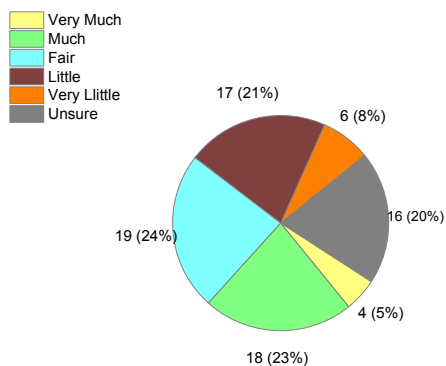
GEO participation at conferences, workshops, or meetings



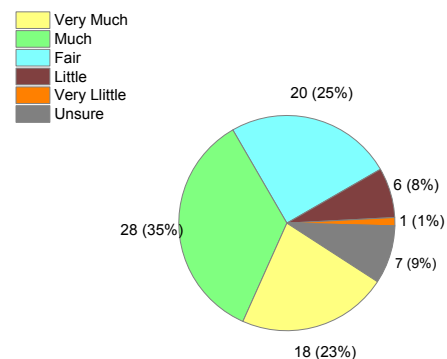
Grey Literature



Peer-reviewed literature



Word of mouth (person to person) communication



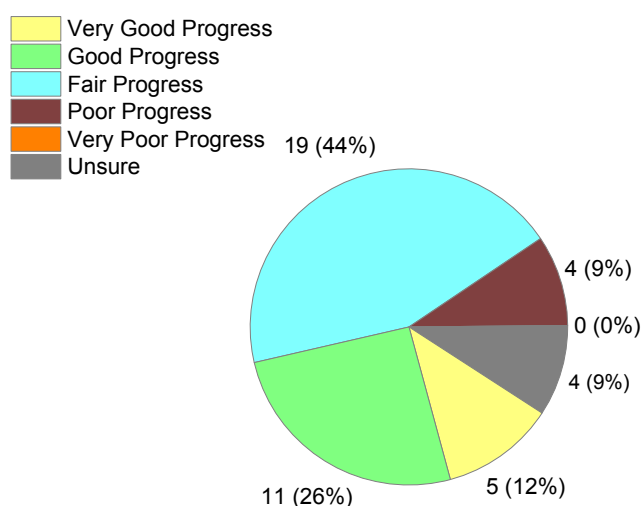
Part 3 – Assessing GEO Success (GEO/GEOSS Participants only)

Work plan - Targets

Q3.1: What Strategic Target is associated with the task/component you are involved in?
Please refer to the Appendix for a list of Strategic Targets.

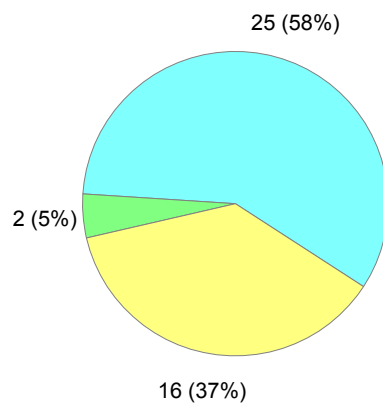
The SBAs: Agriculture, Biodiversity, Climate, Ecosystems, Disasters, Energy, Health, Water, Weather; improvement of imagery use especially through GEOGLAM; improve accessibility and interoperability of biodiversity information; user engagement; Science and Technology; capacity building Architecture and Data Management; effective and sustained operation of the global climate observing system and reliable delivery of climate information of a quality needed for predicting, mitigating and adapting to climate variability and change, including for better understanding of the global carbon cycle; governance; initiating environmental impact studies to identify what data are needed to collect and share by developers to ensure impacts on the environment be as low as reasonably possible for all energy sources (biomass, fossils, geothermal, hydropower, nuclear, ocean, , solar and wind); address the need for timely, global and open data sharing across borders and disciplines, within the framework of national policies and international obligations, to maximize the value and benefit of Earth observation investments; produce comprehensive sets of data and information products to support decision-making for efficient management of the world's water resources, based on coordinated, sustained observations of the water cycle on multiple scales; more timely dissemination of information from globally-coordinated systems for hazard assessment; policy, tropical forests; GEOSS building blocks; Id -C1-01; BI 07-01a; Id- C2-02; GEO BON

Q3.2: To what extent have the Work Plans been completed?



Q3.3: Were all Strategic Target outcomes addressed by the Work Plans?

■ Yes
■ No
■ Unsure

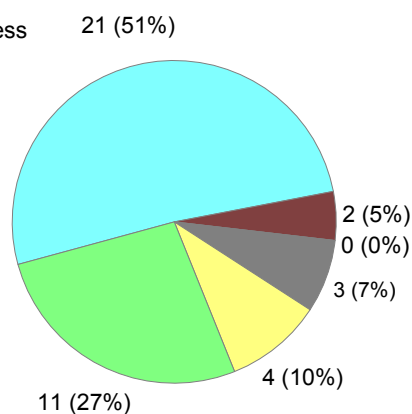


If no, what was missing:

- Without funding or support from my institution for my participation, I have lost touch with the progress.
- Coordinating with fisheries, aquaculture etc., establishing regional components

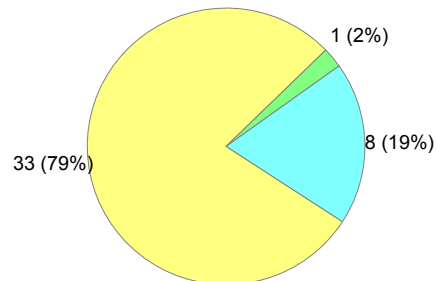
Q3.4: To what extent have the Strategic Targets been achieved for the task / component you are involved in?

■ Very Good Progress
■ Good Progress
■ Fair Progress
■ Poor Progress
■ Very Poor Progress
■ Unsure



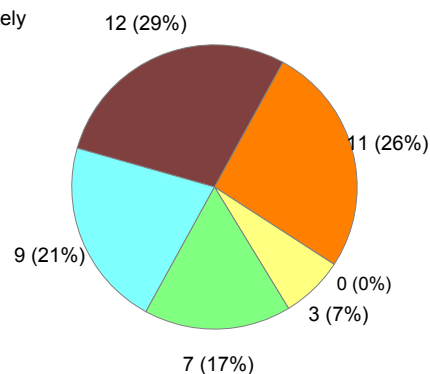
Q3.5: Did GEO/GEOSS provide added value in progress towards outcomes in Societal Benefit Area (SBA) Tasks?

Yes
No
Unsure



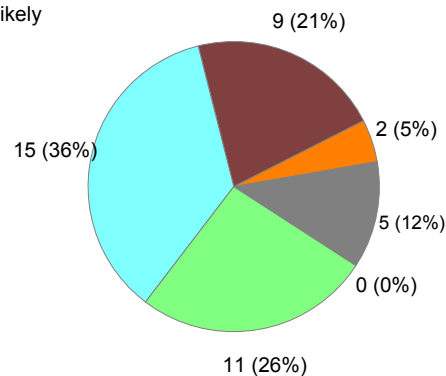
Q3.6: How likely is it that the activities in the GEO Work Plans would have occurred in the absence of GEO / GEOSS?

Very Likely
Likely
Neutral
Unlikely
Very Unlikely
Unsure

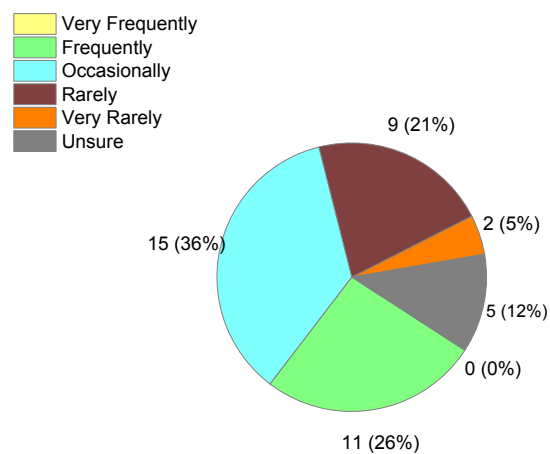


Q3.7: How likely are participants in GEO activities, who are not task or component leads, to be familiar with their contributions to GEO / GEOSS?

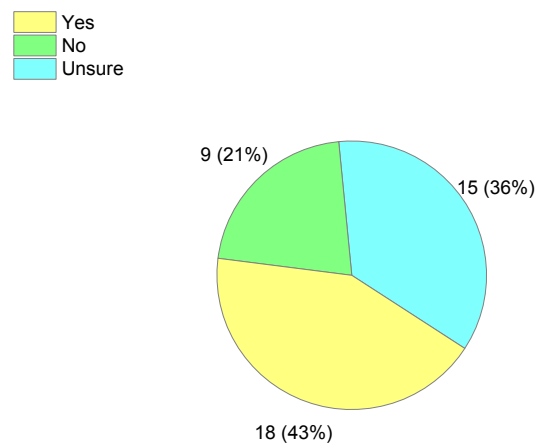
Very Likely
Likely
Neutral
Unlikely
Very Unlikely
Unsure



Q3.8: To what extent do participants in activities below the task component level receive useful communications (directly or via networks) from GEO / GEOSS?

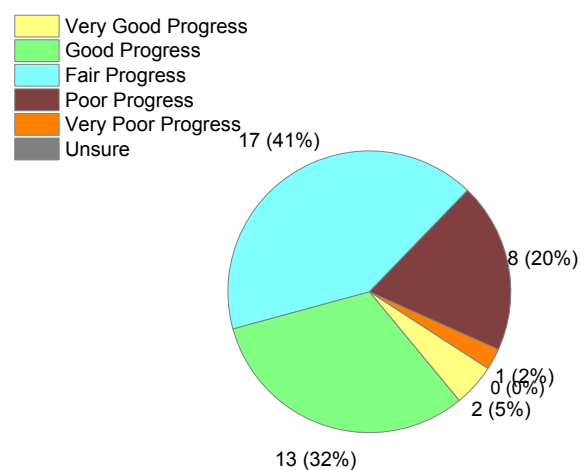


Q3.9: Do participants in activities below the task component level see any benefit from participation in GEO / GEOSS?

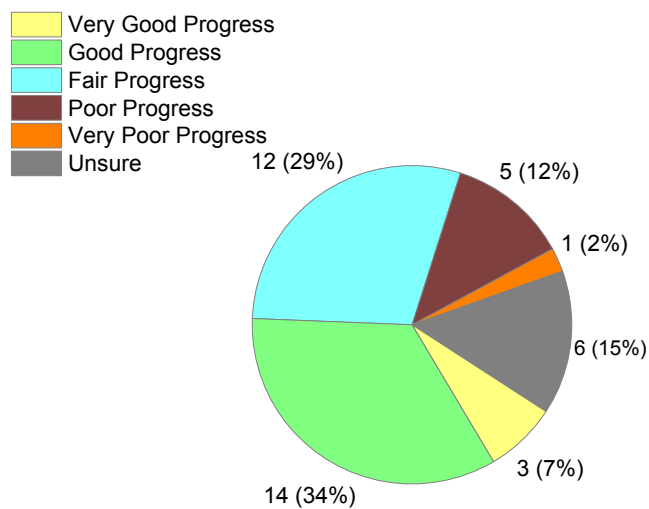


Collaborations

Q3.10: To what extent has GEO led to increased collaboration between relevant projects and programs within the GEO Societal Benefit Areas and Building Blocks



Q3.11: To what extent has GEO enabled broader collaboration among diverse communities by promoting cooperation across the GEO Societal Benefit Area Tasks?

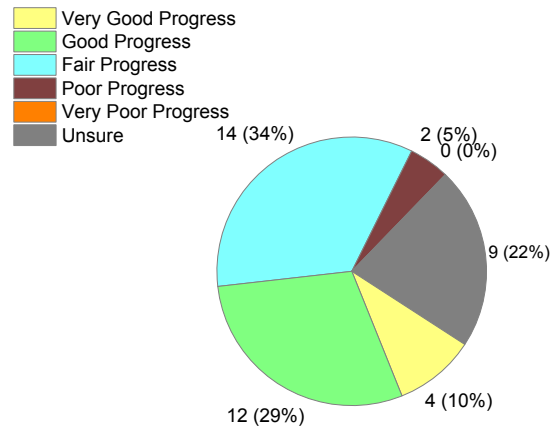


Cross-SBA specific collaborations

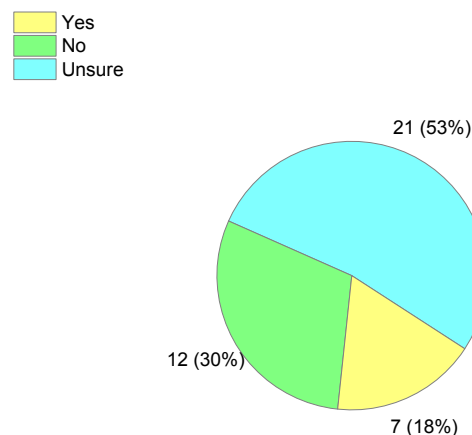
- Capacity building, Agriculture (food security), climate (adaptation actions) Energy (substitutions energy), Water - integrate management
- Climate – Energy Nexus
- Climate Change: Output: Madagascar involved in the group of Climate change and participate actively in monthly teleconference
- Collaboration between the activities in the biodiversity SBA with the ones of ecosystems and water SBAs
- Cooperation and integration of data with CO2 monitoring
- Discussions across SBIB, and the IIB, for the development of the GEOSS Community Portal
- Expansion of grasslands to the agricultural component
- FP7 projects (e.g. EuroGEOSS, GEOWOW, MEDINA, European Supersites); outcomes include: resources mobilization (e.g. data sharing) and their brokerage from the GCI.
- AIP pilots
- GEOGLAM, JECAM - the community of practice has been created, joint FP7 projects have been fulfilled
- Geohazards Supersites and natural Laboratories (GSNL); SB-04 and DI-01
- NAP
- The GEO broker initiative/project has brought several SBAs together, but needs more stimulus

Structure

Q3.12: To what extent did organising GEO / GEOSS across nine Societal Benefit Areas benefit GEOSS implementation?

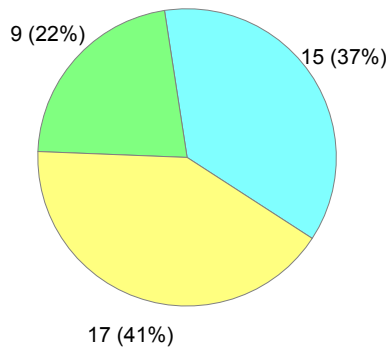
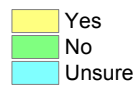


Q3.13: Would a different organisational structure (for example, different definitions for the Societal Benefit Areas) have improved cooperation between communities and user engagement?



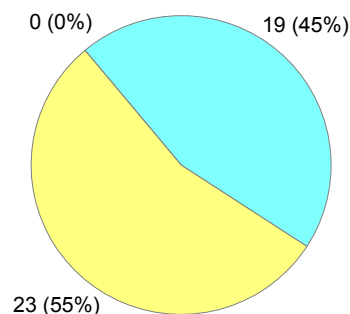
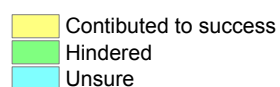
- A bit too much silo thinking, the way SBAs are, the communities stick together and forget cross-SBA cooperation
- GEO and GEOSS shouldn't be scientific initiatives. The focus should be on deliverables and tools for the benefit of society
- More focused on the Strategic Goals
- More user community focused
- There should be an SBA for urban issues
- Biodiversity could have used bioclimatic data from elsewhere. Ecosystems could have provided habitat maps that are useful for biodiversity research.
- Biodiversity and ecosystems should be merged

Q3.14: Would GEO benefit more if it were organised according to large initiatives, such as GEO BON or GEO-GLAM, as opposed to by Societal Benefit Areas?

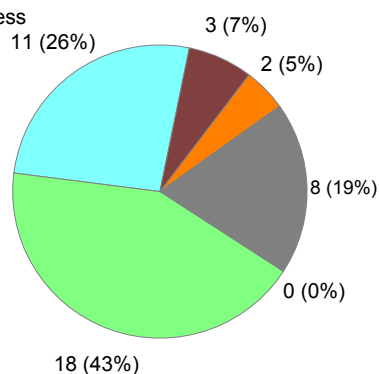


- More targeted and easily seen as working groups with established duties
- Large initiatives articulate clear objectives and define specific roles. They establish working partnership models and work to identify the resources needed. These have all been missing from the other parts of GEOSS.
- GEO global initiatives are the only tangible outputs from GEOSS
- Given that such initiatives are considered flagships in GEO, yes such organization in parallel to SBAs or as an umbrella to link SBAs could be of benefit
- I believe it is generally true that specific initiatives resonate with both science and non-science folks
- Both organisational constructs and initiatives can fit together. The initiatives are implementation mechanisms for projects or programmes within one or more SBAs
- Yes, Initiatives with multidisciplinary character, connected to other international activities (UN, future earth, etc.) and clearly defined goals, approaches etc. would be helpful in my eyes.
- GEO BON surely builds a global community that stimulates cooperation and exchange
- There is clear goal and working plan of the collaboration

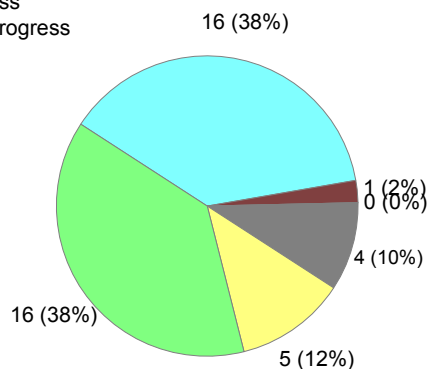
Q3.15: Did the GEO Communities of Practice contribute to or hinder success?



Q3.16: To what extent did the GEO Boards fulfill their purposes?



Q3.17: To what extent has any increased collaboration within the GEO community, or with external partners, led to reaching Earth observation users on a wider scale?



Part 4 – Assessing GEO Success (expanded write-in questions)

Q4.1: Please identify any factors (organisation, people, resources, relationships, etc.) that have contributed to success towards the implementation of GEOSS.

PEOPLE

A widely identified factor of success is people working on a volunteer basis: "several enthusiastic persons ... highly motivated individuals ... people's enthusiasm and commitment ... participants working within the spirit of GEO/GEOSS ... people with energy and interest". Special emphasis is also placed on the efforts of the GEO Secretariat and its staff playing a very positive and pro-active role.

DATA SHARING-BROKERING

The Open Data Sharing approach and the relevant Data Sharing Principles have promoted open data policy and contributed to globally consistent data products. Also, the adoption of a Brokering approach and architecture to implement an actual System of Systems created a more inclusive system for data discovery and access. The Community Portal concept has also been mentioned.

INITIATIVES-PARTNERSHIPS

GEOSS brought together, from the start, the major players in Earth observations, who had common goals. This resulted in further leveraging existing communities, creating large partnerships, which, in turn, lead to global initiatives. The involvement of many different organizations (space agencies, UN, researchers, users) is a unique strength of GEO that should be built upon and expanded (e.g., more non-space asset-based organisations in the driver's seats, because they see benefits to their mandates). As an example, the kick-start of GEO BON, with help from NASA funding and EU funding through the European Biodiversity Observation Network (EBONE) has helped facilitate the community by organising global meetings (Asilomar twice; Wageningen, once).

AWARENESS

All outreach efforts, international workshops and trainings, meetings involving consortia of different FP7 projects and end-users, promoted the existence and activities of GEO and contributed to raising awareness of the importance of Earth observations to support sustainable development.

RESOURCES

The European Commission is identified to have played a pivotal role in implementing GEOSS goals, with financial support of its own (e.g., FP7) and of the Member States, while additional contributors within Europe, such as ESA and the European Environment Agency, have also been critical to the success to GEO to date.

EXAMPLES

GEO BON, GEOGLAM, D-GEO working group, German Federal Ministry of Transport and digital infrastructure (BMVi), EU-BON, IOC, Ministry of Environment, Ecology and Forest, Fisheries Ministry, Ministry of Agriculture, MadBIF.

Q4.2: Please identify any factors (organisation, people, resources, relationships, etc.) that have hindered success towards the implementation of GEOSS.

ORGANIZATION-STRUCTURE-VISIBILITY

The mandate and targeted roles of GEO (as an organization), as well as the benefits it brings to newcomers, has remained unclear. GEO's organizational structures have been a poor match to its objectives and framework. A clearer common goal and steering of GEO and the GEOSS development could be helpful. There is still lack of awareness of GEOSS' role and achievements.

Plenary, due to its size and lack of preparation, has been completely ineffective in giving directions; the Executive Committee has failed to provide the necessary linkage into member administrations; the Boards have acted completely detached from the rest of GEO; GEO Committees could have been more effective but were not, due to a lack of a real mandate to make any decisions; unclear interfaces exist between GEO and intergovernmental and national organizations.

Lacking legal status of GEO; governance of GEO is characterized as too heavy or elsewhere too light, making GEO difficult for outsiders to access and make use of. The changes in terms of organisation impacted on the involvement of GEO participants (UIC, ADC, CBC) in the actual boards.

PEOPLE

Voluntary nature makes it a very slow process and there have been no means to have participants stick to their commitments. Ex-post evaluation of actions and responsible persons should be a rule. National level communication and the knowhow of local staff on usability (access, handling, opportunities and limits) of EO data is often quite limited. There has been general reference to relationships, as well; in some cases it seems like different partners with different interests compete for influence within GEO and want to move in different directions.

RESOURCES

Lack of devoted funds, uncertainty and continuity of funding, limited involvement of the private sector, in particular SMEs, were identified as hindering success factors. The fact that in Europe funding was organized through FP7 and H2020 and was not targeted, was a risk for continuity. Funding for capacity building and travel was highlighted as very important, but quite limited.

DATA MANAGEMENT SYSTEM

The ambitions for the data management system were too high. The underlying concept of having one system fitting all purposes has significantly hindered the development of alternative (federated) approaches; Very High Resolution (VHR) data (better than 4m spatial resolution) and value-added products are required; free access to VHR EO data should be guaranteed to decision makers; business opportunities for the private sector is not in the raw (or pre-processed) data, but in the downstream services they can provide; globally heterogeneous matching data for linking the GEOSS data sets to other variables, greater harmonization of national statistics, *in situ* monitoring, and monitoring/reporting methods are still necessary; climate and weather groups still pondering protocol.

USERS

Poor *ex ante* involvement of potential users: a structured relationship with local user communities should be established avoiding delegation of this issue to national bodies which, very often, do not represent citizen needs but their own or simply national industries' interests; low involvement of beneficiary countries in the choice of themes, and inadequate transfer of data and technology; no operational project in favor of applicant countries; strong scientific bias, global products/data mostly research-oriented.

OTHER

Promoting the use of the best available EO technologies should be a minimum requirement for all GEO/GEOSS actions, particularly for specific initiative like Supersites and Natural Laboratories. The absence of preliminary technological benchmarking, together with poor ambitions (no real-time integration and monitoring activities are foreseen), strongly limited the impact of GSNL as an additional way to support normal activities of national bodies in charge of surveillance.

Maybe the biases of certain big partners (especially in the implementation of GEOSS infrastructure) has hindered the short/medium term goals (and quick wins) of GEOSS. Space-based remote sensing has less value for oceans and for biodiversity than for some other GEO areas, and GEO has not really fully embraced the sensing that is not controlled by space agencies.

Q4.3: Please list any positive or negative lessons learned, encountered surprises, or systematic issues that you have identified during the implementation of GEOSS.

POSITIVE LESSONS

- Products and outcomes are based on participant countries' interest in them. GEOSS provides a platform to recruit additional collaborators.
- The general difficulties in funding relevant capacities and maintaining them, is steadily leading scientists to form clusters and seek other platforms. GEO is offering, with relatively good timing, such opportunities. This is clearly discerned in the region of my interest (SE Europe, Middle East, North Africa) and provides the potential for further development of GEO's vision.
- Incredible impact of GEOSS in terms of collaboration, visibility, etc.
- Without GEOSS, people would have never considered to look into data interoperability across different disciplines to the degree that GEOSS aspired to.
- AfriGEOSS

NEGATIVE LESSONS

- In public services, the reliable long term availability of EO-Data e.g., radar interferometry data, is often doubted. People often ask: "Is it worth it to train human resources and allocate capital in data handling, if the satellite is only five to ten years in space? Long term statistical series will not be possible this way".
- Participation in GEOSS is pretty much a folly, if one's own organization doesn't support one to do so.
- Need more user friendliness and more outreach to the non-geo community. I tried to raise interest of scientists who are in need of such data, and where it would be interesting

to combine EO with their field observations, but they think it is too complicated or out of the scope of their work, and only for satellite imagery specialists or a means to improve satellites.

- Without a major and autonomous role played by GEO/GEOSS governance, most of the resources mobilized by GEO/GEOSS (including the national resources provided directly to maintain GEO personnel) will mostly sustain the GEO machine and national bodies, without any significant impact on citizen life and/or knowledge improvement.
- There is a big distance between the local biodiversity communities and GEO BON that needs manpower, time and strategic work. However, in many countries, local initiatives are being developed. Now to be coordinated.
- Too UN-like for operational purposes.
- Lack of resources has resulted in extremely limited and slow progress.
- Slow progress is inevitable, but is discouraging to participants and to the intended audiences for GEOSS. This, perhaps, indicates a need for more focus on near-term products and less on the grand system behind it.
- A big effort is still needed, even regarding the integration at the national level of nationally available data and relevant infrastructure.

SYSTEMATIC ISSUES

- Small but concise steps of advancement are better through a community of practice than generalized suggestions of projects.
- There are many parallel initiatives sharing some of the goals with the GEO, yet it is insufficiently clear how overlapping and duplication of effort is to be avoided. This will determine the success of the GEOSS in the future.
- GEOSS is a big and rather "invasive" initiative, it must keep on finding the right collaborations and synergies with the constellation of existing international programs and initiatives dealing with Earth Science and Global Changes.
- Systemic issues: (i) Lack of user focus and understanding what this might mean; (ii) lack of orientation towards specific decision-making processes; (iii) piecemeal bottom-up approach to scope and implementation too connected to individual interests. "All above issues are quite evident and on the table since a long-time, but no one can face them mostly due to the main role still played by national governments and institutions with their internal political constraints.
- GEO should provide more documents that clearly highlight its mission and activities in an easily readable and accessible manner. Also, GEO should produce and provide guidelines, e.g., regarding geodata management, geodata sharing, data standards, observation networks, EO Portals, EO methods & standards, so that GEO will provide an easy starting point to get involved in the world of EO. Besides data, the GEOSS Portal should give direct access to such literature, guides, etc.
- I think the approval of a specific activity, particularly at the WG level, should not be pursued by "general consensus", but democratically (e.g., by a vote).
- GEO has been very valuable in getting lots of communities to articulate their needs. It has been less successful in knowing what to do once the communities have done the articulation.
- Policy makers need to be aware of the use of GEO/GEOSS in their economic society.
- A systematic issue is related to the systematic acquisition of Very High Resolution data.

SURPRISES-OTHER

- Generally, few people in the USA oceanographic community have an understanding, or even a basic knowledge, of GEO. Its connection to GOOS is also unclear to many.
- GEOSS infrastructure is a real and unique System of Systems framework providing discoverability and access to tens of millions of data products.
- It is flexible and scalable; it depends on GEO members to build on that sharing information and knowledge besides data.
- GEO must be much more present and advertised. After 10 years, still almost no one that is not involved in GEO knows about it. The visibility of GEO and its mission is very low.
- The steering group and the community around it was well aware of what should be done.
- GEO BON is a nice idea, but it is still a paper tiger, unable to mobilise data, or come up with real products. It has been surprising how the fragmentation of the community still escalates. GBIF is the only working cyber-infrastructure in biodiversity, and will remain so. So build on it, and do not encourage competing initiatives.

Annex C: Case Studies

The Evaluation Team collected a number of case studies as additional evidence to support the Key Findings of this report. Summaries of these case studies are added here to provide concrete examples of initiatives related to GEOSS that have contributed to its success. Each case study was conducted by a subset of the full Evaluation Team (1-3 members), and does not necessarily represent a detailed analysis with thorough community input.

C.1 National (&EU) Programs' Mechanisms and Support for GEO

Support to GEOSS, in terms of funding of projects that can form the whole or parts of a task, as well as the implementation and application of data and information provided by GEOSS in individual countries, requires resources far beyond what is available to the GEO Secretariat. Such resources must be secured at the national level. Successful capacity building is also strongly dependent on national will and a desire to improve the use of EO.

Several GEO members have established functions to handle GEO activities and ensure that there is added-value from GEO membership. The Sixth Evaluation Team selected national GEO organizational structures from Canada, Germany and Greece to serve as case studies of national efforts to support GEO and GEOSS. Examples from the European Commission (EC) are used to illustrate how regional programmes can be used to support GEO.

C.1.1 Canadian Federal Geospatial Platform (FGP)

The Federal Geospatial Platform (FGP) is an initiative of the Federal Committee on Geomatics and Earth Observations. FGP is a Canadian federal government initiative that aims to create a Canadian geospatial platform to be shared by Canadian federal departments and agencies to manage geospatial information assets in a more efficient and coordinated way. The initiative uses a common “platform” of technical infrastructure, policies, standards and governance, and provides geospatial data to support decision-making by government and citizens, and stimulates development of downstream applications. FGP implementation is expected to be completed in 2016-2017.

Funding:

FGP is funded by 21 federal departments, which are allocating resources to implement the project and create a national platform to share geospatial information.

Contribution:

FGP is expected to provide a comprehensive solution to share geospatial resources by providing the means for Canadian federal departments and agencies to manage geospatial information assets in a more efficient and coordinated way, using a common “platform” of technical infrastructure, policies, standards and governance, and providing geospatial data to support decision-making by government and citizens, and stimulate downstream applications development.

The FGP brings together geospatial data from the 21 departments and agencies of FCGEO within a platform that will enable the rapid search of all federal geospatial data assets. The FGP will be freely accessible online for use by Canadians, governments and industry.

Key components of the platform will include:

- Shared infrastructure, managed by Shared Services Canada;
- Data repository of quality-assured, interoperable data;
- Standards-based, searchable metadata catalogue;
- Web service and application development environment; and
- Value-added visualization and analytical capabilities on data.gc.ca.

C.1.2 D-GEO: German contributions to GEO and GEOSS

Structure:

The Federal Ministry of Transport and Digital Infrastructure (BMVI) is the most important provider and user of operational Earth observation systems in Germany, where federal mandates exist. It leads the implementation of GEOSS in Germany and heads the German GEO delegation. Additionally the BMVI brings in a multiplicity of other institutions.

On behalf of the BMVI, a National GEO Secretariat has been established at the DLR Space Administration. Major tasks are the coordination and administrative support of the German GEO Delegation for GEO Committees and the consultations in the European GEO High Level Working Group (GEO HLWG). Furthermore, bundling and disseminating relevant information, communication with the GEO Secretariat in Geneva, and the general point of contact for German stakeholders, are part of the tasks.

Germany's national GEO coordination strategy:

The participants assembled at the GEO Summit in November 2010 included in the Beijing Declaration a call to “support the establishment of national GEO coordination mechanisms among relevant ministries, institutions and agencies.”

The German experience confirms that establishing such a national GEO structure, with a leading coordinating Ministry, a national Working Group consisting of colleagues from concerned authorities, and a national GEO Secretariat, can noticeably improve the effectiveness of GEOSS implementation at the national level, as well as a country's contributions to international efforts.

The national implementation plan:

The German Federal Ministry of Transport, Building and Urban Development (BMVBS, now BMVI), which is an important provider and user of operational Earth observation systems, leads and coordinates the implementation of GEOSS in Germany, in close cooperation with various authorities and facilities.

The Ministry has published a national plan for the German approach to GEOSS. This German implementation plan addresses the central issues and perspectives of Germany's participation in GEO and recommends various measures. It was adopted by the German Interministerial Committee for Geo Information (IMAGI) in 2008 and serves as the basis for the further national development of GEOSS.

Progress on the national plan is assessed yearly, together with an updated annual German GEOSS Work Plan. The annual German GEOSS national progress report and the annual work plan are distributed to relevant ministries, agencies and organizations.

D-GEO at work:

National coordination is achieved through the German GEO Working Group, which is called D-GEO. D-GEO serves as a forum for sharing national and international GEO developments, agendas, proposals and documents. It also develops Germany's opinions and engagement in GEO's efforts to build GEOSS.

D-GEO encompasses, among others, the following institutions: the German National Meteorological Service (DWD), Federal Institute of Hydrology (BfG), the Federal Agency for Cartography and Geodesy (BKG), the Federal Institute for Geosciences and Natural Resources (BGR), the Federal Maritime and Hydrographic Agency (BSH), the Commission of the Geo Information Industry (GIW) and the German Aerospace Center (DLR).

A national D-GEO Secretariat has been established at the German Aerospace Center Space Administration (DLR) on behalf of the Federal Ministry of Transport, Building and Urban Development (BMVBS). The national D-GEO Secretariat works on preparing GEO meetings, distributing relevant information, creating advisory opinions, communicating with the GEO community and acting as a point of contact for interested institutions and protagonists.

The national D-GEO Working Group meets regularly at various facilities throughout Germany. This mobile meeting scheme makes it possible to introduce GEOSS to potential stakeholders and to have contact with organizations active in Earth observation that could possibly contribute to GEOSS. The locations and dates of the D-GEO meetings are planned and announced well in advance so that all colleagues can plan to participate. The presence of the national D-GEO Group can also strengthen working relations and raises awareness of GEOSS within the institutions that host the meetings. Direct contact with potential new "GEO activists" in relevant organizations can be vital for creating a better understanding of GEOSS and a basis of trust for further cooperation.

In addition to the official meetings, there is regular interchange via e-mails, telephone calls and meetings amongst colleagues on specific issues, such as technical requirements providing Earth observation data. D-GEO members are also invited to report on specific activities to ensure continuous information exchange. The German GEO Principal, the German GEO Principal Alternate and the national D-GEO Secretariat regularly meet and communicate to discuss GEO Tasks, to prepare activities and to steer the German GEOSS contributions. In addition to the official D-GEO website, an internal website is maintained by the national D-GEO Secretariat. All German colleagues can use a password to access and download documents in advance of meetings, a list of working actions and their implementation status, the minutes and results of GEO conferences, announcements of GEOSS events, and other information.

Ensuring broader cooperation:

Federal public servants currently carry out most of the work of D-GEO. This network needs to be made broader, e.g., by intensifying the engagement of science and research institutions. These institutions are making important contributions to Earth observation and many of their specific activities are relevant to the GEO Work Plan.

A continuous challenge for GEO, as well as for the German D-GEO Working Group, is to integrate the efforts of generalists responsible for coordination with the work of experienced specialists responsible for implementation in specific SBSAs or domains, such as remote sensing, *in situ* monitoring or data management. Awareness of the broader vision of GEOSS still needs to be increased for certain stakeholders and potential contributors who tend to focus their work on very specific issues.

Finally, as a Member State of the European Union, Germany will continue to ensure that its GEO contributions are coordinated with European activities, such as the European GEO High Level Working Group, the European GMES Programme (Global Monitoring for Environment and Security), European Space Policy and the European Research Framework Programme.

C.1.3 Regional Offices: The Greek GEO Office (GGO)

History:

On February 6, 2006, the participation of Greece in GEO was announced in Brussels. Soon after, the Greek State (General Secretariat of Research and Technology), in collaboration with a Research Center (National Observatory of Athens-NOA), decided to create the GGO to carry out GEO-relevant activities at the national level. GGO, hosted at NOA, began operations in early 2007.

Funding:

Since its inception, the GGO operation is mainly supported by NOA, relevant research projects and a non-profit and non-governmental public welfare institution, the Mariolopoulos-Kanaginis Foundation for Environmental Sciences. These organizations cover the operational costs of the office, the salary of its secretary, travel expenses of the GGO Director and National GEO Principals to GEO relevant events (e.g., GEO Plenary) and costs for dissemination material and events (e.g., workshops). The unfortunate coincidence of the economic crisis in Greece has prevented regular commitment from the State for maintaining and further expanding GGO's activities. Since research projects cannot serve as regular sources of funding for GGO, it is imperative that new resources be sought, for instance, from the private sector, or else its contribution will remain circumstantial and disallow for long-term planning.

Contribution:

Currently, GGO is targeting effective and coordinated participation of the country in global activities under the framework of GEO and GEOSS, and the encouragement of GEO-related projects and activities. As such, GGO undertook a substantial role in enhancing GEO visibility and stakeholder awareness at the regional level, organizing and hosting several important regional workshops and meetings, including:

- October 2014 – 2nd SE Europe GEO Workshop on "Integrating Earth Observation Data and Services for Monitoring the Environment and Protecting the Citizens"
- June 2014 – International Conference "Adaptation Strategies to Global Environmental Change in the Mediterranean City and the Role of Global Earth Observations"
- June 2013 – 8th GEO European Projects Workshop (GEPW-8)
- April 2010 – 4th GEO European Projects Workshop
- June 2009 – 1st SE Europe and E. Mediterranean GEO Workshop on "Earth Observation Services for Monitoring the Environment and Protecting the Citizens"

Greece, thanks also to the efforts of the GGO, has two Participating Organizations involved in GEO, the interBalkan Environmental Center and the Mariolopoulos-Kanaginis Foundation, while GGO staff has actively contributed in several GEOSS evaluation activities (e.g., Fifth and Sixth Evaluation Teams, 2016-2025 Implementation Plan Working Group, Capacity Building Committee). In the last several years, GGO made efforts toward increasing coordination at the regional level via consortium building initiatives and inquiries for resource mobilization. The boom in EO studies, applications and services in Greece has been unambiguously abetted by the operation of the regional office, resulting in key leading and/or participating roles in the GEOSS Work Plan, including:

- Task SB-04 «Global Urban Observation and Information», Global Urban Supersites Initiative
- Task D1-01-C1 “Disaster Management Systems”, Informing Risk Management and Disaster Reduction
- Incorporation of the BEYOND Excellence Center (<http://www.beyond-eocenter.eu/>) activities in the updated GEO Work Plan under the task DI-01 “Informing Risk Management and Disaster Reduction”- Section C1 Disaster Management Systems.

Interview:

The National GEO Principal, Prof. Christos Zerefos, Academician, stated: *"The Greek GEO Office has significantly boosted GEO's vision in Greece, not only because it provided valuable administrative support, but also because it triggered systematic global Earth observations in the region, also in view of the fact that it is located in a well-recognized by IPCC hot spot for climate change, the Mediterranean. It lit the spark for the first, initially timid, steps of local researchers and has, with time, greatly expanded in terms of relevant capacities, like state-of-the-art observational ground-based sites and EO Excellence Centers like BEYOND, which is dedicated to EO-based monitoring of Natural Disasters in South-eastern Europe."*

C.1.4 European Commission (EC)

Europe – both through the participation of EU Member States and the EC itself – has made a leading and substantial commitment to the realization of the objectives of GEO.

Within GEO, the EC stands as a Member in its own right and, with the formal endorsement of the EU Member States, has, to date, held the position as the GEO Co-Chair for the European Caucus.

The EC has significant research and operation programmes, including:

- The EU Research Framework (currently Horizon 2020), which provides GEO with research elements necessary to develop GEOSS;
- Copernicus, the European Earth Observation Programme, coordinated by the European Commission; and
- The INSPIRE Directive (Infrastructure for Spatial Information in Europe), a powerful tool to overcome the major barriers still impeding availability and accessibility to Earth observation data in Europe.

EU Research Framework Programme contribution to GEOSS:

This programme provides GEO with research elements necessary to develop GEOSS and includes projects funded under the FP7 Cooperation Environment Theme (2007-13), which provided research elements very relevant to the development and exploitation of GEOSS. Examples include GEOWOW, EnerGEO, ENDORSE and GMOS. Activities are foreseen to continue under the new Research Framework Programme (Horizon 2020: 2014-2020), with a focus on the capabilities, technologies and data infrastructures necessary for Earth observation and monitoring that can continuously provide timely and accurate information, forecasts and projections.

Copernicus (formerly GMES) - The European Earth Observation Programme:

The EU Copernicus Programme is an ambitious Earth observation programme to provide accurate, timely and easily accessible services to improve the management of the environment, understand and mitigate the effects of climate change, and ensure civil security. As the single most ambitious civil Earth observation programme, the Copernicus Programme provides a major contribution to GEO, in particular through the delivery of a unique space infrastructure.

The Copernicus Programme is driven by a partnership between the European Commission, the European Space Agency (ESA) and the European Environment Agency (EEA).

The main objective of Copernicus is to deliver environmental services, building on Earth observation data sets. The principal achievement to date of Europe's Copernicus Programme is its prominent contribution to the development of space infrastructure necessary for Earth observation.

The INSPIRE Directive:

The Directive 2007/2/EC of the European Parliament and of the Council establishes an Infrastructure for Spatial Information in the European Community, providing a powerful tool to overcome the major barriers impeding availability and accessibility to Spatial Information in Europe. INSPIRE supports the specification and implementation of accessibility and interoperable geodata infrastructures in GEOSS, and is an important complementary contribution of the EC to GEOSS data sharing.

GEOSS benefit for the EU:

GEOSS offered a tremendous opportunity for the EU regarding innovation in the domain of Earth observation as it enabled access to a broad range of observational datasets. It opened new avenues for the delivery of products, services and applications integrating Earth observation data that directly address citizen needs in their day to day life, such as information about the quality of their environment, including factors affecting their health, the quality and quantity of food, the nature and impact of the energy sources used and the optimal use of renewable energy sources.

The EU can derive great benefit from GEOSS as a key instrument to deliver data and information in support of its policies, but also in view of negotiating and enforcing international agreements, such as the post-2015 agenda for sustainable development, the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biodiversity (CBD) and the [Sendai Framework for Disaster Risk Reduction 2015-2030](#).

C.2 Private Sector Engagement

C.2.1 Introduction

This case study, while not a comprehensive analysis of the involvement of the private sector in GEO, provides a view into the current situation regarding the links between GEO and the private sector.

At its inception, the main focus of the intergovernmental GEO was to build GEOSS. As a matter of fact, GEOSS was launched initially as a public good that would network/integrate existing public Earth observation systems at the global level.

Private sector engagement was not well represented in the GEOSS 10-Year Implementation Plan. In Chapter 7.1 (Funding of GEOSS), the Implementation Plan envisages contributions of other "entities" (including from the private sector) to the implementation of GEOSS. This reference was, at that time, more related to the resourcing of GEOSS through possible contributions by the private sector, either in-kind or in cash. It was not intended to create a real partnership between GEOSS and the private sector.

Since 2005, when GEO was launched, the global data landscape has changed. There is now a steady trend towards free, full and open access to public data and, more specifically, to Earth observation data, which opens new possibilities for business within the Earth observation sector.

The situation regarding Earth observations has also changed in recent years, due to constraints affecting public investments. Public infrastructures in the domain of Earth observation (both *in situ* and remote-sensed) are expensive and are now carefully analyzed by governments in terms of their service requirements and economic return on the public investment.

In this context, the use of public data to create services and products is seen by governments as a potential avenue for future growth in the emerging digital economy.

There is also a change occurring in the approach followed by public organizations regarding the management of their own data. As pointed out by the GEOSS 10-Year Implementation Plan Working Group¹², governments are now often passing responsibility for data collection, management and exploitation to the private sector and general public.

The engagement of the private sector in GEOSS has become a key strategic domain for the future of GEOSS, as it is required to determine what is expected by the private sector regarding access to Earth observation data that are handled through GEOSS, and what expectations can be reasonably made regarding the development of a market for services integrating Earth observation data.

¹² Document 5 for the 31st Session of the GEO Executive Committee, Interim Report of the Implementation Plan Working Group: Towards the 10-Year Implementation Plan 2016-2025.

The private sector includes a number of different institutions and organizations that have various interests in contributing to GEOSS development and in using GEOSS data and information. The analysis performed in 2009¹³ identified three broad categories for the private sector: providers of infrastructure and data; developers and providers of services; and end-users.

It also recognized the need to acknowledge the profit or non-profit nature of the institution/organization (e.g., private companies and/or foundations) when defining a potential framework for engagement and interaction. In this case study the private sector is characterized as either non-profit or commercial.

C.2.2 On-going Process for Engagement

The debate within GEO regarding the engagement of the private sector was initiated quite early in the initiative. Already in 2007, at the 11th Session of the GEO Executive Committee in Cape Town, South Africa, a discussion began on the engagement of the commercial sector. The GEO Secretariat had been tasked to work on this issue, to explore options for making commitments with the private sector, including the best practices of other relevant organizations.

However, it was only in 2013 that more concrete decisions were made by GEO to move to a more proactive approach towards the private sector. Following recommendations made at Plenary IX in November 2012, the GEO Secretariat was tasked to draft a plan for launching a GEO private sector forum.

This resulted in the organization of a Pre-Conference Workshop of the Geospatial World Forum in May 2014 in Geneva: "*Geospatial Industry Forging Ties with GEOSS*". The workshop convened approximately 60 representatives of the data provider and value-added companies, government agencies and GEO leaders to discuss the potential benefits of GEOSS to the commercial sector.

Following this event, there were three additional meetings organized by the European Caucus (September 2014), the Implementation Plan Working Group (December 2014) and USGEO (February 2015) to continue the dialogue between GEO and the private sector. Each of these events demonstrated that the commercial sector does not know much about GEOSS.

The main outcome from those preliminary consultations was an acknowledgement by GEO's leadership that a continuous dialogue with the private sector is needed to define modalities and clear boundary conditions stating clearly where GEOSS public services stop, the "boundaries" within which the private sector could operate, and how GEO will engage with the private sector. This also includes a clear definition of the different data policies used by different entities and sound open data licenses concerning the use of data acquired through GEOSS by commercial entities. A continuous dialogue would help to ensure that GEO is recognized as a facilitator for, rather than a competitor with, the private sector. This dialogue has already begun, at least informally with, for instance, the European Association of Remote Sensing Companies (EARSC)

¹³ Executive Committee 16th, Doc.18

Finally, in March 2015, the 33rd Session of the GEO Executive Committee decided to create a sub-group that would prepare an Engagement Strategy outlining GEO's interactions with selected communities, including the private sector.

C.2.3 Current Private Sector Engagement in GEOSS

As GEOSS is implemented on the basis of a voluntary effort, and despite the fact there was not initially a specific strategy regarding the engagement of the private sector within GEO, there are already a significant number of private sector entities involved in the implementation of GEOSS.

1) Case of non-profit entities involved in GEO:

Private, non-profit entities are contributing to various tasks of the GEOSS 2013-2015 Work Plan, and they have been often involved since the beginning of GEOSS as Participating Organizations (<https://www.earthobservations.org/pos.php>). They are conducting various activities that are crucial to the implementation of GEOSS in the domain of capacity building, user engagement, and in implementing various Tasks within the different GEO SBA's. The contribution of private entities to GEO has been very important during the first phase of the implementation of GEOSS. It is impossible here to list all the contributions (see WP 2013-15), but two examples are mentioned here as illustration.

The Open Geospatial Consortium (OGC) is an international consortium of more than 500 companies, government agencies and universities participating in a consensus process to develop publicly available interface standards. OGC is a Participating Organization within GEO. OGC provides GEO with direct connection to the research and private sectors through its consortium role. OGC standards are critical components of the GEOSS Information System, and the organization helps to manage the GEOSS Architecture Implementation Pilot (AIP) program, through which new users, communities (e.g., Energy and Water), datasets and services are engaged in GEOSS.

The Institute of Electrical and Electronics Engineers (IEEE) is a non-profit professional organization, with more than 400,000 international members from the engineering and technical fields. The organization is recognized globally for its development of international standards, publication of high impact journals and the conduct of numerous international conferences. IEEE members have been contributing to the architecture and technology of GEOSS, leading the GEO standards activity and several Work Plan Tasks. IEEE has also contributed to the science supporting GEO and has been instrumental in the formation of a number of communities of practice (CoPs), including health, energy, coastal zone and geohazards. In both the coastal zone (part of the GEO Blue Planet initiative) and geohazards CoPs, IEEE members have played a leadership role. In the area of outreach and awareness, IEEE members have coordinated more than 40 GEO workshops introducing the GEO concepts and practices to the global community, and illustrating its applications to the GEO SBAs. IEEE members also co-chair and contribute to the GEOSS Science and Technology Stakeholder Networks and the workshops organized by this community initiative. Beyond the technical community, an important IEEE support of GEO outreach to the general public is through Earthzine, an IEEE on-line magazine.

2) Case of commercial sector involvement:

The EU Framework Programme for Research and Innovation provides opportunity for small and medium-sized enterprises (SMEs) or larger companies to develop innovative solutions derived from Earth observations, to prototype services, and to deploy and test them in close-to-market conditions.

Examples: The development of Earth observation capabilities under the FP is focusing on novel *in situ* Earth observations systems for GEOSS, such as citizen observatories involving SMEs. The citizen observatory concept¹⁴ includes portable devices and sensors, mobile applications and the necessary infrastructure to facilitate the sharing of data and information provided by citizens, and its integration with authoritative data, taking into account data protection and security issues. Other FP projects are dealing with the development of cheaper sensors and monitoring platforms for the surveillance of the ocean (projects NEXOS¹⁵, SENSE OCEAN¹⁶, SCHeMA¹⁷, COMMON SENSE¹⁸). In all these projects, the commercial sector is involved in the development of the new technologies, mostly through the participation of SMEs.

Some EU projects in FP7 and Horizon 2020 also contribute to developing the use of Earth observation data by involving European companies in different GEO Societal Challenges (for example, the Dutch company, Deltares, has participated in the assessment of global resources). European companies are also actively involved in the development of Copernicus operational services.

Example: collaboration between the US Geological Survey (USGS) and ESRI to produce online map-based versions of the USGS's new map of Global Ecological Land Units¹⁹, intended to improve our understanding of ecological diversity. It is a 250-meter spatial resolution global map and database of ecological land units, derived from a stratification of the Earth into unique physical environments and their associated vegetation. The mapping approach first characterizes the climate regime, the landforms, the geology, and the land cover of the Earth, and then models terrestrial ecosystems as a combination of those four land surface characteristics.

Example MYGEOSS initiative: the EC has launched an open call for development of innovative applications (mobile or web-based) using openly available or crowd-generated data in different domains addressing citizens' needs. The focus of this call is on developing applications that will provide users with quantitative or qualitative information on the changing environment, e.g., change detection in climate, biodiversity, water bodies, coastal areas, built environment, green areas, forestry, agricultural land and crops, and atmospheric composition. The commercial sector can participate in the development of the GEOSS Apps.

¹⁴ http://ec.europa.eu/research/environment/index_en.cfm?pg=gepw-meeting-5§ion=geo

¹⁵ <http://www.nexosproject.eu/>

¹⁶ <http://www.senseocean.eu/>

¹⁷ <http://www.schema-ocean.eu/>

¹⁸ <http://www.commonssenseproject.eu>

¹⁹ http://rmgsc.cr.usgs.gov/ecosystems/docs/AAG_Global_Ecosystems_Booklet.pdf

C.2.4 Questionnaire and On-line Survey Feedback

1) Survey:

Only a small percentage of survey respondents came from the private sector, thus supporting the observation that the private sector is not very involved in GEOSS. Several survey responses, however, mentioned that a lack of private sector engagement has hindered success in the implementation of GEOSS.

2) Interviews:

The interviews were not designed to address GEO-private sector issues, *per se*. However during the interviews, comments came spontaneously regarding the private sector, in particular in the user engagement section.

Throughout the interviews, the private sector stands out as an emerging user of GEOSS. Private sector engagement and, more generally, user engagement is not considered as satisfactory by interviewees. But the fact that GEO intends to increase the involvement of the private sector is more or less welcomed. An interviewee suggested the creation of more public-private partnerships to showcase the daily usefulness of EO data. Others view GEO/GEOSS as a governmental framework for contributing to governmental decision makers; therefore, they do not see benefits from partnerships with the private sector, industries and UN organizations (except in some areas such as Forests, Disasters, etc.)

GEOSS has reached some end-users, such as government agencies or companies, but not, to any significant degree, the value-adding or intermediary users who turn EO data streams into useful information. This could be explained by a lack of exploitation of what the private sector NGO's and academic networks have to offer; limited explicit links to the private sector and non-UN NGOs; or limited knowledge of GEOSS in the private sector.

It should be recognized that many forms of the "private sector" already contribute to GEOSS, yet GEO seems not to be aware of this, and GEO is only now trying to engage the private sector more systematically.

A concern was noted that the technology incorporated in GEOSS is not evolving at the same pace as the private sector and, thus, falling behind. Remediating actions that were solicited by informants included a suggestion to let Portal management be handled by the private sector, and that the Communities of Practice should be strengthened with broader academic and private sector participation.

C.2.5 Findings

- The GEO community seems not to be aware regarding the involvement of the private sector within GEOSS: there are already indeed private sector entities involved in GEOSS implementation.
- The involvement of non-profit entities is already significant in GEOSS, and a clear distinction has to be made between non-profit entities that are already part of the GEOSS organization and the commercial sector.

- Non-profit entities provide a significant contribution to the implementation of GEOSS, notably regarding capacity building activities, the development of the GEOSS infrastructure and in the organization of outreach activities.
- The commercial sector is not really aware of the objectives and content of GEOSS.
- The commercial sector is involved to a lesser extent and, in general, as a provider of technical expertise for the development of new observatories, for the provision of new Earth observation processing facilities, or development of new Earth observation products.
- The involvement of the commercial sector usually resulted from initiatives of Governmental agencies or organizations, such as USGS in the USA or the European Commission Research Programme in Europe.
- There is currently little evidence of commercial exploitation of GEOSS data.
- There have been attempts made within GEO (e.g., the 2014 GEO Appathon) to promote the commercial exploitation of GEOSS data that are good starting points for future efforts.

C.3 Architecture Implementation Pilot (AIP)

C.3.1 What is AIP?

The **GEOSS Architecture Implementation Pilot (AIP)** develops and deploys new process and infrastructure components for the GEOSS Common Infrastructure (GCI) and the broader GEOSS architecture. AIP is an element of GEO Task IN-05 “GEOSS Design and Interoperability” that develops and pilots new process and infrastructure components for the GCI and the broader GEOSS architecture. The main aims of AIP are to reach consensus on Interoperability Agreements and to register operational components and services that carry forward into persistent operations of GEOSS. Further, AIP conducts research and prototyping to recommend improvements to the GEOSS architecture, as well as generates best practices of how GEOSS data and components can be used in scientific workflows outside of GEOSS.

According to the document “AIP Implementation Process. GEOSS Architecture Implementation Pilot (AIP)²⁰. Version 28th January 2015”, AIP employs an “evolutionary development process” whereby the architecture, the delivered systems and the stakeholders co-evolve. Stakeholder needs are reassessed with each iteration of the architecture; the architecture is used to guide each system as it moves through development, and appropriate versions are used to evaluate each system on delivery. So far, the AIP development process has completed seven phases, each initiated with a Call for Participation (CFP). The eighth CFP had a deadline of 27 February 2015.

²⁰ http://www.earthobservations.org/documents/cfp/201501_geoss_cfp_aip8_development_process.pdf

The major deliverables in an AIP phase are:

1. Easy-to-use online (Web and Mobile) apps that demonstrate the value of standards-based access to EO data and services registered with GEOSS and activities to support the key apps;
2. Documentation of the results of the AIP Phase in Engineering Reports regarding the scenarios and technical topics; and
3. Demonstration of the newly developed functionality using the SBA scenarios and selected technical topics.

As an element of the development, AIP has defined a System Design process structured using Scenarios and Use Cases. Scenarios describe how GEOSS is envisioned to support SBA Communities of Practice. Use Cases are reusable transverse technology approaches for implementing the scenarios.

C.3.2 Content

In general, the deliverables from the AIPs have been technical and SBA-related demonstration videos and engineering reports with the following content:

1. AIP-1 addressed the following scenarios: Sub-Saharan African Wildfire, Africa Ecosystems & Biodiversity, Polar Ecosystems & Biodiversity, Oil Spill Response, Volcano Eruption Response, Hurricane Response, GEOSS Registry and Clearinghouse Workflow, and Portal Candidates;
2. AIP-2 covered GCI Publishing Services, Disaster Management, Pika Biodiversity, Arctic Food Chain, Polar Ecosystems, Air Quality, Renewable Energy and GEO Web Portals;
3. AIP-3 included Energy, Disaster Management, Biodiversity: E-habitat, Biodiversity: Arctic SDI, Air Quality, Drought: Global, Drought: European, Data Sharing, Data Harmonization, Semantics and Ontology;
4. AIP-4 had two major activities:
 - Activity #1 focused on increasing the accessibility of priority Earth observations as identified by the GEO User Interface Committee.
 - Activity #2 focused on Application Clients, Community Portals and Mediation tier components development to improve the exploitation of datasets provided through the GCI.Summary videos addressed solar energy, environmental and emergency management and health.
5. AIP-5 was organized in two major activities:
 - Activity #1 focused on the Societal Benefit Areas of Agriculture, Disasters Management, Energy Health and Water, which were covered in summary videos.
 - Activity #2 focused on technical topics.
6. AIP-6 aimed to increase the use of GEOSS resources by the end-users in applying *in situ* and remotely sensed data to the SBAs of Agriculture, Energy and Water.
7. AIP-7 had as a primary outcome the creation and deployment of several modern, light,

Web or mobile applications (“apps”) that are fed by multiple registered standards-based data and processing services. The following activities were included in the demonstration videos:

- Flood and Drought Monitoring, Food Security and Energy Management
- Environmental Monitoring using Mobile Sensors, Citizen Observatories, Crowd Sourcing
- Wind and Solar Energy Potential Estimator
- Earth Cover Change Detection
- Ocean Observations and Commercial Fisheries

8. AIP-8 included the following in its CFP:

Develop and deploy easy-to-use online (Web and Mobile) apps that demonstrate the value of standards-based access to EO data and services registered with GEOSS:

- Flood and Drought Monitoring, Food Security and Energy Management
- Environmental Monitoring using Mobile Sensors, Citizen Observatories, Crowd Sourcing
- Crop Insurance
- Agriculture and Water Pollution
- Wind and Solar Energy Potential Estimator
- Earth Cover Change Detection
- Ocean Observations and Commercial Fisheries
- Precision Farming
- Disaster Monitoring and Management

C.3.3 Results and Deliverables

The AIPs develop solutions for selected scenarios within SBAs. Consortia from the SBAs develop them, and the results are presented via the following deliverables, which have been basically the same since AIP-1, completed in November 2007:

- SBA Demonstration Videos
- Technical Demonstration Videos
- Engineering Reports

The deliverables can be found at the GEO website:

<http://www.earthobservations.org/geoss.php>

As the AIPs have been reviewed by only one Evaluation Team member, only a limited number of videos and reports have been reviewed, and none in a very detailed way. The Demonstration Videos have highly variable information value in explaining the challenges and reasons for developing SBA portals, ranging from one minute of a person with a mobile phone, to 10 minutes or more of guidance on how to access information in a particular scenario.

The Engineering Reports, however, seem to follow a more or less similar outline:

1. Introduction, including summary and future work
2. Community SBA objectives
3. Scenario description, with actors, context, scenario events

4. System model of the scenario
5. Use case, with some information on how to publish and discover resources
6. Implementation, with deployed components, interoperability arrangements and demonstrations, the latter may be links to the Demonstration Videos.

Under 5 above, many of the (cursory) reviewed Engineering Reports do not provide links, but only instructions such as:

- Search for resources of interest. Variations: user initiated (e.g., GEO Work Plan), process initiated, searching data sharing conditions.
- Harvesting and/or query metadata from community catalogs or services via GEOSS Clearinghouse.

Others give quite clear instructions, such as:

“Local policy planners, private investors and/or installers of renewable energy systems (GEOSS User) are searching for resources regarding solar energy for decision-making on a local area. These resources, as a form of Web Services, are discovered through the GEO Portal and/or the Webservice-Energy Catalog. The GEO Portal and/or the Webservice-Energy Catalog provide minimum information about available services and how to access them. This includes GEOSS DataCORE and Helper Application information.”

As the AIPs are usually developed by GEO communities, they often develop separate community portals that can be accessed through the GEOSS Portal. Examples are the:

- WorldWaterOnline portal (www.worldwateronline.org) for Water
- The Brigham Young University HydroServer Lite (worldwater.byu.edu/hydroserverint.php) for Water
- Webservice-energy (www.webservice-energy.org) for Energy

Using the Energy and Water portals as examples, the reviewer found it easier to access specific data from these SBAs than going through the GEOSS Portal itself. Both are accessible from the GEOSS Portal, but the SBA portal names must be known. Thus, it will improve access to information if these two specific AIPs were made more well-known outside the relevant communities.

Many AIPs offered by the SBA communities are based on projects already funded at national or regional levels and adapted to the needs of GEOSS and its GCI.

C.4 GEO Appathon 2014

C.4.1 Introduction

The GEO Appathon was a global app development competition open to any non-commercial individual, team or entity (students, scientists or developers) with interest in relating Earth observations (EO) to decision-making. Using the GEOSS Portal and GEOSS Application Program Interfaces (APIs), Appathon participants were encouraged to discover, research and apply any types of Earth observation data to inform decisions makers at all levels – from ordinary citizens to national level disaster preparedness planners.

Within GEO, there have been few efforts to broadly develop easily accessible and user-friendly decision-making tools. The GEO Appathon was the first attempt to use crowdsourcing and competition to exploit the usefulness of EO data being developed and contributed to GEOSS. The Appathon's primary goal was to demonstrate the potential usefulness of EO to decision-making through the creation of mobile applications that integrate EO in an accessible, user-friendly and visually intuitive manner. In no particular ranked order, other related goals included finding and highlighting innovative uses of EO, addressing specific information challenges, informing and educating the public on the power of EO, engaging new people and communities, and building capacity. The Appathon encouraged the development of applications that relate to GEO's nine SBAs, as well as to the needs of decision makers in developing countries.

C.4.2 Results

The Appathon kicked-off on May 7, 2014 at a special event at the Geospatial World Forum in Geneva, Switzerland. This event, which was attended by prospective competitors both in person and via a webcast, introduced participants to the Appathon's objectives and guidelines and offered "how-to" presentations by experts from the Earth observation and app development communities. The GEO Secretariat used the Appathon's website (<http://geoappathon.org>) and a series of YouTube videos and online presentations as the primary means to distribute information about the Appathon. Teams were required to be registered by August 31, 2014. 246 people registered for the Appathon. 104 of these registered as individual-member teams and the remainder comprised 31 different multi-member team registrations. 49 different countries were represented, spanning North America, South America, Africa, Europe, and Asia.

USAID funded the Appathon's awards. The prize breakdown was as follows: \$5,000 for 1st place, \$3,500 for 2nd, \$2,500 for 3rd, and \$1,250 each for 4th and 5th. Five additional awards of \$1000 each were available to apps that best targeted GEO's SBAs, and two awards of \$1,250 each were available to those that best addressed challenges in developing countries. In total, \$20,000 in prize money was available.

In the end, only 10 teams submitted final apps for judging at the conclusion of the competition on September 30, 2014. Judging took place in late October/early November 2014. All apps were individually and independently judged by a panel of eight EO experts and/or software developers according to the following set of criteria: number of data sets used, relation to GEO Societal Benefit Areas, the number of technical platforms the app was designed for, implementation of the GEOSS API's, possibility for future expansion,

relevance to addressing challenges in developing countries, audience interpretation, ease of use without instruction, visual impact, and app ‘uniqueness’. Five apps ultimately won awards, which were announced on November 13, 2014, during the GEO Plenary Meeting in Geneva, Switzerland.

C.4.3 Analysis of the Low-level of Submission

During the final month of the Appathon, each participant was contacted personally up to 5 times with reminders to submit or provide an explanation for non-submission. Figure C.1 summarizes the responses received. Of the 42% that responded, a common reason for non-submission was that they were too busy or ran out of time (16%). 58% did not respond at all to final communications, which could indicate a degree of misunderstanding of what the Appathon was or a disengagement during the period of the Appathon where little communication was provided.

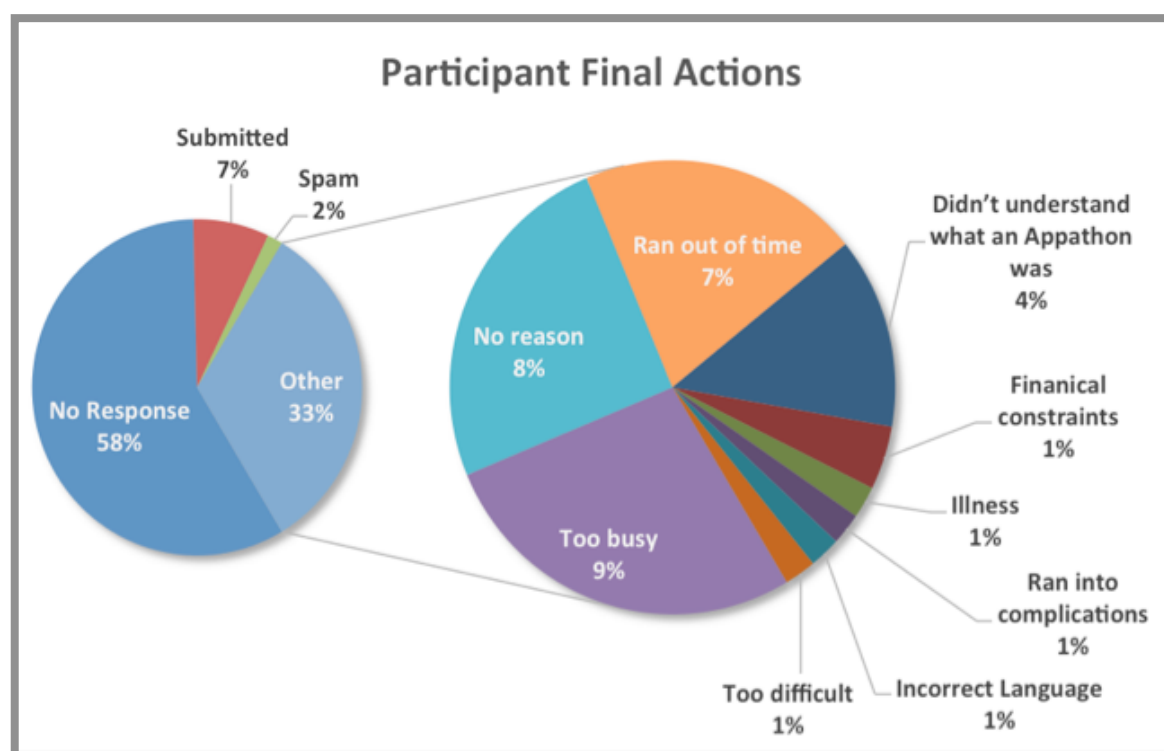


Figure C.1. Feedback (or lack of response) from Appathon participants regarding their participation.

The Appathon was designed from the bottom-up with a new process, website, technical specification and administration route being created with a small team and small budget. Because of the limited resources, the period between the kick-off event and final submission date was streamlined to focus on marketing the Appathon and responding to specific questions from the participants. Originally, this period would have included a dedicated outreach programme to participants, informing them of the GEOSS system and its potentials, as well as other software creation type activities.

Although specific guidance and the judging criteria was provided to the participants, little guidance around the GEOSS system or how to use the data within was provided. This partly

stems from the resource constraint encountered, but also from this being the first Appathon of its kind led by GEO.

The Appathon team also conducted a survey with Appathon registrants and participants to learn more about their experience to inform potential future Appathons. From the 19 survey responses, Figure C.2 lists the challenges that teams faced during the Appathon. The number one challenge was insufficient time. Only one team response indicated that they did not fully understand the Appathon’s instructions and goals, which indicates that the Appathon team did a good job communicating.

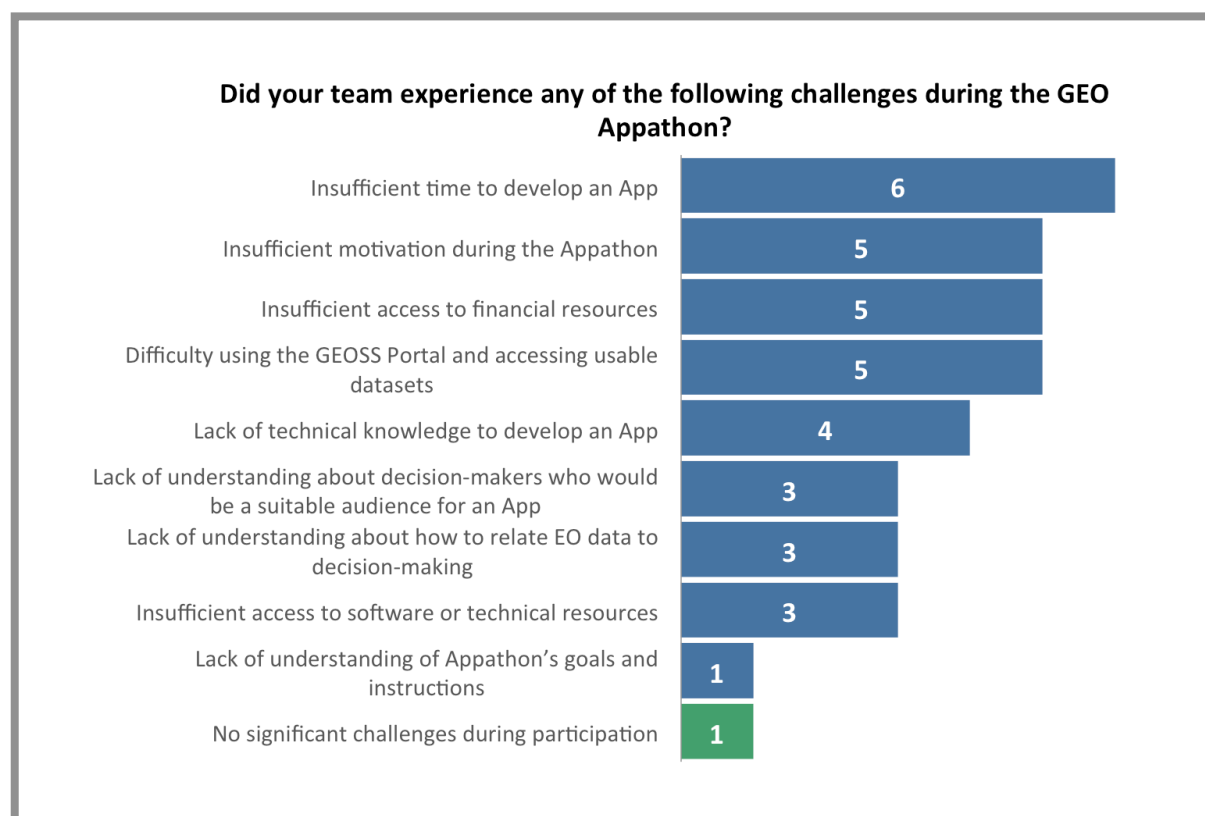


Figure C.2. Challenges that teams faced during the Appathon. Many survey responses listed more than one reason.

Additional survey questions (see Figure C.3) indicated that:

- The majority of respondents were either neutral or satisfied regarding their capability to find data using the GEOSS Portal (only 1 respondent was dissatisfied).
- The respondents were generally split in regards to the importance of prize money as a key motivation to participate.
- The vast majority of respondents are likely to participate in a future GEO Appathon.

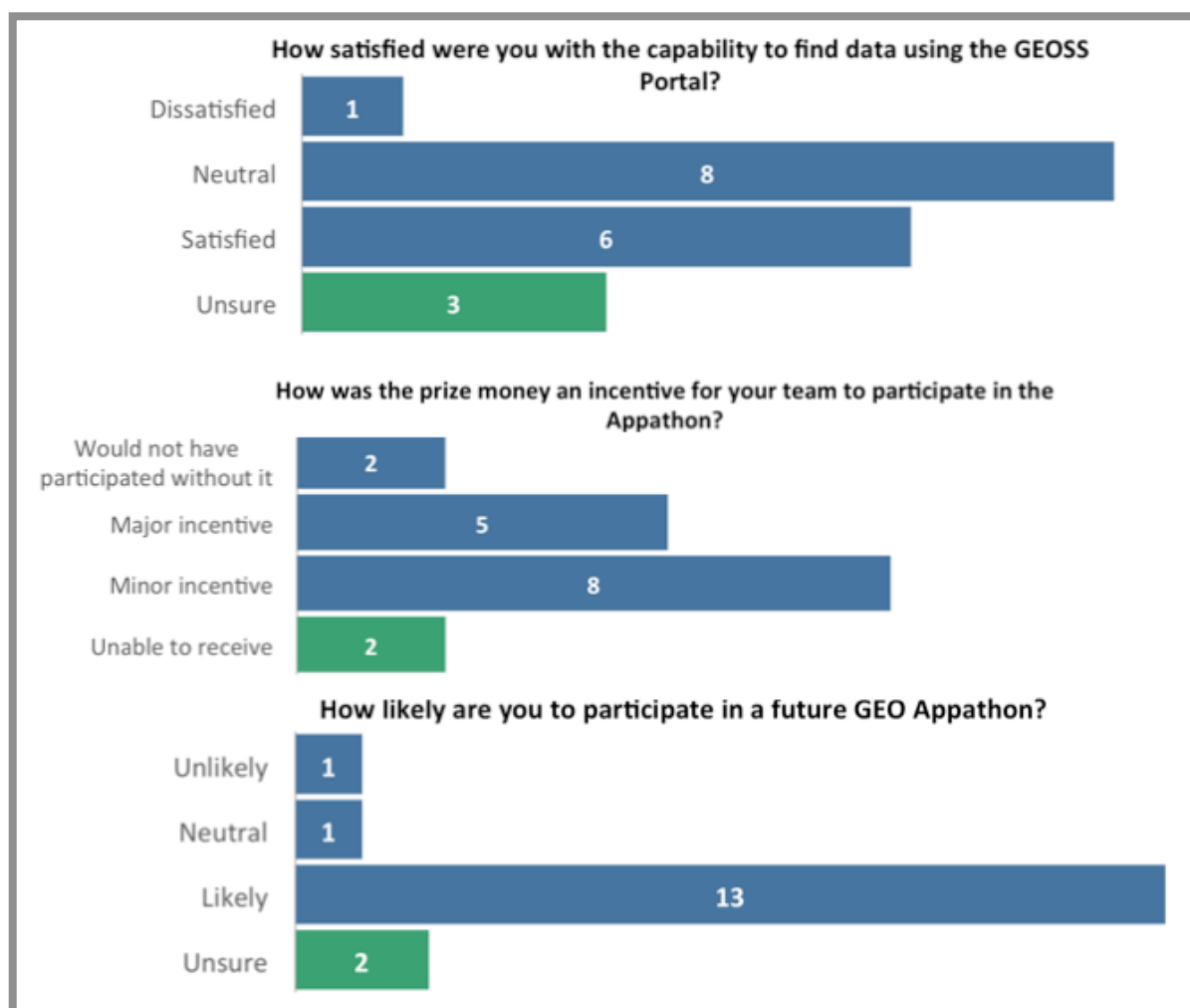


Figure C.3. Additional post-Appathon survey questions and responses.

C.4.4 Conclusions

A higher than expected interest occurred for the Appathon and a clear intent to submit with defined ideas was observed. Only 10 teams (7%) submitted a final app by the conclusion of the competition. The post-competition assessment suggests that a resource constraint, the newness of the approach, and a lack of prior knowledge regarding the challenges that participants would face, may have led to the low submission rate.

The GEO Appathon 2014 was the first of its kind led by GEO in the EO sector and, as such, the Appathon team gained invaluable experience and feedback that could lead to a sharper, more focused Appathon in the future.

Because GEO and GEOSS are global and international voluntary initiatives, underpinned by an emphasis on the importance of open data sharing, an Appathon competition was preferred as a low cost and innovative way to demonstrate the usefulness of the vast EO data resources openly available through GEOSS. Given the voluntary and budget constrained nature of the GEO community, the Appathon could represent a very sustainable approach (if successfully replicated in the future) toward achieving GEO's ultimate goal to broadly inform societal decisions.

C.5 Capacity Building Projects within the Asian Water Cycle Initiative

Within the AWCI (Asian Water Cycle Initiative), international development aid agencies such as the Asian Development Bank (ADB) and the Japan International Cooperation Agency (JICA) support capacity building activities utilizing earth observation data and information.

ADB's Technical Assistance project "Applying Remote Sensing Technology in River Basin Management" supported Bangladesh, the Philippines and Vietnam in applying space-based earth observation information, and information and communication technology, to river basin flood management. The flood management agencies of the pilot countries were the target agencies of the project. ADB supported development of methodologies and systems to apply satellite-based rainfall data to flood models in pilot river basins, to disseminate flood warning information to citizens using mobile phone Short Message Service (SMS) and Web-based Geographic Information System (WebGIS), and to conduct capacity development programs for the developed systems.

The Global Satellite Mapping of Precipitation (GSMaP) product provided by JAXA was used as input data for the flood models in the target river basins for more effective flood forecasting. These models included the Integrated Flood Analysis System (IFAS) in the Philippines, which was developed by the International Center for Water Hazard and Risk Management (ICCHARM), and the Water and Energy Budget-Based Distributed Hydrological Model (WEB-DHM), developed by University of Tokyo. Other activities in this project included:

- A series of training efforts to operate and maintain the introduced systems and to utilize information provided by those systems were conducted.
- Policy guidelines that describe how to expand the introduced systems to other areas in each pilot country, based on a cost benefit analysis, were developed to promote sustainable use and expansion of the developed systems after the project finished.

The project was successful at introducing and demonstrating systems that apply satellite-based rainfall data for flood management, and establishing capacity development programs to ensure sustainable utilization of the systems by end-users. As the systems introduced under the project use free data, the users can continue to operate them in a sustainable manner with minimum operational cost. Capacity development was conducted not only for the data "providers", such as hydro-meteorological agencies, but also for the "users" of flood warning information, such as local disaster management officers. This was important to help end-users understand how to interpret flood warning information, such as forecasted water levels, and make decisions for disaster management.

Another example is the JICA project for Assessing and Integrating Climate Change Impacts into the Water Resources Management Plans in Indonesia. There is growing concern that Indonesia will experience increased future floods and droughts caused by climate change. Therefore, this project aims to assess water resources vulnerability under climate change impacts to inform water resources management in Indonesia. The project is expected to result in a Water Resources Management Plan, with consideration of the impact of future climate change by 2050, for the Brantas and Musi river basins. The Government of Indonesia (GOI)

is expected to learn planning methodologies, including climate change impact analysis, which can then be applied to other river basins in Indonesia. Since the capacity development of the related agencies is a key to successful nationwide water resources management, it is recommended that the Indonesian stakeholders be deeply involved in the planning process. The climate change impact analysis within this project utilizes results from the Coupled Model Intercomparison Project (CMIP), as well as other earth observation data stored in the Data Integration and Analysis System (DIAS) of the University of Tokyo being developed under the scope of GEOSS. Therefore, further promotion of Earth observation data aggregation is also critical to improving the accuracy and reliability of the project's analysis. Incorporating climate change impact analysis into basin-wise water resources management plans is a novel challenge that is rarely practiced in developed countries, so this project may be a model for other countries that are vulnerable to climate change.

In accordance with EU policies and research funding commitments, the EU has continued to support the strengthening of GEO's engagement with developing countries in relation to sustainable development, as well as regional cooperation. Specifically, the EU supports capacity building in the African continent and the greater Mediterranean area. For example, DG DEVCO (EuropeAid) supports Copernicus in Africa, which is being implemented through a series of projects and initiatives funded primarily through the European Development Fund, as well as the MESA initiative (Monitoring for Environment and Security in Africa). EU FP7 capacity building projects in Africa include AGRICAB (Develop Increased Earth Observation Capacity for Better Agriculture and Forest Management in Africa) and MEDINA (Marine Ecosystems Dynamics and Indicators for North Africa).

Annex D: Synthesis and Results of Past Evaluations

D.1 Evaluation History and Methodology

The GEOSS 10-Year Implementation Plan lists, as a functional component, the capacity "to monitor performance against the defined requirements and intended benefits". Toward creating this capacity, the Monitoring & Evaluation Working Group (M&E WG) was established by a decision of the GEO-V Plenary in November 2008. The M&E WG has provided guidance for and ensured consistency between all five past GEOSS evaluations. The first evaluation, which was the Implementation Plan's midterm evaluation completed in 2010, was comprehensive across the GEO Work Plan. Evaluations 2-5 focused on the SBAs of: Architecture and Data Management (#2); Agriculture, Biodiversity and Ecosystems (#3); Disasters, Energy and Health (#4); and Water, Weather and Climate (#5).

All prior evaluations had similar methodology. Data were collected from various sources including key informant interviews, web-based surveys, GEO documents, external documents, case studies, and literature. The later evaluations benefited from improvements in reporting by the several Implementation Boards.

Interviews and web-based surveys have provided large quantities of information from across the GEO community for each of the Evaluations. Table D.1 shows the number of respondents from each Evaluation's interview process and web-survey. The Midterm Evaluation received a larger number of responses than others.

Table D.1: Number of respondents during the successive evaluations

Evaluation	Year Completed	Interviews	Web-Survey
Midterm	2010	75	202
2 – Architecture and Data Management	2011	31	219
3 – Agriculture, Biodiversity, and Ecosystems	2012	46	N/A
4 – Disasters, Energy, and Health	2013	32	70
5 – Water, Weather, and Climate	2014	36	85
Summative (Sixth)	2015	57	80

D.2 Summary of Prior Evaluations

The Midterm Evaluation was quite optimistic regarding GEOSS's progress toward Strategic Targets, while Evaluations 2-5 were more moderated in their assessments. This may be due to two factors: 1) the Midterm Evaluation did not go into great detail as it covered all nine SBAs and the four cross-cutting themes; and 2) the later Evaluations increasingly took place

closer to the deadline for meeting Targets, and therefore were more reasonably able to assess the likelihood of achievement.

The evaluated progress toward Strategic Targets varied across the SBAs. Progress within Agriculture, Biodiversity and Ecosystems was deemed *Moderate*, while progress in Water, Weather, and Climate was identified as *Good*. Work within the Architecture, Data Management, Disasters and Energy SBAs was evaluated as unable to achieve their Strategic Targets unless new tasks or components were added. The SBAs of Water, Weather and Climate were found to be on track to meet their Strategic Targets by 2015 if all associated activities are completed.

Other findings from the first five Evaluations are:

- GEO represents an important new Earth observation community and network, but the mission, roles and responsibilities of GEO/GEOSS are unclear.
- GEOSS has added value to the Participating Organizations and Member States, mostly through large cooperative initiatives, facilitation of international coordination, and creating a global framework for free and open data exchange. There seems to be less evidence that GEO is increasing the use of Earth observations or building institutional capacity.
- Progress within the Work Plans has been slower than planned due to resource constraints, the voluntary nature of GEO, high turnover within Target and Task leadership, and/or national funding restrictions.
- To address the problem of Strategic Targets and related Outcomes being viewed as either too easy to achieve or too ambitious, many respondents suggested that they be revised and indicators developed for assessing progress.
- Cooperation across SBAs, across Tasks, and within SBAs is limited and must be improved.
- The GEOSS Portal was often described as not user-friendly and ineffective for accessing quality data.
- In Water, Weather and Climate, there are unclear interfaces between GEO and intergovernmental and national organizations.
- There is evidence of positive progress in user/stakeholder engagement and capacity building in the Water, Weather and Climate SBAs. Nevertheless, there are gaps in capacity building in developing countries, for example throughout Latin America, Africa and Central/Northern Asia.
- For some SBAs, progress in user/stakeholder engagement was noted, but, in general, the engagement of users and other stakeholders should be improved and the existing user engagement techniques and practices should be strengthened.

D.3 Key Findings

This Section lists the key findings from the first five GEOSS Evaluations. Note that in Evaluations 2 and 3, the key findings were provided as “conclusions”. Within the following list of compiled findings, the first number represents the evaluation and the number after the period representing the finding from the corresponding evaluation.

- 1.1 GEOSS represents an important new Earth observation community and network. GEOSS has raised visibility of the importance and need for integrated global Earth observations.
- 1.2 Current GEOSS implementation sufficiently reflects high-level Ministerial priorities including those contained in the Cape Town Declaration.
- 1.3 Stakeholders are generally positive about the foundation that has been established and optimistic that appropriate outcomes are being realized.
- 1.4 GEOSS implementation has brought together various organizations and governments to collaborate and support integrated global Earth observations.
- 1.5 GEOSS implementation has created a path to enable full and open data sharing and lowered discussion barriers.
- 1.6 GEOSS implementation has resulted in positive outcomes for the Earth observation community, such as Data Sharing Principles.
- 1.7 GEO has not adequately communicated evidence of progress to show value-added results unique to the implementation of GEOSS and to unequivocally prove a positive return on investment.
- 1.8 Survey respondents had an overall “neutral” feeling towards the status of GEOSS development and implementation at this point.
- 1.9 Stakeholders perceive that architecture developed by GEO does not yet meet their needs for data, information, and tools.
- 1.10 Stakeholders are concerned about the sustainability of GEOSS with regard to (a) the voluntary nature of GEOSS implementation which has been beneficial up to this point for engaging partners; and (b) the lack of sufficient resources, both financial and human to sustain efforts into the future.
- 1.11 Stakeholders indicated widely varying expectations for GEO and GEOSS, particularly as a source of new funding or a competing operational entity.
- 1.12 Some stakeholders view current GEO practices as co-opting achievements of contributors and giving them limited or no acknowledgement or credit.
- 1.13 GEO has not conducted a comprehensive gap analysis of either their implementation approach (structural) or observation needs (observational).

- 1.14 The GEOSS implementation approach does not explicitly describe an end-to-end process of how the application of resources supports the overall vision and goals of GEOSS, how or why benefits are expected, or when benefits will be achieved. Without this, it may be difficult for stakeholders to make well-informed decisions about supporting GEOSS.
- 2.1 There is no clear evidence that the ADM Strategic Targets will be met by 2015.
- 2.2 The User Interface is difficult to use because it does not follow good human factors engineering practices.
- 2.3 Although the implementation of the GCI provides a standard infrastructure and platform, there is not a uniform, consistent way that data are registered, stored, and accessed.
- 2.4 Lack of Systems Engineering Rigor
- 2.5 Technology employed by GEOSS is not current.
- 2.6 Data may exist, but it is difficult to find.
- 2.7 There is no formal process by which gaps between Targets and Tasks are addressed.
- 2.8 The present progress reporting against Tasks Sheets, although it uses a standard form, does not allow for a quantitative evaluation of progress.
- 2.9 The capabilities of GEOSS are not well communicated to the global community.
- 2.10 Commercial and intellectual property rights are perceived as a barrier to publishing data in GEOSS.
- 2.11 GEOSS has both direct and indirect effects.
- 3.1 The recognition of GEO work by international entities like the G20 for the Agriculture SBA and the UN Convention of Biological Diversity for the Biodiversity SBA and the establishment of cooperative initiatives are major accomplishments strategically, as well as with respect to cooperation and data sharing.
- 3.2 There is moderate to low confidence that most outcomes of the Agriculture, Biodiversity and Ecosystems SBAs will be achieved by 2015. Where there is success it is mainly due to goals, which are more broadly stated (i.e., increased use of EO or improved collaboration), or activities that are being done independent of direct GEO involvement. The degree to which outcomes will be achieved depends on levels of future funding.
- 3.3 Success has been reported for both GEO BON and GEOGLAM and their plans, but for these tasks, there is uncertainty in terms of resources and coordination. Thus the implementation of these programmes is more uncertain, and only partial implementation of these will be achieved by 2015.
- 3.4 There is no task for desertification.

- 3.5 Poor spatial resolution of most agricultural satellite Earth observations and insufficient coordination with space agencies for Biodiversity are gaps to achieving progress.
- 3.6 There are no established procedures for structural and domain-focused gap analysis. Gap analysis is critical to ensure that Targets and Outcomes can be achieved.
- 3.7 Agriculture and Biodiversity are increasingly driven by cooperative initiatives like GEOGLAM and GEO BON and orienting their activities directly to the targets of stakeholders, like G20 for Agriculture and CBD for Biodiversity.
- 3.8 The Ecosystem task is fragmented, with most tasks within this SBA focusing on activities that straddle several SBAs (marine, forestry) or deal with regional ecosystems that are not represented explicitly in the GEO Targets and Outcomes.
- 3.9 GEO and GEOSS are adding value to the work within member states and organizations, mainly through collaborative initiatives, more so than adding value through contributing to increased use of Earth observations and institutional capacity building.
- 3.10 There is no procedure for systematic progress reporting against Targets and Outcomes. The progress reporting so far is a listing of general progress of activities without mapping these to Targets and Outcomes
- 3.11 Limited funding and availability of dedicated staff is an obstacle to full implementation of the ambitious targets and outcomes.
- 3.12 The limited capacity in developing countries and the inclusion of those countries systematically across the activities is a major organizational challenge.
- 3.13 Users and stakeholders are not always well understood by Task leaders and participants, but there is a general feeling that the Tasks are aligned with stakeholders' priorities.
- 3.14 Tasks are primarily focused on establishing collaboration and developing data products, with less focus on the involvement of users.
- 3.15 Cooperation within the Tasks is reported to be neutral to good, skewed towards the latter. It is unclear whether there is a shared understanding of what is to be achieved and how to get there.
- 3.16 While some policy barriers exist, most barriers are related to funding to support GEO activities, including travel.
- 3.17 Communities of Practice and associated workshops have been effective ways of bringing together practitioners and stakeholders to establish communication, consensus and take advantage of emerging initiatives from international institutions. Communities of Practice that emerged through GEO have been able to establish more outcome-oriented initiatives such as GEO BON and GEOGLAM.

- 3.18 Roles and responsibilities within GEO as a voluntary organisation are unclear to many participants.
- 4.1 The Disasters and Energy SBAs will not achieve their strategic targets unless new Tasks/Components are added.
- 4.2 Within the Health SBA a few Task Components are not described in Task Sheets.
- 4.3 Cross-SBA cooperation is unsatisfactory and must be improved. Tasks and Components consist of activities initiated and funded by sources external to GEO. Coordination of tasks within the SBAs is hardly visible.
- 4.4 Data must be made more accessible over the GEO Portal. Today it is difficult and time consuming to locate data and information.
- 4.5 There is not a clear understanding of the difference between the GEO Portal and the GCI.
- 4.6 Users' response was too low to judge if they are sufficiently involved and their needs are taken properly care of.
- 4.7 Participants and Users perceive that networking and synergy will be the main value-adding elements.
- 5.1 There has been good progress in the WWC SBAs. This is confirmed by the interviews, the survey and Document 7 to GEO-X: "Assessment of Progress Target and Task".
- 5.2 There is good evidence of value added by GEO in the WWC SBAs. This is confirmed by interviews and the survey.
- 5.3 There have been improvements in the way GEO reports on progress. This is confirmed by Document 7 to GEO-X: "Assessment of Progress Target and Task" and the annual Work Plan Symposium.
- 5.4 Interaction between the WWC and other SBAs is presently limited. This is confirmed by interviews and the survey. There is some evidence that GEOSS has enabled the Weather SBA to focus on different users such as energy and ecosystems.
- 5.5 Multiple WWC Component Leads and Contributors were unaware of their listed position and/or GEOSS' work generally.
- 5.6 There are unclear interfaces between GEO and intergovernmental and national organizations.
- 5.7 Capacity building in terms of technical competence and resources appears limited. There is very little evidence that implementation at the national level is occurring after capacity building workshops.
- 5.8 Concerns persist about gaps in observational data and the continuity and quality of datasets. These issues are most notable in Latin America, Africa and Central/Northern

Asia, where there has been limited involvement and capacity building. There is a need to increase hydrological observations worldwide. River discharge and stream gauge networks have decreased and require maintenance. All evidence suggests a need to develop additional *in situ* networks (e.g. temperature, precipitation, carbon flux, soil moisture) and better maintain the current *in situ* and satellite networks.

- 5.9 The Strategic Targets and related Outcomes are viewed by some interviewees as too easy to achieve while others found them too ambitious.
- 5.10 User experiences with accessing data from the GEOSS Portal are diverse. In the web survey, as many users describe their experience as good as say it is poor to very poor. In the survey, Climate SBA reports more negative experiences than Water or Weather.
- 5.11 Many good WWC products have been or are about to be put into operational or semi-operational use. This offers opportunities for use of data by a larger community.
- 5.12 Water: WA-01-C3, GEO Cold Regions, has made progress following a long period of inactivity. Currently the Secretariat is acting as Component Coordinator and Point of Contact.
- 5.13 Climate: Interaction with users is currently limited in the GEO context and there are few feedback mechanisms where users can comment on their climate data needs. This is confirmed by interview evidence.
- 5.14 Weather: Of the three TIGGE data archives, only the European and US archives have confirmed continuation past 2014.
- 5.15 There is very limited evidence of direct user involvement in definition of Task activities and the daily execution of them. Surveys and interviews show that user engagement occurs through national committees, by e-mails asking for input to needs, and by invitations to workshops/seminars.

D.4 Follow-up on Recommendations from Previous Evaluations

“Progress in the Implementation of Recommendations of GEOSS Evaluations. Document 11(Rev1) to GEO XI, 13 – 14 November 2015” summarized the responses to the 46 recommendations given by the mid-term, 2nd, 3rd and 4th evaluations. Action on one of the recommendations was deferred due to its character, as the GEO Executive Committee found that development of performance indicators are not relevant to the Work Plan. Of the remaining 45 recommendations, 16 were directly related to the SBAs and two to gap analysis. Of these 18 recommendations, 13 were completed by the time of GEO-XI in November 2014, and implementation of the rest were in the process of being followed up with satisfactory progress. Overall, 29 responses had been completed and 16 were being implemented with satisfactory progress.

According to this referenced summary document, 11 recommendations from earlier evaluations were directly related to data architecture and management. Eight were completed by the time of GEO-XI in November 2014, and implementation of the rest was in the process of being followed up with satisfactory progress.

Please note that the referenced document only addresses actions implemented by the Executive Committee and does not indicate to what extent the actions have been followed up and led to improvements in performance. The fact that some of the findings of the Sixth Evaluation are similar to findings from earlier evaluations may indicate that actions are difficult to implement.