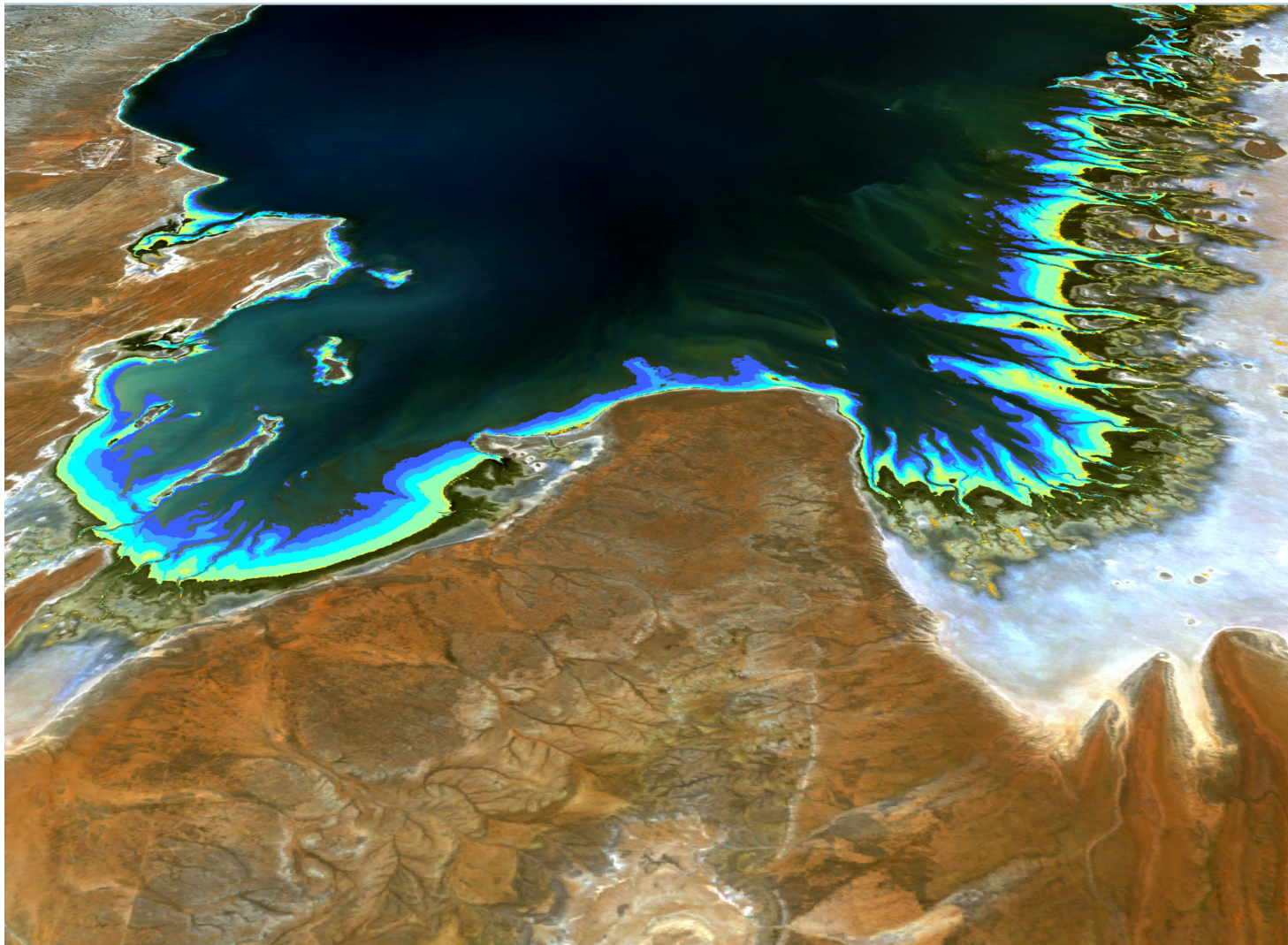


GEO Highlights 2016-2017

Insight for a Changing World



Agenda 2030

Earth observation data is crucial for monitoring progress towards achievement of the Sustainable Development Goals.

Climate

Earth observations support effective policy responses for climate change adaptation and mitigation.

Disaster Risk Reduction

Earth observations contribute to disaster mitigation and response, as well as to building resilience.



GEO Highlights 2016-2017

Editor:

Craig Larlee, GEO Secretariat

Contributors:

Vanessa Aellen, Nicolas Bellemans, Sophie Bontemps, Wenbo Chu, Massimo Craglia,
Douglas Cripe, Paola De Salvo, Michel Deshayes, Hesham El-Askary, Bennet Foli,
Susanna Grita, Tom Harvey, Argyro Kavvada, Stelios Kazadzis, Thomas Kemper,
Haris Kontoes, Andiswa Mlisa, Laetitia Navarro, Terry Newby, Mark Noort,
Andre Obregon, Martino Pesaresi, Nicola Pirrone, Steven Ramage, Jonathon Ross,
Barbara Ryan, Jesus San Miguel, Geoff Sawyer, Fabio Sayour, Hossain Sazzad,
Nancy Searby, Sophie Seeyave, Emily Smail, William Sonntag, Alicia Thomson,
Maddie West, Fredrik Wetterhall

Design:

Maddie West, Vanessa Aellen

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Contents

Message from the GEO Lead Co-Chair	ii
Message from the GEO Secretariat Director	iii
Group on Earth Observations	1
Informing Global Decisions: Sustainable Development Goals	5
Informing Global Decisions: Paris Agreement on Climate Change	7
Informing Global Decisions: Sendai Framework on Disaster Risk Reduction	9
Informing Decisions at National and Regional Levels	11
Coordinating Observing Systems	13
Engaging Users and Building Capacity	15
Sharing Earth Observation Data	17
GEOSS: Enabling Access to Earth Observations	19
Monitoring Work Programme Implementation and Results	21



Message from the GEO Executive Committee Lead Co-Chair

The Group on Earth Observations (GEO) is a truly unique partnership of national governments and international organizations aimed at ensuring that the information about our planet necessary to address global challenges is available to all. With 104 government Members plus the European Commission, and over 115 Participating Organizations, GEO is a confirmation of the willingness to share Earth observation data for the benefit of humankind.

GEO has accomplished much during its first ten years. This is evident in the current GEO Flagships with their policy mandates from international Agreements and Conventions, to the building of the GEOSS Common Infrastructure, to the Regional Initiatives in Africa, the Americas, Asia-Pacific and now Europe, to the many partnerships that have been established among individuals and organizations in many domains.

**GEO demonstrates on a daily basis
the value it brings in its power
to convene Earth observations
expertise and capacity from around
the world to address societal
challenges.**

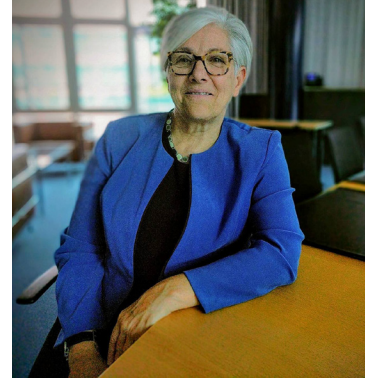
I had the distinct honour to serve as GEO's Lead Co-Chair for 2017, a new practice intended to enhance leadership within the GEO Executive Committee. As part of this role, I proposed a number of priorities for 2017. These included the development of a strategy for GEO's engagement with the commercial sector and further consideration of a more user-centred approach for GEO. Another of my priorities was to enhance the communication of GEO's results to our funders, stakeholders and the wider community.

A key challenge for communicating our results is to focus on impact—how GEO is providing data to support decisions by policy makers and, equally important, how we are making a difference to people's lives. Demonstrating impact is not always easy since GEO's focus has mainly been on collecting Earth observation data and making them interoperable and available. We do have, however, concrete examples of the impact of Earth observations: farming communities combining agricultural know-how with Earth observation information to optimize harvests in a more sustainable way; governmental agencies using Earth observation data for monitoring and advance warning of natural disasters, including the recent hurricanes; policy makers who in follow up to the Paris Agreement are tapping into essential scientific data provided by carbon observing systems operated by GEO partners to monitor greenhouse gases. GEO has an important story to tell, and we owe it to our partners and our ultimate sponsors—citizens of our Member countries—to make our impacts better known.

In this context, I welcome this Highlights Report as a solid step towards making some of the impacts and benefits that the work of GEO and its many partners are having around the world visible. The examples appearing here are only a few of the many ways in which GEO is making a difference at global, regional and national scales.

Robert-Jan Smits
Director-General
DG Research & Innovation, European Commission
GEO Executive Committee Lead Co-Chair 2017

Message from the GEO Secretariat Director



It is indeed a pleasure to introduce to you “GEO Highlights 2016-2017”, an annual report on selected achievements from the GEO community over the past year. The title of the report reflects a new approach in which we aim to speak to a wider audience about the ways in which GEO is making a difference for users and beneficiaries of Earth observations.

This year’s report provides some examples of the valuable work being done in our Flagships, Initiatives, Community Activities and Foundational Tasks in a format that is more concise, less detailed, and with more graphics. Recognizing that this approach inevitably leaves out many contributors, we expect that each annual report will shine the spotlight on a different set of accomplishments. I also invite readers interested in more detail on the examples described or on other GEO results to follow up on the numerous links contained in the report .

Part of what should be apparent as you read this report are the myriad ways in which GEO, and Earth observations more generally, make a difference in the lives of citizens around the world.

These connections are not always visible to those who benefit, but, in a way, that is understandable. Just as a person who checks the daily weather forecast on their mobile phone doesn’t often know how atmospheric conditions are measured or how forecast models are used, neither is it necessary for users of other types of Earth observation products and services to understand the intricate details of the processes that inform their decisions. In fact, we will have succeeded when Earth observations are routinely embedded

in personal, policy and business decision-making across all relevant domains, seamlessly integrating data from many sources across disciplinary and national boundaries – the very reason GEO was created in the first place.

Clearly, we have some distance to go before this vision is fully realized. While many countries have understood the economic and social benefits of open data, many barriers to discovery, access and use of data remain. We have yet to ensure that our fundamental observing systems are sustainable, coordinated globally, and integrated across various platforms. Although we have made great strides recently in being acknowledged as a trusted partner in supporting international agreements, there are still too few direct policy mandates for GEO Initiatives. And, we still face challenges in fully transforming our data, information and knowledge into applications and services that reach every citizen, every day. These challenges to realizing the full potential for Earth observations reinforce the continued need for GEO as a strong and vocal advocate at the international level.

As I look back over my nearly six years as Director of the GEO Secretariat, I am proud of what GEO has accomplished, some of which is showcased in this report. I am confident that GEO has a solid foundation for success and, with the support of our Members, Participating Organizations and growing number of partners, we will look forward to reading about even greater achievements in future GEO Highlights reports.

Barbara Ryan
Director
GEO Secretariat

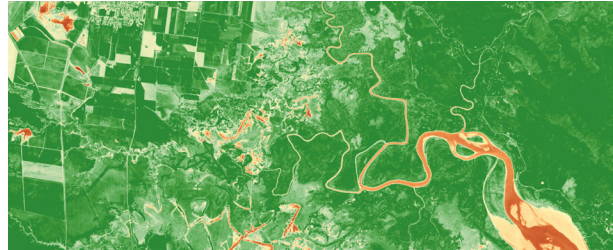
GROUP ON EARTH OBSERVATIONS

The Group on Earth Observations (GEO) is an intergovernmental partnership working to improve the discoverability, accessibility, and use of Earth observations for the benefit of society. Thanks to its broad membership of national governments and Participating Organizations, GEO is able to assemble and coordinate expertise across many disciplines and communities.

GEO uses this convening power to bring together unique combinations of partners required to address societal challenges, drawing on comprehensive, coordinated and sustained Earth observations.

GEO's principal spheres of activity are:

- **Advocating** for the importance of Earth observations as irreplaceable resources that must be protected, rendered fully and openly accessible, and integrated to provide maximum value;
- **Engaging** with stakeholder communities and fostering strategic partnerships to address global and regional challenges; and
- **Delivering** data, information, and knowledge to enable informed public and private decisions, exchange of best practices, uptake of new technologies, and the creation of economic opportunities.



WHAT ARE EARTH OBSERVATIONS?

Earth observations refer to data and information about the physical, chemical and biological aspects of our planet. It involves monitoring and assessing the status of, and changes in, the natural and human-constructed environment.

Earth observations are collected from many different sources, such as biologist's notes of plant or animal sightings; measurements of temperature and wind speed at weather stations; floating buoys for monitoring ocean currents; sonar and radar images; airborne photographs; and data collected by a multitude of instruments aboard satellites.



GEO's Engagement Priorities

At its November 2016 Plenary meeting in St. Petersburg, Russian Federation, GEO adopted an Engagement Strategy setting out priorities for who, how, and why it will engage with other stakeholders in the value-chain of Earth observations, from data collection to use. The Engagement Strategy is intended to establish GEO as the global reference for Earth observation systems, data and information.

In this context, GEO has identified three strategic engagement priorities: the United Nations 2030 Agenda for Sustainable Development, the Paris Agreement on Climate Change, and the Sendai Framework for Disaster Risk Reduction. The following pages will highlight how GEO is engaging with stakeholders to meet these challenges, and the impact of this work.

Societal Benefit Areas

Societal Benefit Areas are domains in which GEO will facilitate the development of solutions to societal challenges by mobilizing resources – including observations, science, modeling and applications – to enable end-to-end systems and deliver services to users. They may also be thought of as GEO’s “shop windows”, the entry points for new users to understand the potential of Earth observations to inform their decisions and address their concerns.

GEO’s Societal Benefits Areas are illustrated below. Climate change, due to its cross-cutting nature, affects all of the Societal Benefit Areas and therefore does not appear in its own right. GEO will continue to work with its Members, Participating Organizations and other stakeholders to strengthen climate observing networks and to produce data and information relevant to climate mitigation and adaptation, and to understand the effects of climate on each of the Societal Benefit Areas.

-  Biodiversity and Ecosystem Sustainability
-  Disaster Resilience
-  Energy and Mineral Resource Management
-  Food Security and Sustainable Agriculture
-  Public Health Surveillance
-  Infrastructure and Transport Management
-  Sustainable Urban Development
-  Water Resources Management



GROUP ON EARTH OBSERVATIONS



GEO Work Programme 2017-2019

GEO's multi-annual Work Programme is the primary tool used by GEO to select, plan, and coordinate its activities. The Work Programme is composed of four types of implementation mechanisms:

GEO FLAGSHIPS

GEO Flagships develop and provide services to well-defined user groups based on global policy mandates. Flagships, once fully mature, exemplify GEO's Vision of providing globally-coordinated observations in support of decision making at multiple levels.

GEO INITIATIVES


GEO Initiatives allow Members and Participating Organizations to coordinate their actions and contributions toward common objectives, within an agreed, yet flexible, framework. They develop and implement prototype services and work with users to understand their requirements and decision contexts. Initiatives may emerge as a maturation of individual Community Activities or as an integration of several.

COMMUNITY ACTIVITIES

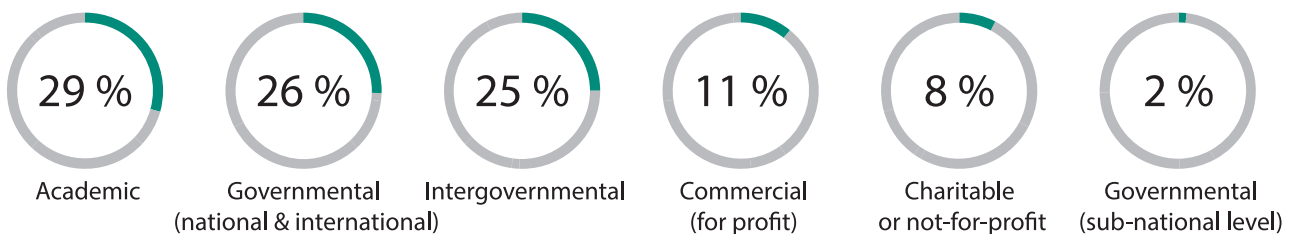
GEO Community Activities enable GEO Members, Participating Organizations and others to cooperate flexibly in areas of common interest. Community Activities may, for example, undertake consultations to define user needs, explore new frontier applications, demonstrate technical possibilities, or agree on observation protocols and data exchange.

FOUNDATIONAL TASKS

GEO Foundational Tasks are specific, selected tasks that enable and support the work across all of the Flagships, Initiatives and Community Activities. Foundational Tasks include: coordination of observing systems and implementation of technical components to allow sharing of data and other resources in GEOSS.

 For more information: <http://bit.ly/2xcPcrZ>

Types of Organizations Contributing to the GEO Work Programme



GEO Flagships

GEO BON GEO Biodiversity Observation Network	GEOGLAM GEO Global Agricultural Monitoring	GFOI Global Forest Observation Initiative	GOS4M Global Observation System for Mercury
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GEO Initiatives

AfriGEOSS Reinforcing Regional African Engagement	AmeriGEOSS	AOGEOSS Asia-Oceania GEOSS	Aquawatch	Climate Change Impact Observation on Africa's Coastal Zones	GEO-DARMA Data Access for Risk Management
EO4EA Earth Observations for Ecosystem Accounting	EO4SDG Earth Observations in Service of the 2030 Agenda for Sustainable Development	EuroGEOSS	GEO Carbon and GHG Initiative	GEOCRI GEO Cold Regions Initiative	GNSL GEO Geohazard Supersites and Natural Laboratories
GEO ECO GEO Global Ecosystem Initiative	GEO-GNOME Global Network for Observation and Information in Mountain Environments	GEOGLOWS GEO Global Water Sustainability	GEO Human Planet Initiative	GEOSS-EVOLVE	GEO VENER GEO Vision for Energy
GEO Wetlands Initiative	GDIS Global Drought Information System	GOS4POPS Global Observations System for Persistent Organic Pollutants	Global Urban Observation and Information	GWIS Global Wildfire Information System	Ocean and Society: Blue Planet

Foundational Tasks

GEOSS Development and GCI Operations			Community Development	Secretariat Operations	
Advancing GEOSS Data Sharing Principles	GCI GEOSS Common Infrastructure Operations	GEOSS In-Situ Earth Observation Resources	Capacity Building Coordination	Management and Support	Communication and Engagement
GEOSS Satellite Earth Observations Resources	GEONETCast Development and Operations	User Needs and Gap Analysis		Monitoring and Evaluation	

Community Activities

- Access to Climate data in GEOSS
- Advancing Communication Networks
- African Geochemical Baselines
- Airnow International: Expanding Networks and Integrating Methods for Air Quality and Health Data
- Chinese Tsunami Mitigation System
- Citizen Observatories and Crowdsourcing
- Copernicus Atmospheric Monitoring Service (CAMS)
- Copernicus Climate Change Service (C3S)
- Data Integration and Analysis System (DIAS)
- Digital GEOMUSEUM
- Earth2Observe
- Earth Observations for Cultural Heritage Documentation
- Earth Observations for Disaster Risk Management
- Earth Observations for Geohazards, Land Degradation and Environmental Monitoring
- Earth Observations for Health (EO4HEALTH)
- Earth Observations for Managing Mineral Resources
- Earth Observations for the Water-Energy-Food (W-E-F) Nexus
- Forest Biodiversity in Asia and the Pacific Region: Capacity Building Phase
- GEO-CRADLE
- Global Agricultural Drought Monitoring
- Global Ecosystems and Environment Observation Analysis Report Cooperation (GEOARC)
- Global Flood Awareness System (GloFAS)
- Global Flood Risk Monitoring
- GFCS - GEO Collaboration
- Global Mangrove Monitoring
- Harmful Algal Bloom (HAB) Early Warning System
- Himalayan GEOSS
- In-Situ Observations and Practices for the Water Cycle
- Integrated City-Region Systems Modelling: resilience.io
- Land Cover and Land Cover Change
- Research Data Science Summer Schools
- Socio-Economic Benefits of Earth Observations
- Space and Security
- Synergized Multi-Source Remote Sensing Products and Services
- TIGGE (Thorpex Interactive Grand Global Ensemble) evolution into a Global Interactive Forecast System (GIFS)

INFORMING GLOBAL DECISIONS: SUSTAINABLE DEVELOPMENT GOALS



In September 2015, the United Nations (UN) General Assembly endorsed “Transforming Our World: the 2030 Agenda for Sustainable Development”. This global development agenda will serve as a blueprint for all countries and stakeholders in seeking progress on economic, social and environmental sustainability.

Seventeen Sustainable Development Goals (SDGs) and associated Targets and indicators anchor the 2030 Agenda, which specifically calls for new data acquisition and exploitation of a wide range of data sources to support implementation. In particular, Article 76 states, “We will promote transparent and accountable scaling-up of appropriate public-private cooperation to exploit the contribution to be made by a wide range of data, including Earth observation and geospatial information, while ensuring national ownership in supporting and tracking”.

Working with international partners

Much of the initial focus within the United Nations system has been on the development of methods for measuring the indicators associated with the Sustainable Development Goals and Targets. National governments will be responsible for monitoring and reporting on these indicators. UN “custodial agencies” – coordinated by the UN Statistical Commission – have responsibility for development of the monitoring methods, collection of data from national sources, providing and updating the indicator documentation, and contributing to statistical capacity building. Application of Earth observations and geospatial information within these Indicators is being led by the UN Committee of Experts on Global Geospatial Information Management (UN-GGIM). GEO works as a partner with UN-GGIM by participating in specific working groups on Earth observations for SDGs and working strategically to help promote geospatial data use in statistical processes through coordinated communication to Members of UN-GGIM and GEO.

Initial analysis by GEO identified three SDGs where Earth observations play an important role:



GOAL 2: ZERO HUNGER

GEO GLAM, GEO’s agricultural monitoring Flagship, has offered its assistance to the United Nations Food and Agriculture Organization (FAO) in identifying global coverage indicators of food crops in support of the Zero Hunger goal. GEOGLAM has developed considerable experience in providing relevant, timely and accurate forecasts of crop yields at national, regional, and global scales using Earth observation data. GEO representatives have also increased contacts with FAO on how to use Earth observations for the SDGs, for instance, in measuring the extent of degraded land and working with FAO and other experts to identify common land classification approaches.



GOAL 6: CLEAN WATER AND SANITATION

GEO is working with UN Environment to refine methods for indicators on water extent, water quality, aquatic ecosystem health, water security, and human settlements in relation to water. This work includes national workshops organized by UN Environment and the Global Partnership for Sustainable Development Data that are helping to create a set of reproducible, scalable tools for use by national governments to report on aquatic ecosystems. Pilot activities focus on the provision of Earth observations-based products and accompanying documentation, including how the products may be used by countries to report on SDG 6 indicators.



GOAL 15: LIFE ON LAND

GEO representatives have been extensively involved with the UN Convention to Combat Desertification (UNCCD) and the FAO as they develop methods for monitoring degraded land through use of Earth observations techniques. Land degradation may result from numerous causes specific to a particular location, making it difficult to fully capture the condition of the land using a single indicator. GEO has been asked to provide advice and expertise to the UN process to replace the multiple proxy indicators that are currently available with a new indicator based on Earth observation

5



techniques. At the thirteenth session of the Conference of the Parties (CoP) to the UNCCD, GEO was formally invited to support the efforts of the UNCCD Parties in implementing the Convention by providing space-based information and in-situ measurements to assist countries in fulfilling the reporting requirements for SDG indicator on proportion of degraded land, as well as to foster data access, national capacity building and development of standards and protocols.

Engaging national governments and local communities

GEO's Earth Observations in the Service of Agenda 2030 (EO4SDG) Initiative is facilitating and coordinating engagement between expert organizations and national governments interested in using Earth observations to support their reporting on the SDGs.

COLOMBIA

Together with the Global Partnership for Sustainable Development Data (GPSDD) and national agencies in Colombia, GEO is working to strengthen intergovernmental collaboration, share experiences, and identify ways to make best use of the capacities and technical assistance developed by international initiatives and agencies to enable reporting on SDG Indicators and to implement sustainability policy.

KENYA

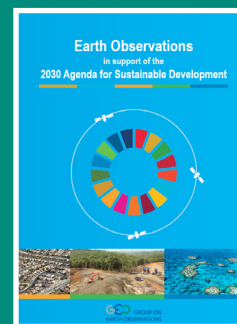
Kenya has identified agriculture and health as its top priorities for applying Earth observations. GEO is working with the Kenyan government to explore how Earth observations can support its upcoming agricultural census, bridge data gaps, and ensure that the data may be used by their farming population, much of which is elderly. Kenya is also seeking help in adapting to shifts in climate patterns and extreme events, such as droughts.

SENEGAL

GEO is participating in a pilot project that will help combine Earth observations and geospatial information with statistics

Earth Observations in support of the 2030 Agenda for Sustainable Development

The GEO Initiative 'Earth Observations in the Service of the 2030 Agenda' (EO4SDG), together with the Committee on Earth Observation Satellites (CEOS), have issued a report highlighting case studies of how Earth observations support decision making for sustainable development in the areas of health, disaster risk reduction or environmental protection.



To obtain a copy of the report visit: <http://bit.ly/2k9YJtt>

for monitoring specific Indicators that reflect Senegal's national priorities. This project will be carried out in collaboration with the African Development Bank (AfDB), Senegal's National Statistical Office, and Knoema, an AfDB-funded company that provides SDG statistics and visualizations for the African continent.

PERU, SENEGAL AND JAMAICA

GEO is coordinating with NASA and UN Environment to measure the spatial extent of open water bodies and vegetated wetlands (such as marshes, peatlands and mangrove forests), as well as water quality indicators, in eight countries, starting with Peru, Senegal and Jamaica. This data will be used to generate maps and analyses.

For more information: <http://bit.ly/2xGJc7P>
www.eo4sdg.org



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INFORMING GLOBAL DECISIONS: PARIS AGREEMENT ON CLIMATE CHANGE



In December 2015, the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) agreed to strengthen commitments to address the threat of climate change and to accelerate and intensify the actions and investments required. Responding to the many specific provisions of the Paris Agreement – which includes articles related to national reporting, mitigation measures, adaptation, technology transfer, and capacity building – will require the contribution of Earth observations.

GEO is positioned to play a critical role in supporting implementation of the Paris Agreement, building on the accomplishments of GEO's first 10-year Implementation Plan for the Global Earth Observation System of Systems (GEOSS). Through its various Work Programme activities and many contributing organizations, GEO is supporting countries with forest carbon monitoring, reporting on national greenhouse gas (GHG) inventories, and in the provision of climate services to enable adaptation to the effects of climate change.

Understanding the Carbon Cycle

Despite the significant progress made by the scientific community, evaluating the success of climate change mitigation strategies is complicated by gaps and uncertainties in carbon cycle observations across the atmosphere, land, and oceans. These include uncertainties in the estimated quantities of carbon in different environmental components, the impacts of understudied gases, the risk of passing tipping points, and the role of critical hotspots. There are also concerns with the sustainability of observing networks, inadequacies of global coverage, lack of interoperability between monitoring systems, and often inadequate communication between different communities.

The GEO Carbon and GHG Initiative, formally launched in July 2017, is facilitating cooperation among existing carbon and GHG observing organizations, promoting interoperability

between data and information systems, and improving integration among atmospheric, terrestrial and ocean networks. The intended result will be a coordinated system of observations for monitoring and evaluating changes in the carbon and related cycles, including GHG emissions as they relate to human activities and their impacts on climate change, and to provide decision makers with timely and reliable policy-relevant information. This would include physical information, such as changes in carbon distributions and fluxes, as well as supporting information needed to evaluate societal impacts associated with emissions reduction, land-use change, or ocean management efforts. This information is expected to support countries in their mitigation efforts and reporting under the Paris Agreement.

GEO CARBON AND GHG INITIATIVE: INTEGRATING CARBON CYCLE OBSERVATIONS ACROSS OCEAN, LAND AND ATMOSPHERE

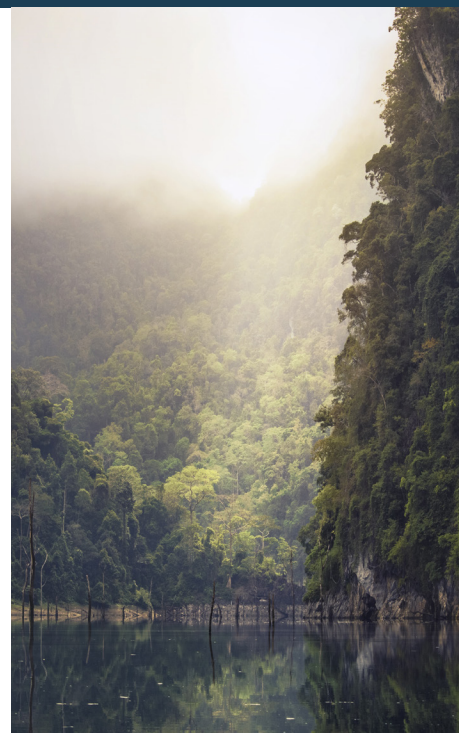


Global Forest Monitoring

The Global Forest Observation Initiative (GFOI), a GEO Flagship, is a partnership of Australia, Norway, and the United States, along with the Food and Agriculture Organization of the United Nations and the Committee on Earth Observation Satellites. GFOI supports countries on reducing emissions from deforestation and forest degradation (REDD+) by assisting them to develop their national forest monitoring systems and associated emissions measurement, reporting and verification (MRV) procedures. With forests playing a central role in the Paris Climate Change Agreement, robust forest monitoring will be vital in helping countries to meet their emissions reductions pledges and ultimately help to mitigate climate change.

In 2016, GFOI launched REDDcompass, a web application to help countries develop national forest monitoring systems and associated MRV procedures. REDDcompass provides user-friendly guidance on designing and establishing MRV processes that are consistent with the Intergovernmental Panel on Climate Change guidance and UNFCCC requirements for REDD+ reporting. It is based on the GFOI's Methods and Guidance Document and supporting training materials and tools developed by GFOI.

 For more information: www.gfoi.org



Climate Adaptation

While much of the attention regarding Earth observations for a changing climate has focused on efforts to mitigate human impacts on the climate, there is growing realization that Earth observations can also play an essential role in helping societies adapt to these changes.

Informing decisions about climate adaptation is challenging because it must take account of considerations that extend beyond the traditional realms of meteorology, hydrology, and climate science, into ecology, economics, engineering, and social science. Climate adaptation thus requires a broad and integrative approach. GEO is well positioned to deliver in this area due to its convening power and its experience in providing data across disciplinary and geographic domains.

The Global Climate Observing System (GCOS) and the World Meteorological Organization (WMO), both GEO Participating Organizations, are authoritative sources for climate information and essential partners in understanding

the kinds of information needed to help individuals and organizations adapt to a changing climate.

Beyond these, however, are many other GEO activities and partners relevant to developing an integrated approach to climate adaptation. These include:

- Global Forest Observation Initiative (GFOI)
- Copernicus Climate Change Service (C3S)
- GEO Global Water Sustainability Initiative (GEO GLOWS)
- Global Drought Information System (GDIS)
- Data Integration and Analysis System (DIAS)
- Climate Change Impact Observation on Africa's Coastal Zones




INFORMING GLOBAL DECISIONS: SENDAI FRAMEWORK ON DISASTER RISK REDUCTION



The Sendai Framework is a 15-year, voluntary, non-binding agreement that aims to achieve a “substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries”. The Sendai Framework was endorsed by the United Nations General Assembly in 2015. The United Nations Office of Disaster Risk Reduction (UNISDR) supports national governments in its implementation.

GEO supports disaster resilience by improving coordination of Earth observations to forecast and prepare for disasters, to mitigate damage, and to better manage and recover from disasters. A substantial reduction of losses of life and property can be achieved by strengthening cooperation and sharing of the satellite and surface data needed to manage risks posed by fires, floods, earthquakes and other hazards. Better information, made widely accessible, leads to improved understanding and management of disaster risk. This role for GEO and Earth observations was recognized in the UNISDR Sendai Framework Data Readiness Review 2017.

 For more information: www.unisdr.org



FLOOD FORECASTING IN BANGLADESH


The Global Flood Awareness System (GloFAS) is a GEO Community Activity jointly developed by the European Commission and the European Centre for Medium-Range Weather Forecasts (ECMWF). An important aspect of GloFAS is its ability to provide warnings of flood events that occur across country borders along very large rivers. This helps national hydro-meteorological services, humanitarian agencies, and commercial companies to strengthen and improve forecasting capacities, preparedness, and the response to and mitigation of natural hazards.

Bangladesh is located downstream of three large river basins: the Ganges, Brahmaputra and Meghna. During the monsoon season, rainfall in the three basins will cause rivers to rise, though some days after the rains occur. If the peak flow is synchronized across more than one basin, a common occurrence, severe flooding can result.

Recent work in GloFAS has aimed to improve hydrological forecasts beyond 15 days by using information available from ECMWF's monthly forecasts. At the time of the August 2017 floods, the new system was already running on a test platform, thus providing an opportunity to evaluate in near real-time the improvements brought by the new system.

Initial tests before 28 July showed that a relatively large flood peak would occur between 13 and 22 August. The Bangladesh Flood Forecasting and Warning Centre was following GloFAS information on a daily basis and provided information on the potential flood event to the Bangladesh Water Development Board, whose field offices took charge of flood preparations.

While the actual flood peaked around 16 August, the extended-range system showed a marked improvement from the previous version, which forecasted a much smaller flood which peaked too early. These results appear promising, although further tests are needed before the new version is operationally implemented in GloFAS, especially as some river systems are more predictable than others.

 For more information: globalfloods.jrc.ec.europa.eu

Wildfire Monitoring and Fire Danger Forecasts in Chile


Wildfires continue to present a major risk in many countries. It is estimated that nearly 400 million hectares of natural areas are burnt every year, causing loss of life, tremendous environmental and economic damage, and contributing to the increase of carbon emissions worldwide.

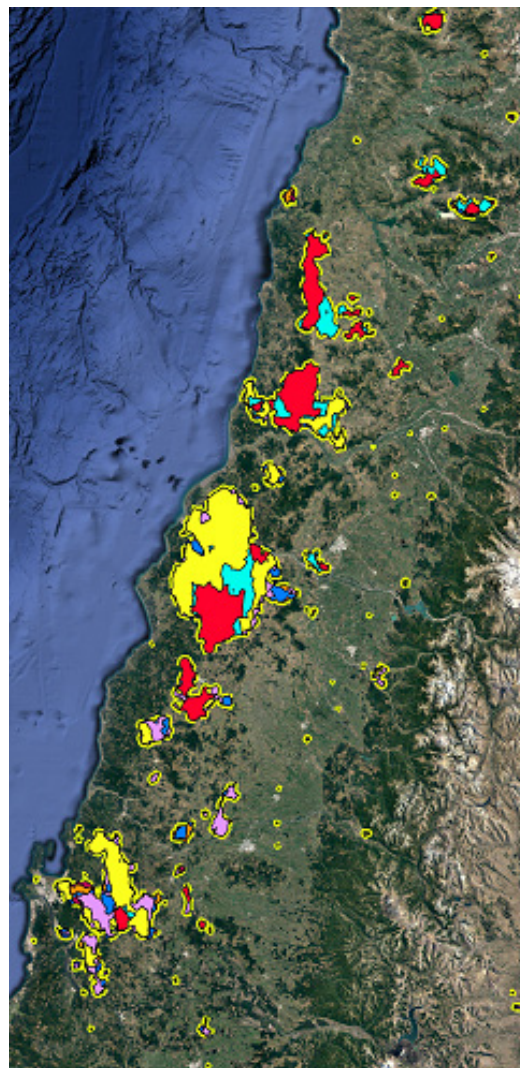
The Global Wildfire Information System (GWIS) is a joint initiative of the GEO and the Copernicus Work Programs. GWIS brings together existing information sources at regional and national levels to provide a comprehensive view and evaluation of fire patterns and effects at a global level.

A long drought at the end of 2016 created extreme fire danger conditions in Chile. This led to a large number of wildfires early in 2017 that caused unprecedented damage to the environment and required evacuation of many people. In total, over half a million hectares of forest and natural areas were burned.

Following a request by Chile, the European Commission's Emergency Response Coordinating Centre led the provision of European assistance, including experienced firefighting crews from European Mediterranean countries. GWIS provided near-real time information on active fires and burnt areas and fire danger forecasts (up to 10 days in advance) supporting preparedness against fire outbreaks and firefighting operations. Active fires and burnt areas were identified using NASA MODIS and VIIRS sensors, and fire danger predictions were based on numerical weather predictions from the European Centre for Medium Range Weather Forecasts.

While GWIS is currently still under development, it is able to provide accurate information on fire activity anywhere in the world. In 2017, reports on critical fires were also provided for Australia, the USA, and Canada. Ongoing collaboration on real-time monitoring is also underway in other fire-prone regions, including Indonesia and central Africa.

 For more information: gwis.jrc.ec.europa.eu



Above: Colours represent areas burned on different days, showing the progression of the fires.



Copernicus is the European Union's Earth observation and monitoring program. It provides users with free, full and open access to data.



INFORMING DECISIONS AT NATIONAL AND REGIONAL LEVELS



INFORMING DECISIONS ON ENERGY MANAGEMENT

Europe, North Africa, and the Middle East offer considerable potential for solar energy, which is critical for regional sustainable development. The need for improved solar energy forecasting is increasing as more solar farms (photovoltaic installations) and concentrated solar power plants come online worldwide. As solar makes up an increasing share of the energy portfolio for many electrical utility companies, incorporating the highly-variable power output from solar arrays into the grid is becoming more difficult. Utilities require predictions in the nowcasting (minutes to 1-2 hours ahead) and forecasting (1-2 days ahead) time scales with high frequency (every 5-15 minutes) in order to perform load balancing properly.

The GEO-CRADLE initiative, funded under the European Commission's Horizon2020 program with leadership from the World Radiation Centre in Switzerland and the National Observatory of Athens in Greece, developed the Solar Energy Nowcasting System (SENSE) as a pilot test in Egypt, in partnership with the Egyptian Ministry of Electricity and Renewable Energy. Using a mix of real-time satellite observations of clouds, simulations of radiation transfer, and neural network computing, SENSE is able to quickly generate high-resolution maps, solar radiation time-series and other products. The methods used are also being tested by the Greek national independent power transmission operator for use in power-load balancing.

“SENSE is a clear example of successfully building a value chain through a partnership between innovation and capacity building provider – the GEO-CRADLE team – working with the Ministry and associated renewable energy authority, to deliver the solar atlas and the dynamic output... resulting in better schemes of energy production and hence in customer satisfaction.”

Dr. Mohamed Shaker El Markabi,
Egyptian Minister of Electricity and Renewable Energy

 For more information: geocradle.eu

Supporting Decisions on Food Security

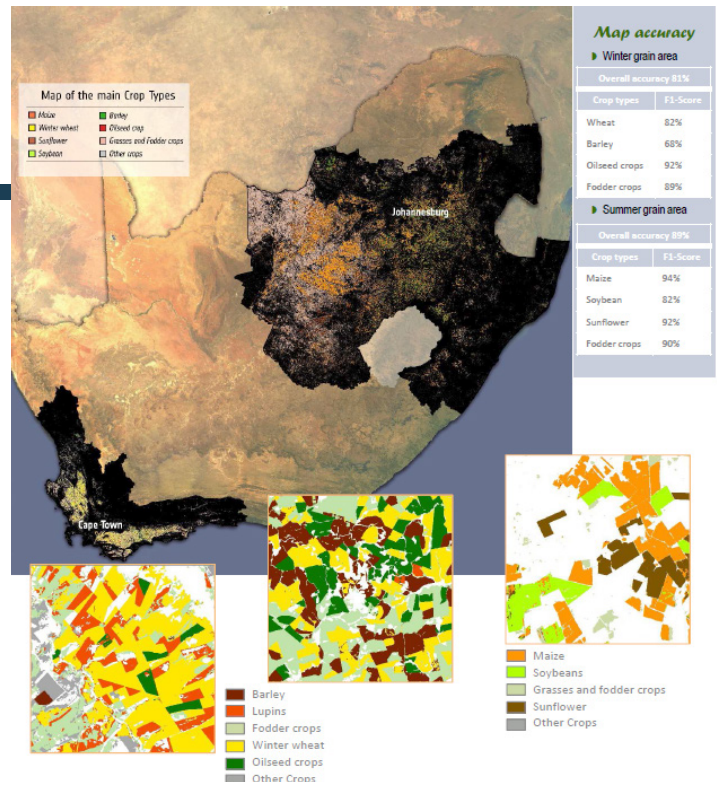
South Africa is one of the world's driest countries and has always experienced highly variable rainfall, but recently it has been hit with the worst drought in over 100 years. Many stakeholders in the South African agriculture sector have raised the importance of accurate, reliable, and early information on expected grain production so that deficits and surpluses may be managed effectively.

The GEO Global Agriculture Monitoring Initiative (GEOGLAM) and its partners – in particular Université catholique de Louvain (Belgium), Center for the Study of the Biosphere from Space (France), CS Information Systems (France), CS Romania S.A., and the European Space Agency – are working with the South African Agriculture Research Council to demonstrate the potential of a national version of the Crop Monitor for Early Warning using Sentinel-2 satellite data. This is one of three national (the others were in Mali and Ukraine) and eight local demonstrations that were conducted in 2016-17 within the Sentinel-2 for Agriculture project.

Using freely available satellite data will enable more frequent updates – in near real-time – and, combined with the data collected by ultralight aircraft, will improve accuracy and confidence in estimates. The added frequency of coverage is important, as some agricultural regions of South Africa use frequent crop rotations during the year, with many different crops. The new approach will also improve the accuracy of the forecasts, as it can provide complete coverage of all growing regions rather than observing only a sample.

Interest in accurate, reliable and early information about expected grain production is of great interest to firms involved in grain trading, transport and storage, as well as to government agencies responsible for managing surpluses and deficits.

For more information: www.geoglam.org



“GEOGLAM has provided regular updates on the growing conditions of AMIS [Agricultural Market Information System] crops in the world’s major producing regions using satellite imagery, ground observations, and meteorological data. This information has proved a valuable supplement to the analytical work of AMIS. The [AMIS] Secretariat was therefore happy to welcome GEOGLAM as a new member of AMIS in June 2016.”

Five-Year Progress Report of the Global Food Market Information Group

COORDINATING OBSERVING SYSTEMS

One of GEO's fundamental roles is to encourage collaboration among countries, international organizations and other partners in the development of common observing strategies. Collaboration helps to ensure that observations can be sustained over time and that the data being collected responds to the needs of the wide variety of users globally.

This work occurs within individual Work Programme activities and from a cross-cutting perspective in the Foundational Tasks dealing with space-based and in-situ observation resources.

COORDINATING BIODIVERSITY OBSERVATIONS

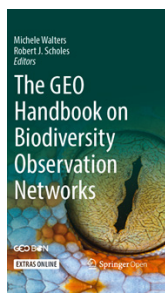
GEO BON is developing a global community of practice for the collection, curation, analysis and communication of terrestrial, freshwater and marine biodiversity data and for the development of national and regional Biodiversity Observation Networks, or BONs.

Biodiversity Observation Networks within GEO BON can have a national, regional or thematic scope. As of 2017, there are 7 formally endorsed BONs: the French BON (ECOSCOPE), the Colombia BON, the China BON, the Asia Pacific BON, the Arctic BON (Circumpolar Biodiversity Monitoring Program), the Marine BON, and the Freshwater BON. National BONs are also in development in Brazil, South Africa, Bolivia, Japan, and South Korea.

At the global scale, the Marine BON, along with the Global Ocean Observing System, is working on a common framework for biodiversity observations and biological Essential Ocean Variables. The recently endorsed Freshwater BON is also using the Essential Biodiversity Variables framework for organizing and prioritizing the steps needed to monitor the different components of freshwater biodiversity in order to support a future global assessment.


To support countries in the establishment of their Biodiversity Observation Networks, the BON development working group of GEO BON is proposing a step-wise and flexible approach, which builds on the successful experience of the Arctic BON. This nine-step process is applied to build the different components of a national observation system and involves four development phases: engagement, assessment, design, and implementation. This approach is currently being applied in Colombia, and can also be utilized at the regional (e.g. Arctic) and sub-national level, as is the case in New South Wales, Australia. To further support the development of those networks, and provide access to state-of-the-art tools for biodiversity observations, GEO BON and the Alexander von Humboldt Institute in Colombia developed an online capacity building and knowledge transfer platform, BON in a Box.

 For more information: geobon.org



HANDBOOK ON BIODIVERSITY OBSERVATION NETWORKS

In 2017, GEO BON published the GEO Handbook on Biodiversity Observation Networks with contributions from over 100 authors, both scientists and practitioners, from all over the world. It covers approaches from in-situ observations to remote sensing, to modelling biodiversity and reporting. The book was designed to provide practical guidance to broadly-defined biodiversity observation networks at all scales, but predominantly the national scale and higher. The GEO Handbook on Biodiversity Monitoring Networks is a practical how-to book with substantial policy relevance, that includes practical suggestions on how to develop biodiversity monitoring programs. As of August 2017, the book, in open access, had been downloaded over 90 000 times.

 To obtain a copy of the Handbook: geobon.org/products/books

Open Data Cubes


Space agencies are now generating massive quantities of space data, and GEO Work Programme activities have been developing new techniques for analysing this data. However, for many uses, a lack of data or analysis techniques is no longer the problem: a lack of tools to exploit data and techniques is.

The prototype Australia Geoscience Data Cube has organized over 30 years of free and open Landsat data across the entire Australian continent into an analysis-ready time-series tool for delivering information products of use to non-remote sensing specialists. "Water Observations from Space" was the first product developed. It tracks the presence or absence of water over the last 30 years for every 25-metre square in Australia. This product is being used for flood risk assessment, agricultural water tracking, coastal change detection and even mangrove monitoring.

The prototype will be turned into an operational service called Digital Earth Australia, which will provide regular updates of all the products showcased in the Australia Geoscience Data Cube and improve the resolution and frequency of all products by using multiple satellite sources.

Each product produced by Digital Earth Australia can potentially also be generated for every country in the world. Digital Earth Australia has been developed on the open-source "Open Data Cube" platform, which is being further developed both by Australian researchers and through the Committee on Earth Observation Satellites (CEOS).



 For more information: datacube.org.au

COORDINATING MERCURY OBSERVATIONS

The Global Observation System for Mercury (GOS4M) is intended to provide spatially-distributed mercury monitoring data for public health and ecosystem protection. It is based on a collaborative, transparent engagement strategy designed to build on the successes of many existing global and regional monitoring initiatives. GOS4M will also harmonize metadata production, archiving and sharing data from global and regional mercury networks, and develop advanced services in support of anticipated decisions taken by Parties to the Minamata Convention on Mercury, which entered into force on 16 August 2017.

 For more information: gos4m.org



ENGAGING USERS AND BUILDING CAPACITY

An important part of GEO's role is to work with users of Earth observations to understand the kinds of decisions that will be made, the information needed to support those decisions, and their preferred methods and tools for receiving, analysing and reformulating that information. GEO also works to ensure that these users, wherever they may be located, have the capacity to make optimal use of Earth observations in their work or in their daily lives.

Much of this user engagement and capacity building occurs in the context of GEO's Flagships, Initiatives and Community Activities. Users are consulted as part of the process of identifying the products and services to be developed by the Initiative, as experts during the implementation process, and may even participate as partners in the Initiatives' design and management. Once the products and services are available, many Initiatives and Flagships also provide capacity building activities and resources to benefit users.

A key role in reaching out to users is played by the GEO Regional Initiatives: AfriGEOSS, AmeriGEOSS, Asia-Oceania GEOSS, and EuroGEOSS, as well as some regionally-based Community Activities. Regional activities can deepen connections with organizations in their regions and can help other GEO Initiatives to find partners there. They are also best placed to understand the requirements for, and barriers to, the effective use of Earth observations in their region.

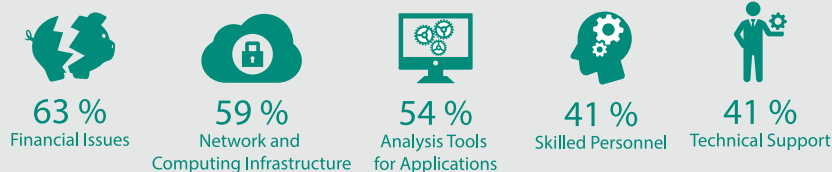
User engagement and capacity building are also GEO Foundational Tasks, led by volunteer Task Teams and supported by the GEO Secretariat. These Foundational Tasks provide coordination and tools to support the efforts in the Flagships, Initiatives and Community Activities. They may also take the lead on cross-cutting types of user engagement and capacity building activities.

ADDRESSING ACCESS BARRIERS TO EARTH OBSERVATIONS

While more organizations are making their Earth observations data freely and openly available, encouraged by the GEOSS Data Sharing Principles, many barriers continue to prevent users in many parts of the world from making optimal use of this data.

GEO's AfriGEOSS Initiative conducted a survey in 2016-2017 to understand some of the challenges users were facing in Africa, as well as to collect information on products and services that are being developed to serve the African continent.

Top 5 challenges affecting use of Earth observations identified by AfriGEOSS survey respondents



Infrastructure issues, including network adequacy, data access and computing infrastructure and processing tools are among the most significant barriers. Availability of skilled personnel and technical support from data providers were also common. And, not surprisingly, financial constraints, which likely impact many of the other issues, were the most common barrier identified.

To address some of these barriers, AfriGEOSS is developing a coordinated data acquisition strategy for Africa, led by the South African National Space Agency (SANSA) in partnership with GEO Participating Organizations. It is also leveraging the astronomy infrastructure being built through the Africa Data Intensive Research Cloud initiative.

 For more information: www.earthobservations.org/afrigeooss.php

A PARTICIPANT'S PERSPECTIVE ON CAPACITY BUILDING

The Partnership for Observation of the Global Oceans (POGO) has been a GEO Participating Organization since 2005 and is a major partner and founding member of the GEO Initiative Blue Planet: Oceans and Society. POGO offers several training and capacity building programs, some with support from the Nippon Foundation. One of these programs is the NF-POGO Centre of Excellence scholar program, which provides world class education internships and training courses in the field of observational oceanography.

Bennet Foli, an oceanographer with the Monitoring for Environment & Security in Africa program who is based at the University of Ghana, provides this account of his experience:

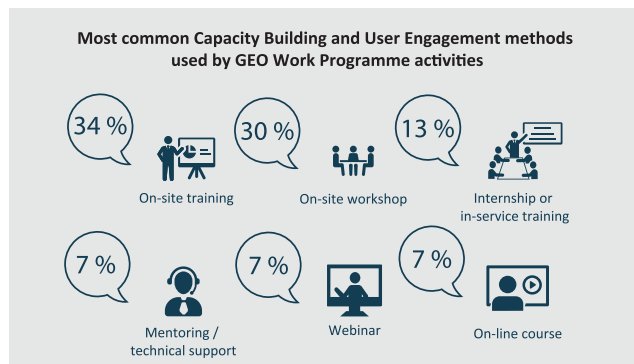
"Being one of ten scholars to be selected from around the globe to study about the ocean gave me the confidence of how important this area of study is to the global community. It was my first experience travelling outside my country. I continue to benefit from the enormous resources that are shared by this network of scholars. The skills acquired from the Centre of Excellence scholar program has really helped me to communicate science and to easily transfer skills to upcoming young scientists."



 For more information: ocean-partners.org

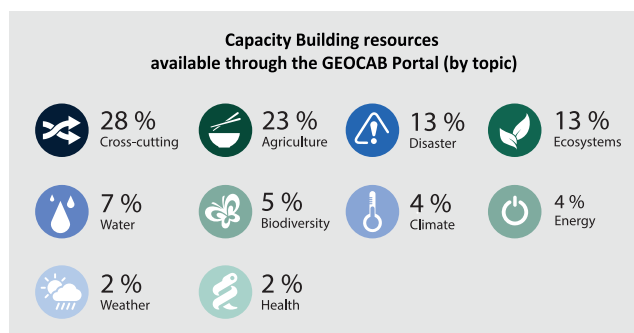
User Engagement and Capacity Building by Numbers

In 2016-2017 alone, GEO Work Programme activities have engaged over 5,000 individual users in identifying needs, requirements or preferences for Earth observations information, and have provided over 1,000 individuals with capacity building training or support. This engagement has occurred through more than 50 separate user engagement activities and over 60 capacity building events or programs.



Resources for Capacity Building

Many products and services to support the use of Earth observations are developed in the context of capacity building events and activities conducted by GEO Work Programme activities and GEO partners. Ensuring that these resources are easily discoverable and accessible to users around the world is a key focus of the Capacity Building Coordination Task Team. While many capacity building resources exist and may be found on various websites, the GEOCAB Portal serves as a dedicated entry point to Earth observation capacity building resources, encouraging re-use, while avoiding duplication of effort.



Case Study: Pipeline Monitoring in the Netherlands

Satellite imagery has been shown to improve management for sub-surface pipeline monitoring. This imagery can show ground movement that could damage the pipelines, and potentially cause breaks. For this purpose, however, it is necessary to use high-resolution radar imagery that is generally available only at relatively high cost.

A 2016 study by the European Association of Remote Sensing Companies and The Green Land BV showed that the freely available lower-resolution imagery from Europe's Sentinel satellites can reduce the costs to utility companies by enabling them to focus their purchase of high-resolution imagery to only areas identified as being at risk.

The study estimated that the use of open Earth observation data would reduce their need for high-resolution data by about 30%. Across the Netherlands, this would amount to a saving of between €4.25m to €5.25m. This suggests that the use of satellite imagery for this purpose may not even be economically viable without the free Sentinel data as a starting point. The total potential economic benefit of using radar imagery for pipeline monitoring was estimated to be between €15.2m and €18.3m.

For more information: ears.org/news/copernicus-sentinels-products-economic-value-study



GEOSS DATA MANAGEMENT PRINCIPLES

To maximize the value and benefit from data sharing, GEO promotes the implementation of the GEOSS Data Management Principles. Putting these principles into practice helps to ensure that data and information of different origin and type are comparable and compatible, facilitating their integration into models and the development of applications to derive decision support tools.

For more information: <http://bit.ly/2g7Mucn>

BENEFITS OF OPEN DATA

The GEO/CODATA report "Value of Open Data Sharing" explores various benefits of open data policy, including:

- Supporting broad economic benefits and growth
- Expanding interdisciplinary and international research
- Reducing duplication and inefficiencies in data collection
- Stimulating new user applications and commercial uptake
- Building capacity in less developed countries

To obtain a copy of the report: <http://bit.ly/2k9YJtt>



GEOSS: ENABLING ACCESS TO EARTH OBSERVATIONS

A central part of GEO's Mission is to build the Global Earth Observations System of Systems (GEOSS). GEOSS is a set of coordinated, independent Earth observation, information and processing systems that interact and provide access to diverse information for a broad range of users in public and private sectors.

The GEOSS Common Infrastructure, or GCI, is the name given to the physical and software infrastructure that enables the connection and coordination of the many autonomous and multi-organizational systems and services contributing to GEOSS. The GCI ensures that the data in GEOSS may be

discovered and accessed by users and is interoperable with other data to support the delivery of information services and tools. The GCI is unique in that it allows data providers to make their data available to users while retaining control and continuing to use their existing standards and formats.

The GEOSS Portal offers a single Internet access point for users to discover, access and use the data available through the GCI. For users with limited or no access to the Internet, similar information is available via the 'GEONETCast' network of telecommunication satellites.

Recent Improvements to the GCI

The GCI operations team works continuously on improving and upgrading the functionalities and user experience for both data users and data providers. Some examples of recent changes include:

- **A simplified registration process** for new data providers that:
 - Offers greater visibility for the contributions to GEOSS by the data providers;
 - Allows data providers to tag their data to specific Societal Benefit Areas or Sustainable Development Goals and thus make it easier for users to discover; and
 - Requests data providers to assess their adherence to the GEOSS Data Management Principles.
- **New GEOSS Portal functionalities** requested by the GEO community, including:
 - Geographical locations recognized among search terms;
 - Search terms hints, based on most frequently searched terms, to help the user in filling a search text;
 - New smart filters and visualization for specific communities or data types, for example, earthquake events and Sentinel data;
 - Ability to share searches and resources;
 - User authentication to allow customization functionalities; and
 - Certain additional kinds of resources (KML-type) displayed as a layer superimposed on the map.

- **GEOSS Portal mirrors and widgets** that allow for the creation of web portals that share the look, feel and functionality of the GEOSS Portal, but focus on topics and data of interest to a specific community. For example, such topic-oriented web portals have been created for wetlands (GEO Wetlands) and for mountain regions (GEO GNOME).
- **A "Status Checker" has been implemented** that automatically assesses and reports on the availability of the resources connected to the GCI. This service supports both the data providers and the data users, including using icons that appear during searches in the GEOSS Portal.
- **Virtual workshops** based on Societal Benefit Areas and their related GEO Flagships and Initiatives have identified gaps in data that are being addressed by seeking and brokering additional data providers. They have also identified new functionalities of interest to these user communities.
- **GCI Views** that enable showing users only certain selected content (the View) out of the entire set of GEOSS resources. A View is defined and used by a specific user community to focus on its needs and may be used to access GEOSS content and services through Community Portals.

 Visit the GEOSS Portal: www.geoport.org

Exploring the Universe of GEOSS

After more than a decade of development, GEOSS provides access to one of the largest collections of Earth observation resources in the world, spanning continents and disciplines. It is a “universe” of data about our planet.

The European Commission’s Joint Research Centre and the Italian National Research Council have begun a project to explore this universe of data in GEOSS. The first step has been to analyze the contents of the 1.8 million data collections and systems most closely connected to GEOSS; other systems will be explored later. The project GEOSS Explore relies on the most recent developments in “big data” analytics and artificial intelligence. In addition to mapping information systems dealing with Earth observation, it will provide important

insights about how to automatically improve metadata and make it easier for users to find and access information in GEOSS and other large distributed information systems.

Even with this initial partial view, project leads estimate that more than 5,000 organizations contribute to GEOSS, using almost 200,000 different keywords, in more than 35 languages. Using a semantic analysis of the titles and abstracts of all these data resources to cluster and link related concepts and the organizations using them, the team was able to find the disciplinary and thematic linkages across this universe.



Connecting Providers and Users of Earth Observations

An example of how GEO connects innovative Earth observations solutions with those who need them can be seen with the Global Human Settlement Layer (GHSL), which was developed by the European Commission’s Joint Research Centre with the support of many partners. Key products emerging from this work include the two editions of the “Atlas of the Human Planet” and further applications are being explored within the GEO Human Planet Initiative.

The International Committee of the Red Cross (ICRC) works around the world to protect and assist the victims of the war and other emergency situations. To be most effective, it is vital that the size of the populations affected by a conflict or disaster situation be accurately estimated. Unfortunately, reliable information from statistical or government bodies is often missing or fragmented in the areas where the ICRC works, and some of the data ICRC was using is subject to significant cost.

At the end of 2016, the GHSL dataset was brokered by the GEOSS Common Infrastructure (GCI), making it widely discoverable and accessible through the GEOSS Portal. Thanks to this work, GEO enabled ICRC to access free and open global population data and use it in their field operations.

 For more information: ghsl.jrc.ec.europa.eu



MONITORING WORK PROGRAMME IMPLEMENTATION AND RESULTS

GEO Indicators Strategy

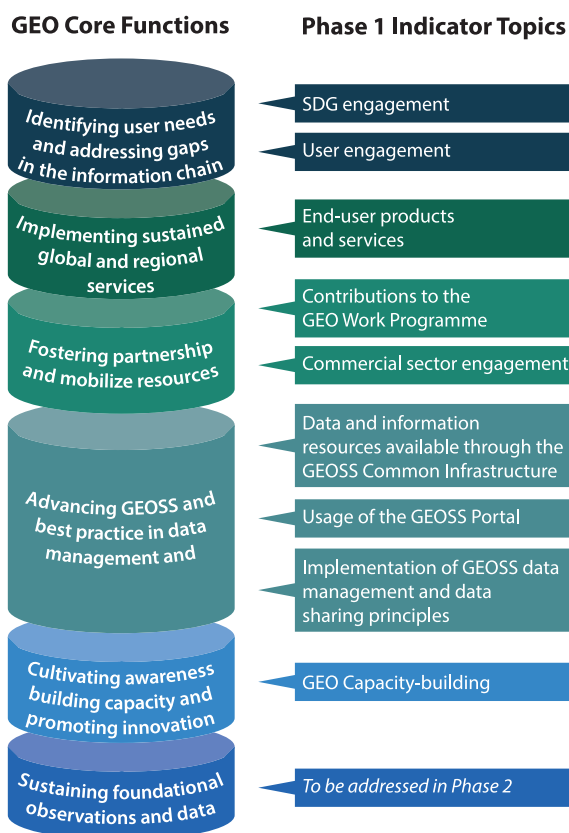
GEO has long used monitoring and evaluation to assess progress and identify opportunities for improvement, beginning with the Mid-Term Evaluation of the first GEO Implementation Plan in 2010. The 2016–2025 Strategic Plan brings an increased focus on using quantitative and qualitative indicators to assist in these efforts.

The indicators being put in place are part of a broader system for collecting information about GEO Work Programme activities and other aspects of GEOSS implementation. This information is intended to support decisions by the GEO Plenary, Executive Committee, and Programme Board, as well as ongoing work within the Secretariat. It is also expected to provide a useful resource for leads and participants in GEO Work Programme activities.

The first phase of indicator data collection is being implemented in 2017, following consultation with the GEO community at the 2017 Work Programme Symposium and with the Programme Board. The indicators are aligned to the Core Functions identified in the 2016–2025 Strategic Plan, as shown in the table. A second phase of indicators will be implemented in 2018. The indicator data will be updated on an annual basis until 2025, thus enabling the tracking of change in the indicators over time.

While many of the Phase 1 indicators monitor GEO inputs, activities, and outputs, collecting this data is an essential first step toward measurement of outcomes and impacts (see Results Chain diagram).

GEO 1ST PHASE INDICATORS



GEO RESULTS CHAIN

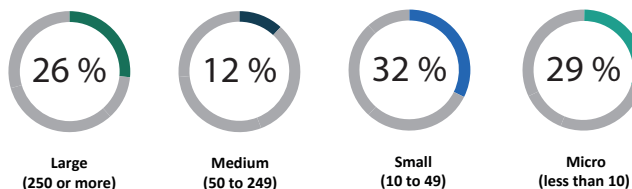


Preliminary Indicator Results

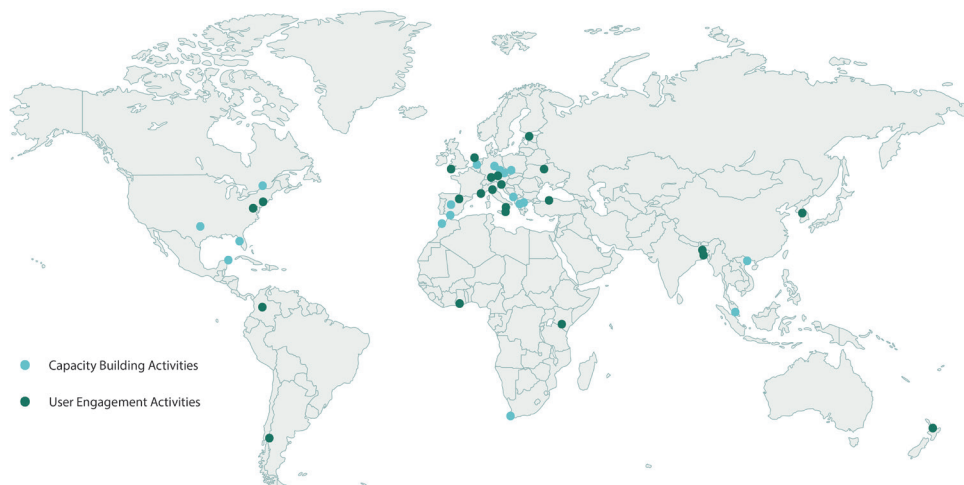
Some preliminary results from Phase 1 indicators were included in the User Engagement and Capacity Building section of this report. Additional examples are provided below to illustrate the potential utility of the data for informing GEO participants, partners and others about the nature and scope of GEO's work.

We are unable to draw firm conclusions at this time, as data collection is still underway. Just over half (23 of 44) of the activities targeted for the initial round of data collection have provided their data to this process, with the rest still in progress. Data collection will continue through the remainder of 2017 to obtain as complete a baseline as possible.

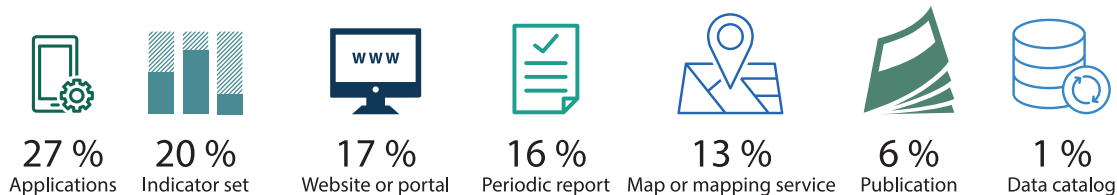
DISTRIBUTION OF COMMERCIAL SECTOR ORGANIZATIONS ENGAGED IN THE GEO WORK PROGRAMME (BY NUMBER OF EMPLOYEES)



DISTRIBUTION OF CAPACITY BUILDING AND USER ENGAGEMENT IN GEO WORK PROGRAMME ACTIVITIES 2016-17



TYPES OF END USER PRODUCTS AND SERVICES DEVELOPED BY GEO WORK PROGRAMME ACTIVITIES





www.earthobservations.org