REPORT ON IMPACT
2016 - 2019
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GEO REPORT ON IMPACT 2016 – 2019

The Group on Earth Observations (GEO) is turning Earth observation data and information into knowledge for action.

A global partnership of 100+ member countries and 120+ partner organizations and associates, GEO envisions a world where Earth observation data is used to drive better decision making.


Explore the online report to discover more than 50 initiatives and activities of the GEO community. They represent just a few examples where GEO is making a difference with Earth observations for impact.

About the image: The Larsen Ice Shelf. Copernicus Sentinel-3A satellite takes us over the Antarctic Peninsula and the adjacent Larsen Ice Shelf, from which a massive iceberg broke off in July 2017. The image has been manipulated, so clouds appear pink while snow and ice are blue to help us differentiate between them. The only land clearly visible is the tip of the Peninsula in the upper left, while sea ice covers the Weddell Sea to the right. Copyright contains modified Copernicus Sentinel data (2017), processed by ESA, CC BY-SA 3.0 IGO
MESSAGE FROM THE GEO LEAD CO-CHAIR

As the GEO Lead Co-Chair, I am encouraged by the work and dedication of the GEO community that continues to build on the solid foundation laid by previous Lead Co-Chairs in the period from 2016 to 2019.

Reflecting on the Mexico Ministerial Summit in 2015, GEO committed to strengthen its focus on users and to develop new approaches to effectively engage with United Nations’ agencies, Development Banks, while engaging additional Participating Organizations and the Commercial Sector. This, it was clear, would entail governments promoting GEO nationally and through their respective regions, to result in more effective collaboration with GEO.

Identifying Earth observation needs and gaps and developing knowledge and tools to enable delivery of useful services to users has characterized the work of GEO since the Mexico Ministerial Summit and our commitment to the GEO Strategic Plan 2016-2025: Implementing GEOSS.

As the Lead Co-Chair for 2019 I have focused on three goals, and I am proud to say that we have made considerable progress in developing approaches and partnerships in these areas:

- Supporting global policy priorities and United Nations agencies through Earth observations data and information
- Engaging the Global South in building the Global Earth Observation System of Systems (GEOSS)
- Increasing engagement with small and medium-sized commercial organizations

I am pleased that the ‘Framework for a Results Oriented GEOSS’ was approved by an Expert Advisory Group to include a knowledge-based GEOSS that delivers decision ready products and services. It is important to note that while capacity gaps still remain, both in terms of underlying technologies and human capability especially in developing countries, much has been achieved through promoting open access to data and information.

“I am proud that the GEO community has leveraged its unique position to foster strategic partnerships to coordinate and contribute to sustainable solutions to global challenges.”

The highlight for this year has been the launch of the Digital Earth Africa programme to improve the understanding of Africa’s changing landscape, and to enable policy makers and public officials to make better-informed decisions, and increases commercial efficiency and economic growth opportunities for businesses and entrepreneurs. Digital Earth Africa is based on Open Data Cube (ODC) technology pioneered by Geoscience Australia and the Committee on Earth Observation Satellites (CEOS), as well as other technologies, including cloud computing and advanced machine learning,

Digital Earth Africa will deliver a unique continental-scale, operational platform to consume and translate decades of satellite imagery into actionable information for Africa’s land surface and coastline. To date, significant levels of resources have been mobilized to support Digital Earth Africa including $18m USD in funding from the Helmsley Charitable Trust in the USA and the Department of Foreign Affairs and Trade (DFAT) in Australia. In this regard, the role of United States Geological Survey in providing Landsat as Analysis Ready Data for Digital Earth Africa is highly appreciated.

Our engagement with small and medium-sized enterprises has been launched as part of the new GEO Associates category, and we have seen increased commercial sector participation in various related EO events, including businesses attending from Ghana and South Africa. The ongoing efforts to build partnerships with the commercial sector will culminate in the first ever Industry Track at GEO Week 2019 including the Canberra Ministerial Summit taking place in Australia.

I also wish to acknowledge Australia for hosting GEO Week 2019 and the Canberra Ministerial Summit, and also recognize the work of the GEO Ministerial Leadership Team, which left no stone unturned in ensuring the successful hosting of GEO Week 2019. Finally, I wish to thank my fellow Co-Chairs, the Executive Committee and the GEO Plenary for their respective roles in strengthening activities to deliver the GEO vision and impact.

Mmboneni Muofhe, GEO Lead Co-Chair
MESSAGE FROM THE GEO SECRETARIAT DIRECTOR

As we embark on a newly defined GEO Work Programme, I would like to reflect on the achievements and impacts of the GEO community from 2016-2019.

Around the world, GEO is delivering data, information and knowledge for coordinated and sustained global action. Earth observation data is now integrated into strategies and approaches to Disaster Risk Reduction, Climate Adaptation and Mitigation, Sustainable Development and other areas. I am proud to say that GEO is making advances with science-based evidence for policy making in these areas.

Merging technologies present new opportunities to access, use and apply Earth observation data. GEO must ensure that big data applications and cloud services are not only adopted by the EO community, but are also optimized for open sharing of EO data. We must continue to build trust in these technologies and promote capacity development, so that no one is left behind by the opportunities they present.

Standout activities from GEO Flagships including GEOGLAM, GEOBON, GFOI, and GOS4M are supporting action on the world’s most pressing issues, such as the sustained ecology of our planet and food insecurity. These are in addition to the activities carried out under the GEO umbrella including the Human Planet Initiative, EO4SDG, GEOGLOWS, Regional GEOS, and the countless other community activities making a difference.

Exemplary efforts have resulted in strengthened relationships and increased engagement with global policy institutions, including the World Economic Forum (WEF), UN Office for Disaster Risk Reduction (UNDRR), UN Framework Convention on Climate Change (UNFCCC), UN Convention to Combat Desertification (UNCCD), UN Environment (UNEP), UN-Habitat and others.

“Reflecting on GEO’s accomplishments as outlined in this report, two things are abundantly clear: the impact of GEO continues to develop and grow in efforts to reach new users and communities, and the need for our global partnership is more crucial than ever.”

As a voluntary organization, GEO is supported by the actions of ambitious colleagues around the world. It is befitting that this year, exceptional contributions and commitments to GEO will be celebrated through the inaugural GEO Individual Excellence Awards. GEO is also awarding projects using Earth observations for the Sustainable Development Goals as part of the EO4SDG initiative.

2019 has been a very busy year for the GEO Secretariat and the entire GEO community. It has been a year of transition, as an ambitious and forward looking plan has been established for the future of GEO. I acknowledge and congratulate the Programme Board for their dedication to the successful development of the GEO Work Programme 2020-2022.

It is my hope that you are not only inspired by the stories in this Report on Impact, but are motivated to support activities under the new GEO Work Programme. I know that with the continued backing of committed individuals across the global GEO community, we will expand our impact in existing and new domains and continue to build on the success of these achievements together.

I look forward to maintaining our strong relationships across the community during my tenure as Secretariat Director, and thank you all for the continued engagement and support that have made the impacts of the past year possible.

Gilberto Camara, GEO Secretariat Director
ABOUT THE GROUP ON EARTH OBSERVATIONS

The Group on Earth Observations (GEO) is making a global impact. GEO promotes open, coordinated and sustained data sharing for better research, improved policy making, data informed decisions and action.

From 2016-2019, GEO has convened partners to address some of the world’s greatest challenges. The GEO community focuses its efforts around three global priority engagement areas: the United Nations 2030 Agenda for Sustainable Development, the Paris Agreement, and the Sendai Framework for Disaster Risk Reduction in addition to supporting other environmental international policy directives and agreements.

GEO brings together hundreds of National Government agencies from 108 Member countries, 132 Participating Organizations, 6 GEO Associates and encompasses over 7000 data providers to ensure EO data, information and knowledge is shared and applied for the benefit of society and our planet.

WHAT ARE EARTH OBSERVATIONS?

Earth observations (EO) refer to data and information about the physical, chemical and biological aspects of our planet including remote sensing technologies, supplemented by Earth surveying techniques.

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 and sensors aboard satellites.

About the image: The Operational Land Imager (OLI) on NASA's Landsat 8 satellite acquired this large natural-color image showing a view of the Caspian Sea around the Tyuleniy Archipelago on April 16, 2016. North Caspian Sea. Image Credit: NASA image by Norman Kuring, NASA’s Ocean Color web. Caption: Kathryn Hansen
WHO ARE WE?

The Group on Earth Observations (GEO) community works together to:

- Advocate for Earth observations as an important and useful way to highlight irreplaceable resources that must be protected, made fully and openly accessible, integrated with other data sources and included within decision making processes to drive action;

- Partner with stakeholder communities and to foster long-term partnerships to address global and regional environmental and societal challenges; and

- Deliver data, information, and knowledge to enable informed public and commercial sector decisions, exchange of good practice, uptake of new technologies, and the creation of economic opportunities and sustainable development decisions and action.

GEO’S GROWING MEMBERSHIP

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- Partner with stakeholder communities and to foster long-term partnerships to address global and regional environmental and societal challenges; and

- Deliver data, information, and knowledge to enable informed public and commercial sector decisions, exchange of good practice, uptake of new technologies, and the creation of economic opportunities and sustainable development decisions and action.

In 2016, three new Member Countries included: Uruguay, United Arab Emirates and Mongolia as GEO’s 101st, 102nd and 103rd Member Countries.

In the period from 2017-18 new Members included: The Royal Government of Cambodia and the Sultanate of Oman became the 104th and 105th GEO Member Countries in 2017.

In 2019, three countries joined including: Sierra Leone, El Salvador and Guatemala. GEO’s membership now totals 108 countries that have agreed to the broad principles of open data sharing and have committed to GEO’s vision of a world informed by Earth observation data, information and knowledge.

NEW PARTICIPATING ORGANIZATIONS

Since 2016 GEO’s Executive Committee welcomed the following new Participating Organizations:

- European Association of Remote sensing companies (EARSC)
- Mountain Research Initiative (MRI)
- Association of Geospatial Industries (AGI)
- African Regional Centre for Space Science and Technology Education English (ARCSSTEE)
Since 2017-2018, GEO’s Executive Committee approved 20 new Participating Organizations. These organizations contribute to the work of Member Countries to support GEO’s vision and mission. Those Participating Organizations include:

- African Climate Change Research Centre (ACCREC)
- AGRHYMET Regional Centre
- Asian Disaster Preparedness Centre (ADPC)
- Afriterra Foundation
- Centre for Environment and Development for the Arab Region and Europe (CEDARE)
- Central African Forest Commission (COMIFAC)
- Community Surface Dynamics Modeling System (CSDMS)
- Conservation International (CI)
- FrontierSI
- Earthmind
- Environment Pulse Institute (EPI)
- EuroGeographics
- Global Partnership for Sustainable Development Data (GPSDD)
- Global Data for Agriculture and Nutrition (GODAN)
- IHE Delft Institute for Water Education
- Higher Institute for Space Studies and Telecommunications (ISESTEL)
- Radiant Earth Foundation
- Resources for the Future (RFF)
- Secretariat of the Pacific Regional Environment Programme (SPREP)
- The Paul G. Allen Philanthropies
- United Nations Economic Commission for Latin America and the Caribbean (UNECLAC)
- United Nations Economic and Social Commission for Western Asia (UNESCWA)
- United Nations Children’s Fund (UNICEF)
- World Resources Institute (WRI)

This year, the newest Participating Organizations to join GEO include:

- World Food Programme (WFP)
- Economic Community of West African States Commission (ECOWAS Commission),
- Mercator Ocean International
- The OpenGeoHub Foundation (OpenGeoHub).
For more information, view the full list of Participating Organizations [here](#).

In 2019 GEO announced a new category for commercial entities. The new GEO Associates category paves the way for commercial and non-governmental, not-for-profit and civil society organizations to join governments and international organizations as official collaborators of GEO. This new category reflects the growing engagement and contributions of diverse sectors in GEO’s Work Programme.

The approved GEO Associates include:
- Acclimatise
  - The Centre for Ecological Research and Forestry Applications (CREAF)
  - Beijing Piesat Information Technology Co.
  - Environmental Systems Research Institute (Esri)
  - International Centre for Earth Simulation Foundation (ICES)
  - SpaceWill Info. Co. Ltd.

For more information, view the full list of GEO Associates [here](#).

THE GEO WORK PROGRAMME

As GEO’s membership continues to grow and evolve, GEO’s Work Programme Activities, Initiatives and Flagships reflect the changing nature and growing importance of Earth observation data, information and knowledge to a wide range of applications and thematic areas.

In 2019, the GEO Programme Board underwent a comprehensive review process to assess the impact and effectiveness of the GEO Work Programme 2017-2019. They agreed on an ambitious plan for 2020-2022 to strengthen, scale up and support the GEO Work Programme around four types of activities:

**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: the coordination of observing systems, implementation of technical and policy components, sharing of data and other resources in the Global Earth Observation System of System (GEOSS).

**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.

**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 activities.
CHAPTER 1 | IMPACT ON BIODIVERSITY

Established in 2008, the Group on Earth Observations Biodiversity Observation Network (GEO BON) improves the availability of biodiversity data for decision makers and scientists in support of better policies.

GEO BON has made remarkable progress since its inception over a decade ago. It has developed into an internationally recognised organization with 800 members registered on the online platform from over 560 institutions and 90 countries. It is recognised by the Convention on Biological Diversity (CBD) and by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) as a key organization for biodiversity monitoring globally.

GEO BON coordinates efforts to design and implement interoperable national and regional biodiversity monitoring programmes. GEO BON has developed a global network and community of practice for biodiversity observations. This open network includes world-renowned leaders in biodiversity observations, as well as major partner organisations working in biodiversity monitoring. Through its global network of organizations and experts, GEO BON supports the sharing and dissemination of information and technology for biodiversity observations.

GEO BON MARKS A DECADE OF BIODIVERSITY & CONSERVATION EFFORTS

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THE ESSENTIAL BIODIVERSITY VARIABLE FRAMEWORK (EBV) AND “BON IN A BOX”

The Essential Biodiversity Variable framework (EBV) and the “BON in a Box” tool catalogue are two of GEO BON’s primary vehicles for delivering technical information to its participants. The EBV Framework was referenced in the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Global Assessment in 2018. The development of the “BON in a Box” toolkit has increased engagement of National, Regional and Thematic Biodiversity Observation Networks (BONs).

In July 2018, GEO BON organised an All Hands meeting in Beijing, China which developed the “Beijing Call on Biodiversity Observations for Post-2020 Decision Making.” The Beijing Call has been central to GEO BON’s contribution to the post-2020 biodiversity framework of the UN Convention on Biological Diversity (CBD). It was presented as one of the interventions during the UN CBD COP14 in Sharm El Sheikh, Egypt in December 2018.

Mike Gill, Director of Biodiversity Indicators Programme, NatureServe, and Laetitia Navarro, Executive Secretary of the Group on Earth Observations - Biodiversity Observation Network (GEO BON) reading the Beijing call during the COP14 in Egypt

Read the Beijing Call [here](#).

At the 14th meeting of the Conference of the Parties to the Convention on Biological Diversity (UN CBD COP14) Sharm El-Sheikh, Egypt, 17 - 29 November 2018, the GEO BON Portal was launched with datasets loaded in the visualizer/analyser part of the portal.

The network continues to grow, in November 2018 a new thematic BON, the Soil BON was approved and a new regional BON, the Americas-BON was accepted in July 2019.

The gallery can be accessed [here](#).

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The network continues to grow, in November 2018 a new thematic BON, the Soil BON was approved and a new regional BON, the Americas-BON was accepted in July 2019. GEO BON also produces a range of scientific publications, with a total of 74 peer reviewed articles now available on the website [here](#).

The GEO Handbook on Biodiversity Observation Networks, published in open access in 2016 with Springer, has been downloaded 170K. Get your copy [here](#).
**ASIA PACIFIC BON SHOW IMPACTS OF DAMS ON FRESHWATER FISH BIODIVERSITY IN THE LOWER MEKONG BASIN**

The lower Mekong region is a global biodiversity hotspot. It is characterized by high fish richness. As the world’s largest freshwater fishery, yields from the Lower Mekong Basin (LMB) alone are estimated at 2.1–2.2 million tonnes annually.

Asia Pacific BON (APBON) studied the impacts of hydropower dams and global warming (and their synergistic effects) on freshwater fish biodiversity in the lower Mekong region, estimated by fish biodiversity data from more than 1500 sites. This research was conducted by The Ministry of Environment Japan, which aimed to enhance the observation and monitoring of biodiversity in the region.

While hydropower dams produce energy with less exhaust from CO2 and GHG emissions than carbon intensive energy production, the negative impacts on freshwater fish biodiversity seemed to be significant. For example, fish species richness of the lower Mekong region was expected to reduce by more than 30% due to the dam construction. This information has significant on decision making for future construction projects. Nagao Natural Environmental Foundation provided the extensive fish distribution data for the region.

The study not only focuses on biodiversity of fish, but also on the issue of water resources management in river basins under climate change. Notably the data is relevant for SDG2 and SDG6, by ensuring lower Mekong region has better information to make decisions in support of food security and sustainable use of inland water resources.

**BON-COLOMBIA BIOMODELOS: A COLLABORATIVE ONLINE SYSTEM TO MODEL SPECIES DISTRIBUTION**

BON-Columbia, a national network of GEO BON, has created the BioModelos system to strengthen collaboration and networking for national biodiversity modelling and monitoring. BioModelos is a collaborative online system to model species distribution using, inter alia, national biodiversity monitoring.

The system is improving open and collaborative communication between experts in biodiversity to develop distribution models for the existing species in Colombia. This initiative brings together researchers, government institutions, NGOs and citizens to access accurate and validated information on the distribution of species in Colombia. The system serves as reference for future studies and decision making on biodiversity.

In addition, one of the A.50 projects funded by NASA for the GEO Work Programme is directly linked to BioModelos. The project, “Expanding Wallace Biodiversity Modeling Software to Support National Biodiversity Change Indicator Calculations for GEO BON Assessment and Reporting” is developing new software to assess biodiversity change indicators by building on the recently developed software Wallace as a new GEO BON in a Box tool.

The data can be found here.
QUANTIFYING FOREST VERTICAL STRUCTURE USING SPACEBORNE LIDAR: A GEO BON ESSENTIAL BIODIVERSITY VARIABLE APPLICATION IN COLOMBIA

In collaboration with BON-Colombia and NASA, researchers at the Northern University of Arizona and Colombia’s Alexander von Humboldt Institute have developed an Essential Biodiversity Variable (EBV) application for quantifying forest vertical structure using spaceborne lidar. By quantifying habitat structure and its changes over time, researchers can better predict habitat use for a range of animals and plant species in forest ecosystems.

Built on a NASA project called “Quantifying Forest Vertical Structure Using Spaceborne Lidar: A GEO BON Essential Biodiversity Variable Application in Colombia,” a comprehensive mapping of Earth’s biodiversity is a priority to maintain healthy ecosystem functions.

Habitat structure is one of six EBV classes defined in the EBV framework and has been highlighted as a priority for mapping from space. Although Earth observations have greatly increased our understanding of Earth’s ecosystems over the past several decades, especially the horizontal distribution of forests and other major vegetation types, we still lack precise measurements of vertical habitat structure and its distribution for large land areas. This application aims to increase the use of EO for these purposes.
CHAPTER 2 | CAPACITY DEVELOPMENT

Over the past decade, GEO has been working to build the GEO System of Systems (GEOSS). GEO has already made over 400 million open Earth observation data and information resources available via the GEOSS Portal and through the GEODAB API, both part of the GEOSS Platform, in order to contribute to global development efforts.

Efforts to reach new communities have resulted in GEO Community Portals developed using the GEOSS Platform technology.

NextGEOSS data hub and platform was unveiled to promote scalable transformation of Earth observation data into actionable information and knowledge across all 17 SDGs.

GEO and Amazon Web Services (AWS) announced the Earth Observation Cloud Credits Programme, a joint collaboration to offer GEO members and research organizations access to AWS Cloud services to help countries realize the potential of Earth observations for sustainable development.

Digital Earth Africa will provide a routine, reliable and operational service that will enable African nations to track changes across their countries and the continent in unprecedented detail.
GEO-CRADLE: COORDINATING EARTH OBSERVATIONS ACTIVITIES IN NORTH AFRICA, THE MIDDLE EAST, AND THE BALKANS

GEO-CRADLE is the GEO regional initiative to coordinate and integrate Earth observation activities in North Africa, the Middle East, and Balkans (NAMEBA) and to develop links with GEO initiatives and GEOSS.

Launched in 2016 with funding from H2020, it comprises 25 partners from 3 continents to work in a highly-complementary team that combines a strong background in EO coordination activities. It is organized in four key thematic areas: adaptation to climate change; improved food security & water extremes management; access to raw materials; and access to energy.

Assessing and building up EO maturity in NAMEBA to address regional needs

The GEO-CRADLE project, a GEO Initiative, responds to the challenges and critical gaps that prevent EO uptake in North Africa, Middle East and the Balkans (NAMEBA). This is mostly due to the limited cooperation between the EO stakeholders, the linguistic and cultural differences, the big diversity in EO maturity, the ineffective exploitation of resources and expertise, the limited public awareness on the benefits of EO, and the low involvement of the industry sector in the development of EO services.

In order to tackle these challenges, GEO-CRADLE established a regional coordination network in NAMEBA which integrated existing EO capacities through the extensive inventorying of the EO capabilities. This included analysis of space/air-borne, ground-based/in situ monitoring, modelling and computing. It carried out detailed collection of user needs in 93 interviews from 14 countries, followed by a gap analysis, and a priorities action plan with four pilot activities. Finally, the Regional Data Hub was connected to the GEOSS platform with 25,534,239 datasets, 45 regional portals and sites including the four GEO-CRADLE pilots.

GEO-CRADLE has established a path for increased engagement through a Networking Platform that hosts 268 profiles of EO actors from 29 countries. In addition, liaison activities and capacity building events, including 19 regional workshops and dissemination activities including 31 scientific papers and articles have been achieved.

The initiative successfully developed a novel methodology for EO Maturity Assessment (32 indicators across 3 fields: “Capabilities,” “Cooperation” and “National Uptake and Awareness”) and application in 11 countries using an analytical tool that allows the quantitative measurement of the current EO capacities in a given country and their evolution over time, as well as their standardised visualisation in the form of a “maturity card.”

GEO-CRADLE has resulted in important societal benefits through networking, capacity building and exchange of EO methodologies, know-how, datasets and services in the NAMEBA region. In this region, where EO awareness, needs, capacities and synergies with Europe were limited before, GEO-CRADLE has achieved great scientific, societal and economic impact, as is the case several of the pilots, specifically the Access to Solar Energy (SENSE) pilot.

SENSE supports SDG 7 Affordable and Clean Energy and SDG 9 Industry and Infrastructure. Using free access to Copernicus data and Core services, innovative modelling and state-of-the-art real-time solar energy calculating systems, it delivered reliable and high resolution Solar Atlases and broader climatology studies. It integrated a solar energy nowcasting system into the wider GEOSS. It also helped to stimulate the interest of key energy stakeholders and decision
Read the full story, Europe’s eyes in the sky are helping to solve energy, land-use problems in Africa: [https://horizon-magazine.eu/article/europe-s-eyes-sky-are-helping-solve-energy-land-use-problems-africa.html](https://horizon-magazine.eu/article/europe-s-eyes-sky-are-helping-solve-energy-land-use-problems-africa.html)

“GEO-CRADLE has demonstrated through its pilots in the strategic and challenging NAMEBA region that the continuous provision of accurate and timely information through coordinated and sustained EO is a key enabler for the maximisation of the impact of EO activities and the informed decision making, in response to regional/global challenges and towards the achievement of the UN SDGs.” Haris Kontoes, GEO-CRADLE Project Coordinator.

“We find that the idea of the Solar Energy Nowcasting System (SENSE) pilot in order to produce (i) the analytical solar energy Atlas of Egypt mainly for the efficient solar energy exploitation and (ii) the nowcasting of the solar energy potential in real time in order to support the Egyptian energy authorities to better plan solar energy demands, is of great and absolute importance. It is also a clear example of successfully building a value chain through a partnership between innovation and capacity building provider, GEO-CRADLE team, working with the Ministry and associated Renewable Authority, to deliver the Solar Atlas and the dynamical output, hopefully to meet the mandate of the investors and fund providers resulting in better schemes of energy production and hence in customer satisfaction.” Mr Mohamed Shaker El-Markabi, Minister of Electricity and Renewable Energy, Egypt

“The Ministry of Military Production believes that this developed Solar Atlas is an excellent addition, complementing the Government’s efforts in finding other venues for electricity production. The Ministry of Military Production will be willing to adopt this technology while being engaged in solar-related projects in Egypt.” Mr Mohamed Said El-Assar, Minister of State for Military Production, Egypt

**DIGITAL EARTH AFRICA: DELIVERING DECISION READY PRODUCTS FOR THE CONTINENT**

A number of countries in Africa supported by Australia, USA and other GEO members have embarked on a long-term programme to provide analysis ready datasets available to users and decision makers, through the Digital Earth Africa (DE Africa). Building on Open Data Cube technology originally developed In Australia, DE Africa delivers the capability to store, manage, process, interrogate, and present Earth observation data as decision ready products. It marks the beginning of the new era of open data and knowledge for Africa.

Digital Earth Africa will provide a routine, reliable and operational service that will enable African nations to track changes across their countries and the continent in unprecedented detail.

In the era of the big data revolution, more and more data is becoming open and easier to access and use. This is particularly true of Earth observation data, notably satellite imagery. Users are benefiting from the fusion of technologies from satellites to mobile phones, cloud based services, high performance computing and machine learning to make unprecedented volumes of data available and usable.
Launched at the AfriGEO Symposium in August 2019, Digital Earth Africa is set to deliver a continental-wide platform and programme that democratizes the capacity to process and analyze satellite data.

**GEO AND AMAZON WEB SERVICES ANNOUNCE CLOUD GRANTS TO IMPROVE UNDERSTANDING OF OUR PLANET**

In December 2018, GEO and Amazon Web Services (AWS) announced the Earth Observation Cloud Credits Programme, a joint collaboration to offer GEO members and research organizations access to AWS Cloud services to help countries realize the potential of Earth observations for sustainable development.

Through this programme, GEO encouraged agencies and research organizations from countries categorized as Developing Countries by the United Nations Development Programme (UNDP) to apply for cloud credit grants to support non-commercial projects. Agencies and organizations from a single country could apply for up to $60,000 of AWS Promotional Credits over a three-year period, while multinational projects could apply for up to $100,000 in AWS Promotional Credits over the same period. Submissions were accepted from December 2018 through April 2019.

In June 2019, the GEO Secretariat announced 21 projects from 17 developing countries that would be awarded $1.5 million USD worth of cloud services, i.e. receiving grants and technical support through the Earth Observation Cloud Credits Programme.

Under the [Amazon Sustainability Data Initiative (ASDI)](https://www.aws.amazon.com/asdi/), this programme enables developing countries to use Earth observations and applications to support sustainable environmental development including the United Nations Sustainable Development Goals, the Sendai Framework for Disaster Risk Reduction, and the Paris Agreement on Climate Change.

There has also been additional support from the [Sinergise Sentinel Hub](https://www.sinergise.com/) Credits programme, which has provided access to the repository of data from the Sentinel-2 Earth observation mission from the European Union’s [Copernicus Programme](https://Copernicusobservatory.eu/) that acquires optical imagery at high spatial resolution.

Recipients of cloud credits through this initiative are also receiving support from the GEO community and AWS experts to refine and implement their projects for the best possible results. They will leverage Earth observation data from open, free, and fully accessible sources and are encouraged to use the GEOSS Platform and the [Registry of Open Data on AWS](https://aws.amazon.com/registry-of-open-data/). All data and software used and developed in the course of the selected projects, along with the associated good practice, will be made fully accessible to the wider GEO community, in compliance with the [Global Earth Observation System of Systems (GEOSS)](https://www.geneva.un.org/) Data Sharing Principles.
CHAPTER 3 | IMPACT ON CLIMATE CHANGE ADAPTATION & MITIGATION

The data, information and knowledge derived from Earth observations helps countries respond to environmental challenges presented by climate change. GEO’s deepened engagement at the international policy level and through increasing contributions to UNFCCC efforts illustrates GEO’s increased impact on global policy and climate change.

In 2015, the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) agreed to undertake ambitious efforts to both combat climate change and adapt to its impacts. Earth Observations help countries respond to the specific provisions of the Paris Agreement – including national reporting requirements, greenhouse gas mitigation measures, climate change adaptation and more.

The Paris Agreement called for a balance of climate finance between adaptation and mitigation, specifically underscoring the need to increase adaptation support for parties most vulnerable to the effects of climate change. 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 multiple disciplines and geographic domains.

About the image: Baltoro Glacier. Glaciers are shown in pale blue, snow in light blue to cyan, clouds in white, water in dark blue, vegetation in green and bare terrain in pink to brown. Copyright F. Paul, The Cryosphere, 2015 & USGS/NASA
ROLE OF EARTH OBSERVATIONS FOR THE PARIS AGREEMENT REAFFIRMED AT COP23

GEO has been working to strengthen the role of Earth observations to support countries’ monitoring of climate change targets. GEO participated as an official exhibitor and side event organizer at the 23rd UNFCCC Conference of the Parties (COP23) in November 2017. The GEO Secretariat has been actively pursuing the status of observer organization with the UNFCCC since August 2018.

Together with the Global Climate Observing System (GCOS) and the Remote Sensing Technology Center of Japan (RESTEC), GEO organized an official side event that explored the role of Earth observations to support National Greenhouse Gas (GHG) Inventories and the ongoing refinement of the Intergovernmental Panel on Climate Change (IPCC) Guidelines. The European Commission, and Germany as the host country, supported this side event for COP 23.

During the 47th session of the UNFCCC’s Subsidiary Body for Scientific and Technological Advice (SBSTA), this issue was formally brought forward and included in the outcome document, which noted the “increasing capability to systematically monitor greenhouse gas concentrations and emissions, through in situ as well as satellite observations, and its relevance in support of the Paris Agreement.”

UNFCCC’s Subsidiary Body for Scientific and Technological Advice (SBSTA)
Following the 47th session of SBSTA in 2017 in Bonn, Germany, space agencies provided a white paper describing a constellation architecture for monitoring atmospheric CO2 and CH4 concentrations and their natural and anthropogenic fluxes from space to support climate policy for the 49th session of SBSTA, 3-14 December 2018.

Taking the opportunities, such as Expert Reviews and statements during the SBSTA session, the global EO community have advocated the support of the Earth observations including satellite observations to improve the national greenhouse gas Inventories.

Read the full statement reporting on progress by the Committee on Earth Observation Satellites (CEOS) and the Coordination Group for Meteorological Satellites (CGMS) on Coordinated Response to UNFCCC Needs for Global Observations available here.

UNFCCC 50th session of the Subsidiary Body for Scientific and Technological Advice (SBSTA-50) Research Dialogue

In the ongoing effort to engage with the UNFCCC, the Secretariat presented a poster titled “GEO Knowledge Hub for Transformative Solutions through Open Science” during the Research Dialogue portion of SBSTA-50.

The Secretariat also delivered the following intervention at the Science Open Dialogue with the SBSTA chair: “Along the lines mentioned by the World Climate Research Programme (WCRP) of collaboration in a “landscape” of groups working to deliver information that decision-makers need, GEO, the Group on Earth Observations, is committed to helping its 108 Member states report under conventions and policy agreements to which they are signatories. To this end, GEO is working to open access to Earth observations, share knowledge in an open science context, and co-produce applications and tools in support of sustainable development and mitigation / adaptation measures under the Paris Agreement.”
GEO REPORT ON IMPACT

2019 REFINEMENT TO THE 2006 IPCC GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES

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GEO’s CLIMATE WORKSHOP ADVANCE COLLABORATIVE EFFORTS FOR CLIMATE CHANGE

In June 2018, GEO’s first Climate Workshop marked a significant milestone in GEO’s efforts to engage key organizations with explicit mandates in the climate policy process and specifically on the Paris Agreement. The workshop was attended by over 100 participants, including representatives active in the GEO Work Programme, including GEO Members and Participating Organisations.

Key speakers from UNFCCC, IPCC, GCOS, WMO, CEOS, CGMS and the World Climate Research Programme (WCRP), as well as contributors from GEO Flagships and Initiatives shared their current needs and discussed opportunities for GEO to support the international climate agenda.

Concrete action areas identified for GEO included:

• Helping to improve climate data access;
• Supporting actions on mitigation, adaptation, and loss and damage;
• Integrating climate with monitoring mechanisms for SDGs, Sendai Framework and other international conventions;
• Engaging with national stakeholders e.g. in National Adaptation Planning;
• Supporting IPCC processes (2019 Refinement of 2006 IPCC Guidelines on National GHG Inventories; Sixth Assessment Cycle);
• Responding to actions in the GCOS Implementation Plan; and
• Enhancing the use of climate data records for a variety of application areas, including drought monitoring, renewable energy assessments and health early warning systems.

FOREST MONITORING FROM SPACE: GLOBAL FOREST OBSERVATIONS INITIATIVE (GFOI)

The year 2017 marked a major milestone in forest monitoring from space. Complete forest cover data is crucial for countries to be able to report on GHG emissions from deforestation and forest degradation in support of the Paris Agreement. Deforestation and forest degradation is the
second leading source of carbon emissions globally, and must be reduced significantly in order to meet global climate targets.

Comprehensive, accessible forest data is now available for all countries as a result of the open data policies and collaboration of a variety of national space agencies and coordinating bodies, thereby ensuring full satellite coverage of the world’s forests. The space agencies operating the world’s largest civil Earth observing satellite programmes declared a major milestone where all countries now have the necessary data for annual forest monitoring for the first time ever.

In addition, CEOS had been coordinating space agency support to the data needs of the Global Forest Observations Initiative (GFOI) since 2011. This involved ensuring coordinated and complementary systematic acquisition strategies for a suite of relevant Earth observation satellites to provide all countries with the data necessary for annual monitoring of their forests.

The core data streams underpinning this coordinated multi-annual global coverage of forests are the optical sensors on the Landsat series (USGS), and from the European Union Copernicus programme the Sentinel-1 radar series (EU/ESA) and the optical Sentinel-2 series (EU/ESA). Further data contributions are provided by the space agencies of Japan (JAXA), Brazil (INPE), China (CRESDA), France (CNES), Italy (ASI), Canada (CSA), and Germany (DLR). Further useful datasets are anticipated next year from the space agencies of the UK (NovaSAR mission) and Argentina (SAOCOM mission).

Global coverage of forests through this collaboration will continue until at least 2030, allowing countries to confidently apply satellite data in their national forest monitoring and reporting systems.

COPERNICUS CLIMATE CHANGE SERVICE & BULLETINS

The Copernicus Climate Change Service

The Copernicus Climate Change Service (C3S) supports society by providing authoritative information about the past, present and future climate in Europe and the rest of the World. C3S combines observations of the climate system (from in-situ and satellite observing systems) with the latest science to develop authoritative, quality-assured information about the past, current and future states of the climate in Europe and worldwide.

The European Centre for Medium-Range Weather Forecasts (ECMWF) operates the C3S on behalf of the European Union and will bring together expertise from across Europe to deliver the service. C3S provides key indicators on climate change drivers such as carbon dioxide and impacts, for example, reducing glaciers. The aim of these indicators will be to support European adaptation and mitigation policies in a number of sectors.

The service builds upon and contributes to the European Union and the WMO Global Framework for Climate Services (GFCS) and its Climate Monitoring Architecture.

Last year C3S released European State of the Climate 2018, compiled by the C3S, implemented by the ECMWF on behalf of the European Union.
Copernicus’ Climate Change Bulletins

Through the production of monthly maps, the current condition of the climate and key climate change indicators are freely available to the public and policy makers. They also provide analysis of the maps and guidance on how they are produced.

The Monthly climate updates can be found here.

The latest data show that this year continues to bring record-breaking temperatures. Every month in 2019 has ranked among the four warmest for the month in question, and the globally-averaged air temperature for June was the highest ever recorded. It is now confirmed that July was also an exceptional month. The global average temperature for July 2019 was on a par with, and possibly marginally higher than, that of July 2016, previously the warmest July and warmest month of all on record, and which followed an El Niño event.

The Climate Data Store from Copernicus Climate Change Service
The Climate Data Store infrastructure aims to provide a "one stop shop" for users to discover and process the data and products that are provided through the distributed data repositories.

The CDS also provides also a comprehensive set of software (the CDS Toolbox) which enables users to develop custom-made applications. The applications will make use of the content of the CDS to analyse, monitor and predict the evolution of both climate drivers and impacts. To this end, the CDS includes a set of climate indicators tailored to sectoral applications, such as energy, water management, tourism, etc. – the Sectoral Information System (SIS) component of C3S. The aim of the service is to accommodate the needs of a highly diverse set of users, including policy-makers, businesses and scientists.

Visit the climate data store here: https://cds.climate.copernicus.eu/#!/home

Emergency Management in the Age of Climate Change

In a world with a changing climate, disaster patterns are shifting and intensifying. We are experiencing stronger hurricanes, forest fires in uncommon areas over longer time-frames, prolonged droughts and widespread flooding. Earth observation applications for emergency management are becoming increasingly important.

For example, a large number of a forest fires in winter months are being closely monitored. By early March 2019, the European Forest Fire Information System reported that the number of fires in Europe reached a level usually recorded in August.
While disasters strike indiscriminately, disaster mitigation, preparedness, response and recovery call for coordinated approaches to emergency management. The European Union’s Civil Protection Mechanism enables an internationally coordinated response. Under this mechanism, French firefighting aircraft can extinguish forest fires in Spain, while experts in Italy prepare satellite-based flood maps for Sweden.

Despite this international collaboration, not every country has equal capacity to deal with an increasing number of disasters, nor do they all have their own space programme to support disaster risk management efforts. Earth observation satellites orbit the Earth without border restrictions, and the data they provide can help bridge the emergency management capability gap between high- and low-income countries.

The Copernicus Emergency Service (Copernicus EMS) supports disaster risk reduction and emergency management at various stages. The data collected, combined with tools and services that turn data into information for decision makers, can contribute to better results at all stages of the disaster risk reduction cycle.

2018 October earthquake and tsunami in Indonesia: grading map of Palu city show that almost over 37,000 people, 10,000 buildings and other infrastructure were affected (Copernicus EMS © 2018 EU, [EMSR317] Palu: Grading Map)
CHAPTER 4 | IMPACT ON DISASTER RISK REDUCTION

GEO supports disaster risk reduction by improving coordination of Earth observations for disaster forecasting, mitigation, management and recovery, in line with the Sendai Framework and to support countries to incorporate Earth observations into their national disaster risk reduction strategies.

In 2017, the United Nations Office for Disaster Risk Reduction (UNDRR) Sendai Framework Data Readiness Review assessed the readiness of countries to report against the targets of the Sendai Framework. Produced with input from the GEO community, the Review highlighted the role that Earth observations can play in the reduction of disaster risk, and the value that Earth observation-derived monitoring and methodologies have within the Sendai Framework.

The development and strengthening of the partnership between GEO and UNDRR has been a key focus for the GEO Secretariat. In addition to the inclusion of language relating to Earth observations and GEO in the Sendai Framework Data Readiness Review, UNISDR representatives have expressed their Sendai-related requirements as input to GEO work programme activities and invited the GEO Secretariat Director to be a member of the Global Assessment Report (GAR) Advisory Board.

About the image: Visible image of Major Hurricane Matthew taken from NASA’s Terra satellite on Oct. 7, 2017 as it continued moving along Florida’s East Coast. Matthew was a Category 3 hurricane at the time of this image. Credit: NASA’s Goddard MODIS Rapid Response Team
Earth observation data is readily available at the time of a crisis through a variety of channels, including the International Charter for Space and Major Disasters. The accessibility and use of geospatial information from government sources ensures that decision makers and other stakeholders get an accurate common operational picture of critical scenarios before, during, and after disasters.

In July 2018, GEO worked closely with the United Nations committee of experts for Global Geospatial Information Management (UN-GGIM) and UN Member States to provide input to the UN Resolution on Geospatial Information and Services for Disasters, which was adopted by the UN Economic and Social Council. The Resolution guides stakeholders in the management of geospatial information and services through better governance and policies, awareness raising and capacity building, data management, common infrastructure and services, and resource mobilization.

GEO also contributed to the updated 2018 Strategic Framework on Geospatial Information and Services for Disasters, providing information on Earth observation requirements and use cases to the UN-GGIM Working Group on Disasters, in close collaboration with UNDRR.

**GEOHAZARD SUPERSITES & NATURAL LABORATORIES PROVIDE DATA FOR DISASTERS**

Geohazard Supersites and Natural Laboratories (GSNL) is a GEO Initiative composed of the Committee on Earth Observation Satellites (CEOS), space agencies, in situ data providers, including monitoring institutes, agencies and consortia managing data infrastructures, and engagement with the international scientific community.

Since its inception in 2010, GSNL has promoted rapid and effective uptake of scientific results for in Disaster Risk Reduction (DRR). The focus of the initiative is areas with important scientific problems and high risk levels, including Supersites and the Natural Laboratories. Two recent case studies illustrate the value of analysis ready GSNL data for disaster response.

The supersite data and resources are open for the international scientific community and this stimulates collaboration, knowledge transfer, capacity building, and the generation of new scientific results, which are shared within the community. These research results, which are relevant to geohazard assessment, are then communicated by a Supersite Coordinator to end users and decision makers, through national institutional channels.
SATELLITE-BASED RADAR IMAGES OF MOTION ALONG TURKEY’S ANATOLIAN FAULT REVEAL SEISMIC HAZARDS

In 2019, researchers used high resolution InSAR data, shared by the Marmara Permanent GSNL Supersite, to analyse a seismic slip occurring along Turkey’s North Anatolian Fault. The 1,600 kilometre slip feature separating the Eurasian and Arabian plates has produced seven large (magnitude >7) earthquakes since 1939. The most recent event, the 1999 magnitude-7.4 Izmit earthquake that occurred roughly 100 kilometres east of Istanbul killed more than 20,000 people.

Using 307 images acquired by the Sentinel-1 and TerraSAR-X satellites, the researchers examined deformation and changes in the direction of motion across the central segment of the 1999 rupture for the period spanning 2011 to 2017. The results indicated this segment continued to creep nearly two decades after the earthquake. The team also presented evidence for a transient “creep burst” in November 2016 that corresponded to 1.7 years of average creep in just three weeks.

Collectively, these findings indicate that post-seismic slip along the North Anatolian Fault is more complex than has previously been suggested. This study offers new insight into long-term, post-seismic deformation following a major earthquake along one of Earth’s most active strike-slip faults.

Without the joint interpretation of satellite and in situ data, organized by GSNL, this study could not be made. This initiative provides innovative methods for earthquake hazard assessment and improvement of our shared knowledge. These observations are important for decision makers to be prepared for emergency management, via rapid generation of critical information relevant to the co-seismic deformation event, using pre- and post-event imagery.
GSNL SUPPORTS EMERGENCY RESPONSE TO THE 2018 LOWER EAST RIFT ZONE AND SUMMIT COLLAPSE IN HAWAII

In 2018, the Hawaii Supersite was impacted by a crisis at Kilauea volcano, where a lava flow destroyed over 700 homes. Starting in late May, the Kilauea caldera began to rapidly subside. In two months, parts of the ground had dropped by 400 meters, a level rarely observed in a volcano eruption.

High resolution InSAR monitoring with COSMO-SkyMed and TerraSAR X images granted through the GSNL Supersite provided unprecedented views of the collapse and have been critical for understanding how the subsidence was evolving over time. This data, along with high temporal resolution global positioning system (GPS) and seismic data, were analysed by the Hawaiian Volcano Observatory and the scientific community, generating information which guided the disaster response.

This information was of crucial importance to the Hawaii County Civil Defense, which is responsible for emergency response operations, including evacuations. The Supersite data collected by international space agencies form a valuable source of information to understand the scientific aspects of this unprecedented eruptive event at Kilauea, and can contribute to volcanic hazard assessments for similar volcanoes around the world.
ASIA OCEANIA GEO (AOGEIO) FACILITATES GLOBAL DATA SHARING FOR EARTHQUAKE DISASTER RESPONSES

In 2017, over 126 Gigabytes (GB) of data collected from eight satellites operated by AOGEIO countries was shared with Mexico during the Central Mexico earthquake to assist with disaster response and recovery. The 2017 Puebla earthquake killed an estimated 370 people with more than 6,000 injured.

Previously, a similar amount of data was rapidly shared with New Zealand, Australia and other countries affected by the 2016 New Zealand earthquake. Under the coordination of AOGEIO, a new mode of international disaster emergency cooperation is being established. This data sharing for disasters is expected to supplement other international disaster cooperation mechanisms, and has already proven valuable in several cases over the last few years.

GLOBAL WILDFIRE INFORMATION SYSTEM (GWIS)

The Global Wildfire Information System is a joint initiative of the GEO and the Copernicus Emergency Management Services (EMS) Work Programmes. (GWIS) brings existing information sources together at regional and national levels to provide a comprehensive view, and for evaluation of fire regimes and fire effects at global level.

GWIS builds on the ongoing activities of the European Forest Fire Information System (EFFIS), the Global Observation of Forest Cover- Global Observation of Land Dynamics (GOFC-GOLD) Fire Implementation Team (GOFC Fire IT), and the associated Regional Networks, complementing existing activities that are ongoing around the world with respect to wildfire information gathering. The development of GWIS is supported by the partner organizations and space agencies. NASA has made financial support for GWIS available through its ROSES programme.

Access to worldwide information on wildfires is available through the GWIS viewer.
MONITORING THE SPREAD OF ARCTIC WILDFIRES IN THE HOTTEST MONTHS IN HISTORICAL RECORD

During summer 2019, a heatwave spread across Europe, and high temperatures resulted in July 2019 being declared one of the hottest months on historical record. GWIS was monitoring active wildfires and their impacts across northern Europe, Russia, Canada, Brazil and in regions of the Arctic.

The Current Situation Viewer provides users near real-time updates in the online portal with information on the Fire Danger Forecast. It also provides the status of wildfire effects in the online Rapid Damage Assessment including information on Black Carbon, Methane, Carbon Dioxide, Carbon Monoxide, Sulphur Dioxide, Nitrogen Oxides, Organic Carbon, Particulate Matter and other gases or substances in the atmosphere.

SUPPORTING IRAN FLOOD DISASTER RESPONSE

Record rainfall and flooding in mid-March 2019 in Iran forced evacuations of thousands of people, causing hundreds of millions of dollars of damage, and led to substantial loss of life. Iran's Mehr News Agency reported that 1,900 cities and villages were flooded, while CNN reported that more than 140 rivers burst their banks, 409 landslides were reported, 78 roads were blocked, and 84 bridges affected. Rapid access to high resolution satellite imagery was important for government agencies and first responders to assess damage, and prioritise and plan their response operations.

Responding to requests from the UN Economic and Social Commission for Asia and the Pacific (UNESCAP) and the Iranian Earthquake Engineering Association (IEEA), China GEO activated its Disaster Data Response (CDDR) mechanism to provide high resolution satellite imagery in support of disaster response planning. Following the activation of the CDDR for Iran, four contributors developed satellite observation plans for flooded areas in Aq Qala, Darvazeh Quran and Pol Dokhtar, and provided high resolution Jilin-1 sp06 satellite images to support disaster response.

UNESCAP confirmed that the data was then provided to Iran's National Disaster Management Organization (NDMO) and the Iranian Red Crescent as the key disaster management operational bodies. The data was also used for flood analysis in cooperation with UN-Habitat and the Saman Paydar Insurance Risk Management Institute (SPRMI).

DAM COLLAPSE DISASTER IN BRAZIL AIDED BY HIGH RESOLUTION SATELLITE IMAGES

On 25 January 2019, the tailings dam to the Córrego do Feijão mine burst near Brumadinho, Minas Gerais, Brazil, resulting in hundreds of lives lost and extensive environmental and economic damage. Following the devastating Brazilian dam collapse, Chinese satellite data products were provided to support Brazilian disaster response as part of CDDR.

Just two days after the dam burst, the ChinaGEO Secretariat - based in the National Remote Sensing Center of China - triggered the ChinaGEO Disaster Data Response (CDDR) mechanism to collect high resolution satellite data of the impacted area in. High resolution optical images obtained by SuperView-1 were used for planning field operations and for tactical planning by the search and rescue team, and supported Brazil's disaster response efforts.
Between 28-30 January 2019, various Chinese optical satellite data products were provided to Brazil’s National Center of Risk and Disaster Management (Centro Nacional de Gerenciamento de Riscos e Desastres - CENAD). A 2m resolution image (GaoFen-1 satellite) provided an overview for planning, while a 0.92m resolution image (JiLin-1 satellite) provided river pollution information and a 0.5m resolution image (SuperView-1 satellite) assisted with assessments of building damage.

 “[The ChinaGEOSS Disaster Data Response Mechanism] is complementary to the International Charter Space and Major Disasters,” explained Professor Li Gouging, coordinator of ChinaGEOSS Data Sharing Network and co-chair of CODATA’s task group on Linked Open Data for Global Disaster Risk Research, “We are able to mobilize high resolution satellite resources operated by both government institutes and commercial sectors for international emergency response and make the data openly available to the public afterwards.”

PLANNING FOR DISASTERS, CLASSIFYING GLOBAL LANDFORM TYPES, AND REGIONS

The United States Geological Survey (USGS), in close collaboration with GEO Associate Esri, produced several standardized, rigorous, high spatial resolution global data layers with considerable potential utility for disaster applications. These products have been commissioned by GEO and many of these resources are a first to characterize earth surface features at finer spatial and thematic resolution.
Published in 2017, the World Hammond Landforms product was developed by classifying 250 m global DEM data produced by USGS into 16 landform types, including several subclasses of plains, hills, and mountains. This product emphasizes regional terrain expressions and is a useful resource for identifying areas and types of relief based on analysis of slope, elevation, and ruggedness.

This data is useful for identifying candidate areas of vulnerability to landslides and flooding, including both downstream flooding form landform-determined “water towers,” and in low elevation coastal areas subject to tidal surges. Data on landforms plays a useful role in all natural science fields of study and planning disciplines.

Download the publication here

**MAPPING CHANGES TO THE WORLD’S COASTLINES WITH A NEW ONLINE TOOL**

In 2019, a freely available booklet made a major contribution to understanding the physical and ecological geography of the Earth. A New Map of Global Islands publication maps hundreds of thousands of islands in greater detail than previous efforts. The islands range in size from continental mainlands to tiny islets smaller than a fraction of a square kilometer. The work was done at a very fine spatial resolution, and the shorelines and islands were mapped from hundreds of 2014 Landsat images.

The publication also describes an elegantly simple tool, the Global Island Explorer, which was designed as a window for users of the data. The Global Island Explorer is an online visualization and query tool, which allows anyone with an internet connection to explore any of the world’s islands in an easy to use app. Further opportunities are also available for developing machine learning and AI approaches to updating the vector shoreline.

As a new product from USGS and Esri at 30 m spatial resolution, it is the finest global shoreline product available in the public domain. Research and development opportunities are abundant with respect to reconciling the new vector shoreline with existing Digital Elevation Models (DEM) with an aim to improving the accuracy and spatial resolution of DEMs.
DATA ANALYSIS & INTEGRATION SYSTEM (DAIS) CONTRIBUTES TO PRE-DISASTER EARLY WARNING AND POSTER-DISASTER ASSESSMENT OF SEVERE FLOODS IN SRI LANKA

A devastating flood disaster occurred in Sri Lanka in late May 2017, leaving over 300 people dead or missing. Since further flood damage was anticipated, The University of Tokyo (U-Tokyo) and the International Centre for Water Hazard and Risk Management (ICHARM) developed a prototype of flood hazard information system to provide real-time flood monitoring and forecasting for Sri Lanka using the Data Integration and Analysis System (DAIS) developed by Japan.

DAIS/U-Tokyo/ICHARM provided support for the post disaster assessment using the integrated flood monitoring and forecasting system. DAIS is an advanced GEOSS-compliant e-infrastructure component that addresses the challenges of a large increase in the volume of Earth observation data by developing a core system for data integration and analysis. The system integrates ground and satellite precipitation data, rainfall forecasting data, results of flood inundation analysis and forecasting. This system provided the information in real time to the related organizations of the Sri Lankan government.
CHAPTER 5 | ECOSYSTEM ACCOUNTING

Knowledge-based conservation and management policies are necessary to preserve and improve the benefits that healthy ecosystems provide for our well-being. The value of ecosystems should not be based only on economic estimates and it should also include other aspects such as landscape and ecosystem integrity and functionality, biodiversity conservation, and cultural values.

Earth observations play a key role in ecosystem accounting.

About the image: The Lena River, some 2,800 miles (4,400 km) long, is one of the largest rivers in the world. The Lena Delta Reserve is the most extensive protected wilderness area in Russia. It is an important refuge and breeding grounds for many species of Siberian wildlife. via NASA Goddard
SUPPORTING SOUND ENVIRONMENTAL MANAGEMENT

ECOPOTENTIAL aims to support effective monitoring and understanding of ecosystem conditions, processes, dynamics and changes, fully accounting for the wide spectrum of interactions between society, geosphere, biosphere and climate.

A new research publication, *Earth Observation for Environmental Management: Science for post 2020 Environmental targets Insights from Earth Observation of Protected Areas* was presented at the Science-Policy Brief meeting at the European Parliament, Brussels on 27 September 2018.

The event was co-organised by ECOPOTENTIAL, IUCN and UNEP-WCMC to highlight the use of Earth observations for improving nature conservation policies.

Download the report [here](#).

THE EARTH OBSERVATION DATA FOR ECOSYSTEM MONITORING TOOL

EODESM is a tool developed under the Horizon 2020 ECOPOTENTIAL project that automatically classifies land cover according to the Food and Agricultural Organizations’ (FAO) Land Cover Classification System (LCCS2) taxonomy from environmental variables, enabling users to detect changes in vegetation, soil moisture, and other environmental variables.

An ECOPOTENTIAL Community Portal based on GEOSS Mirrors and GEOSS Widgets technologies was developed. Through a new graph-widget the user can explore ecosystems, related protected areas and select one of the available storylines. Then, the user can run the [EODESM model](#) to compute land cover changes relevant for the selected storyline and...
protected area. The result is visualized as a map providing knowledge useful for ecosystem management.

Several GEO members were involved in the project, including: GEOSS EVOLVE that provided the general architectural framework for the generation of knowledge from data as a potential enhancement of the GEOSS Platform; the GEOSS Platform operations team provided the technical support for the implementation of the pilot; and EuroGEO and GEO ECO provided the liaison with the European ecosystem and biodiversity community in particular through the members involved and leading the H2020 ECOPOTENTIAL project.

**EARTH OBSERVATION DATA TO SUPPORT GLOBAL CHANGE STUDIES**

The Global Ecosystem and Environment Observation Analysis Research Cooperation (GEOARC), produces openly available reports and environmental baseline data to support global change studies.

As part of GEOSS, GEOARC produces Annual Reports on Remote Sensing Monitoring of Global Ecosystem and Environment. During 2016 to 2019, the cropland and yield monitoring, the global carbon source and sink monitoring, the “Belt and Road” regional ecological environment monitoring have been conducted based on multi-source Earth observation satellites service especially the FY series and the TanSat, supported by the Ministry of Science and Technology of the People’s Republic of China.

Employing multi-source, multi-scale, multi-temporal satellite data, several quantitative products and reports have been generated. The reports about Regional Ecosystem Trends along the Belt and Road, the Supply Situation of Maize, Rice, Wheat and Soybean, the Temporal Dynamics and Spatial Distribution of Global Carbon Source and Sink were released. These datasets, information and knowledge can support the monitoring of several sustainable development goals (SDGs).

**GEOARC** was initially launched in 2012 to strengthen global ecosystem and environment monitoring by improving the use of remote sensing tools. Using GEO’s Multi-source Synergized Remote Sensing provided coordinated Earth observations from satellites and helped to integrate them with ground-based and other in situ measurements. The initiative is generating reliable, accurate, timely and sustained datasets for the public for free. GEOARC supports developing countries to overcome the high cost of processing satellite data. GEOARC makes a positive contribution with analysis-ready data for policy-making and knowledge services to the international communities.
CHAPTER 6 | IMPACT ON FOOD SECURITY & SUSTAINABLE AGRICULTURE

The GEO Global Agricultural Monitoring Flagship Initiative (GEOGLAM) was launched by the Group of Twenty (G20) Agriculture Ministers in Paris, June 2011 as part of the G20 Action Plan on Food Price Volatility. Since 2016, it has broadened the focus to include support for early warning in food insecure regions of the world. GEOGLAM is a global community consisting of over 100 institutions from about 40 nations and a dozen international agencies.

GEOGLAM uses Earth observations to increase market transparency and improve food security by producing and disseminating authoritative, timely, and actionable information on agricultural conditions at national, regional, and global scales.

Key GEOGLAM products include the Crop Monitor for major producing nations and the Crop Monitor for Early Warning. These are produced monthly to support the Agricultural Market Information System (AMIS) and international food security organizations.

Beyond the impact of the global crop monitors on market transparency and food security, the following impact stories focus on co-development accomplishments of the GEOGLAM community at the national and regional level:
GEOGLAM STRENGTHENS GLOBAL FOOD SECURITY & EARLY WARNING SYSTEMS

The GEO Global Agricultural Monitoring Flagship Initiative (GEOGLAM) was launched by the Group of Twenty (G20) Agriculture Ministers in Paris, June 2011 as part of the G20 Action Plan on Food Price Volatility. Since 2016, it has broadened the focus to include support for early warning in food insecure regions of the world. GEOGLAM is a global community consisting of over 100 institutions from about 40 nations and a dozen international agencies.

GEOGLAM uses Earth observations to increase market transparency and improve food security by producing and disseminating authoritative, timely, and actionable information on agricultural conditions at national, regional, and global scales. Key GEOGLAM products include the Crop Monitor for major producing nations and the Crop Monitor for Early Warning. These are produced monthly to support the Agricultural Market Information System (AMIS) and international food security organizations.

Since 2013 GEOGLAM has produced monthly global crop condition reports for AMIS and since 2016, an Early Warning Crop Monitor focussing on food insecure regions of the world. In 2019, in response to a request from the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), GEOGLAM began producing mid-month reports in regions of emerging concern. So far in 2019 these include Eastern and Southern Africa (Drought and Cyclones), Iran and Iraq (Floods) and in major crop producing regions in the United States (Flood and Delayed Planting).

In recent years GEOGLAM’s attention has turned to the co-development of national agricultural monitoring systems in food insecure regions. The information is trusted and quickly converted to decisions that support proactive policies and programmes because these systems are operated by mandated by national and regional government agencies. This has a significant positive impact on food security and we have seen proactive responses save lives and improve outcomes for thousands of people while reducing emergency response costs.

Beyond the impact of the global crop monitors on market transparency and food security, the following impact stories focus on co-development accomplishments of the GEOGLAM community at the national and regional level:

REGIONAL CROPLAND ASSESSMENT & MONITORING SERVICE

Several African nations are benefitting from a Regional Cropland Assessment and Monitoring Service.

The Regional Cropland Assessment and Monitoring Service seeks to provide timely information for food security assessments through the development of national and regional crop monitors in East Africa, including Burundi, Ethiopia, Kenya, Rwanda, South Sudan, Tanzania, Uganda, Djibouti and Eritrea.

The crop monitors are helping to streamline data collection and synthesize crop conditions through a combination of field assessments and Earth observation data. Information about crop conditions is supplemented with climate outlook and market information. The resulting maps provide an understanding of crop conditions and drivers of less than favourable conditions, such as droughts and flood coupled with unpredictable rainfall due to climate variability, and changing temperatures which result in poor yields.
The service has been co-developed by SERVIR-Eastern and Southern Africa from the Regional Centre For Mapping Resource For Development (RCMRD), College Park University of Maryland, Kenya State Department of Crops Development, International Society of Precision Agriculture (ICPA), Kenya National Bureau of Statistics, Ministry of Agriculture and Irrigation, Food and Agriculture Organization (FAO), Famine Early Warning Network (FEWSNET), using satellite data and products from CHIRPS, LANDSAT 5, LANDSAT 7, LANDSAT 8, MODIS, Sentinel.

**PROTECTING FARMERS’ LIVELIHOODS USING SATELLITE IMAGERY**

More than half of Kenya’s 52 million citizens work in the agricultural sector, underscoring the important role farming plays in Kenya’s economy and individuals’ livelihoods. Despite the importance of agriculture to the economy, until recently the Government of Kenya had been using outdated cropland maps (from 2000-2001) to conduct food security assessments.

To help address this problem, in 2017, SERVIR–Eastern and Southern Africa at RCMRD worked with the Kenyan State Department of Agriculture to release updated cropland maps that were co-developed with USAID’s FEWSNET — a leading provider of early warning and analysis on food insecurity.

The completed cropland maps (or crop masks) provide information on the locations of the major and minor crops being grown, and if rain-fed or irrigation systems are being used. This information allows for rapid identification of changes in crop development, helping the Government of Kenya better plan where to deliver village-level food assistance during droughts, flooding, and other food security crises.

To ensure the long-term availability of updated crop masks, several technical training sessions have been offered to equip key stakeholders in the agricultural sector with the necessary skills for developing updated maps and computing image changes from different periods. The Government of Kenya continues to view agriculture as a priority for national economic development. More accurate, timely, and cost-effective crop masks will help the government meet this objective by improving food security assessments to better protect vulnerable communities and to ensure a strong agricultural sector.

“Participants can now use the technical knowledge gained and apply it directly to their agricultural field work.” Antony Ndubi, RCMRD’s Remote Sensing Expert

**ASIA-RiCE: IMPROVING AGRICULTURAL STATISTICS IN CAMBODIA**

The Cambodian Department of Planning and Statistics (DPS), Ministry of Agriculture, Forestry, and Fisheries (MAFF) generates national agricultural statistics by aggregating data collected from local offices using a manual reporting system. A more robust and comprehensive process was needed for statistical information generation and DPS needed a method to verify rice crop statistics reported by local offices.

GEOGLAM’s Rice Crop Estimation and Monitoring (Asia-RiCE) team members worked with the DPS to develop a standardized, accurate, cost-efficient and timely method to monitor rice crop area using ALOS-2 synthetic aperture radar (SAR) and machine learning based tools. ALOS-2 SAR data and the INAHOR (International Asian Harvest monitoring system for Rice) crop planted
area estimation software was used to create maps on land use/land cover as a baseline, and a prototype validation framework for statistics reported from local offices was developed.

Through an Asian Development Bank Technical Assistance project and SAFE projects under Asia-Pacific Regional Space Agency Forum, INAHOR was found to produce rice crop maps with mapping accuracies of 80-90%. These maps also found rice planting in unrecognized areas on the borders of lakes and wetlands, and also identified discrepancies in statistics from some districts, which is useful for quality checks and overall improvement of the statistics.

The goal of Asia-RiCE is to foster the widespread use of Earth observations for timely and accurate forecasts of rice production at national, regional, and global scales. As an input to the GEOGLAM Crop Monitor and AMIS Market Monitor, it significantly contributes to the United Nations Sustainable Development Goal SDG2 Zero Hunger, by ensuring Cambodia has better information to make decisions in support of food security.

CropWatch CLOUD SUPPORTS FOOD SECURITY MONITORING IN MOZAMBIQUE THROUGH A MOBILE APP

Mozambique faces food insecurity and instability of agricultural production as a result of the vulnerability of the agriculture sector to natural hazards. Ensuring food security requires knowledge of the cropland area, water conditions, crop yield estimation, water availability and other factors.

By providing Mozambique with a tool that can give the prior information about the precipitation or water conditions, combined with agronomic indicators and predicted yield and production, CropWatch Cloud for Mozambique is contributing to better decision making and increased food security.

The customization of Cropwatch for Mozambique was requested by Mozambican Ministry of Agriculture and Food Security to improve their capacity in crop monitoring and forecasting. The CropWatch Cloud Platform utilizes multi-source satellite imagery, information from weather stations, as well as thousands of in situ data of crop yield measurements, crop practices and crop type information gathered by volunteers via a phone app. The first draft came out in December 2017 and was modified and revised several times after further discussion in April and May 2018. Four different components, CropWatch Processing, CropWatch Explore, CropWatch Analysis, and CropWatch Bulletin subsystems are all required from the local team.
CropWatch uses 19 indicators for crop assessment which can be sorted into four categories of indicators: CropWatch agroclimatic indicators, arable land use intensity indicators, crop condition indicators and crop production indicators. Those indicators were spatially averaged over Mozambique cropland mask and crop type mask for further analysis. Machine learning methods and big data analysis techniques are applied for crop identification and yield prediction by the integration of multiple satellite images, weather station data and crowdsourcing in situ measurements. Local agriculture practices and landscape are considered in the calibrated model in CropWatch Cloud for Mozambique.

A series of technical training sessions for the Mozambican team included training for National and Provincial Departments of the Agriculture and Food Security that were carried out in Maputo and Nampula. After several training workshops, experts from the Ministry of Agriculture and Food Security of Mozambique incorporated findings into the Mozambique National Agro-Meteorological Bulletin in June 2018. In 2018-2019, the Ministry of Agriculture and Food Security of Mozambique used CropWatch Cloud to do crop assessment and for the Mozambique National Agro-Meteorological Bulletin in November, December 2018 and March 2019. Currently, they are working with partners from Zambia, Egypt, Russia, Mongolia, Thailand, and Cambodia on capacity development for crop monitoring. Regional meetings and training workshops are being organized with the World Bank, FAO, and other UN agencies.

“We highly appreciate the assistance of CropWatch Cloud Platform for Mozambique which improves our monitoring ability and promotes innovation in agriculture monitoring.” Hiten Jantilal, Chief of Department of Crops and Early Warning, Ministry of Agriculture and Food Security of Mozambique.
CHAPTER 7 | IMPACT ON THE NEW URBAN AGENDA

The New Urban Agenda represents a shared vision for a future where well-informed and well-planned urbanization can be a powerful tool for sustainable development for both developing and developed countries.

The New Urban Agenda was adopted at the United Nations Conference on Housing and Sustainable Urban Development (Habitat III) in Quito, Ecuador, on 20 October 2016. It was endorsed by the United Nations General Assembly at the 71st session on 23 December 2016.

Several GEO activities are supporting the New Urban Agenda with tailored Earth observation data and products that inform policy makers about the effects of human presence on our planet.
EARTH OBSERVATIONS DATA SUPPORT UN-HABITAT ON SUSTAINABLE URBAN DEVELOPMENT

Based on the GEOSS Open Principles, the GEO partners provide open access to data and related activities range from monitoring human settlements to air pollution and the role of wetlands in cities. As well as enabling global, free resources for researchers and policy makers, GEO is also contributing to policy with respect to SDG 11 Sustainable Cities and Communities and the New Urban Agenda, for example assessing land use change against population growth.

Supporting sustainable urbanization requires up-to-date and accurate data to support informed actions. To promote transformative change in cities and human settlements, Earth observation and geospatial information and knowledge can help provide a clear understanding of human settlement systems (and needs) in diverse contexts.

Over the last 5 years, UN-Habitat has been collaborating with different GEO Work Programme activities, particularly EO4SDG, GEO Human Planet Initiative (HPI) and Global Urban Observation and Information (GUOI). These collaborations range from methodological developments to production of global baseline datasets and building capacities of countries to adopt emerging EO & GI technologies and adopt them in urban monitoring processes.

“Earth observation data and information are key to understanding the changing trends in human settlements, especially in urban areas, where majority of the world population lives today…. We welcome engagement with the GEO community, which will provide relevant and near real-time geospatial and EO data and help us appreciate changes in more than 10,000 urban settlements globally. This data and information will significantly shape our understanding and actions in support of sustainable urbanization, and also help countries to make informed development decisions.” Dennis Mwaniki, Spatial Data Expert, Global Urban Observatory / Data and Statistics Unit, UN-Habitat.

GEO HUMAN PLANET INITIATIVE: SPATIAL MODELLING OF IMPACT, EXPOSURE, AND ACCESS TO RESOURCES

The GEO Human Planet Initiative is developing a new generation of measurements and information products that provide new scientific evidence and a comprehensive understanding of humanity’s effects around the globe. This data is supporting global policy processes with agreed, actionable and goal-driven metrics. The Initiative relies on a core set of partners committed in coordinating the production of the global settlement spatial baseline data.

The core partnership involved in the global baseline data production are the European Commission, Directorate General Joint Research Center (DG JRC), Global Human Settlement Layer project (GHSL), the University of Southampton WorldPop project, and the Columbia University, Center for International Earth Science Information Network (CIESIN). The extended partnership involves more than 150 individual scientists and policy makers belonging to 85 different organizations including UN-Habitat, academies, international stakeholders, governmental bodies and commercial sector organisations.

The initiative promotes cooperation in producing and harmonizing high quality data products and services needed by a range of scientific and applied users. It works to improve data access, timeliness, consistency, and utility; support data use and interpretation; identify and address pressing user needs; reduce duplication and user confusion; and encourage innovation and cross-disciplinary use. The Human Planet Initiative brings expertise and perspectives from diverse natural, social, health, and engineering science disciplines and sectors.
GLOBAL HUMAN SETTLEMENT LAYER: AN OPEN & FREE TOOL FOR ASSESSING THE HUMAN PRESENCE ON OUR PLANET

The Global Human Settlement (GHSL) produces global spatial information about the human presence on the planet over time. This in the form of built-up area maps, population density maps and settlement maps. This information is generated with evidence-based analytics and knowledge using new spatial data mining technologies. The GHSL data and tools are applied to the monitoring the implementation of international frameworks and for sustaining scientific research requiring consistent and open planetary data.

In 2017, GHSL was applied to the Global Definition of Cities and Settlements. The GHSL is the common baseline data used for testing alternative use of urban vs. rural definitions, contributing to a global, people-based concept that has been under discussion with the UN statistical commission.

In 2018, Spatiotemporal activity and population mapping in Europe (ENACT) used GHSL tools applied to European data. It demonstrated the capacity to produce monthly and nightly/daily maps of population density and how such maps can be used for crisis management.

The framework uses numerous different data sources including global archives of fine-scale satellite imagery, census data, and citizen generated data. The data is processed fully automatically, analytics are generated and knowledge reporting is objectively and systematically carried out relating to the presence of population and built-up infrastructures.

The initiative is producing new global spatial information, evidence-based analytics and knowledge describing the human presence on the planet. It operates under an open, free data and methods access policy, relying on open input, open methods and open output. Supported by the Joint Research Centre (JRC) and the DG for Regional Development (DG REGIO) of the European Commission, together with the international partnership, the GEO Human Planet Initiative, this data is freely available to assist researchers and policy makers with their online tools and data.

POPGRID PROVIDES POPULATION, SETTLEMENT, AND INFRASTRUCTURE DATA TO SUPPORT SDG 11 SMART CITIES

Spatially accurate and up-to-date population and settlement data are widely used in planning and decision making in both the public and private sectors to improve the effectiveness and efficiency of decisions, monitor impacts, and identify those who might otherwise be left behind.

The POPGRID Data Collaborative brings together the international community of data providers, users, and sponsors concerned with georeferenced data on population, human settlements and infrastructure.

POPGRID is currently supported by Columbia University Earth Institute’s Cross-Cutting Initiatives and by the Bill & Melinda Gates Foundation. It is an element of the Group on Earth Observations (GEO) Human Planet Initiative (HPI) and is coordinated by CIESIN, the Global

For more information click here
Partnership for Sustainable Development Data (GPSDD) and UN Sustainable Development Solutions Network, Thematic Research Network on Data and Statistics (SDSN TReNDS).

The current work stream includes:
- Improving accessibility and documentation of data sets and data services
- Comparing and contrasting methods and implications of different data sources
- Convening technical experts from the geospatial and demographic communities at events and conferences worldwide
- Developing an comparison report and tool that clarify how different data sets fit different needs for statisticians, policymakers, development practitioners, and other applied users
- Understanding where people live and work, and the type and condition of their housing and other infrastructure, is critical in times of disaster, enabling emergency responders to reach those most in need more quickly with appropriate assistance. Such data is helping to improve access to public and private services, increase the sustainability of natural resources, and facilitate progress towards meeting the internationally accepted Sustainable Development Goals (SDGs), including SDG 11: Sustainable Cities and Communities.

Visit the website: [https://www.popgrid.org/](https://www.popgrid.org/)

**USE OF SENTINEL-1 & SENTINEL-2 IMAGERY TO ANALYSE SECURITY ISSUES AFFECTING ROHINGYA REFUGEES**

The Rohingya are a Muslim ethnic group from Myanmar that, since 2017, have been forced to look for asylum in the neighbouring country of Bangladesh. Bangladesh policy makers started construction of refugee camps in several remote islands, one of them known as Char Piya. An analysis of the area using satellite imagery was considered a key tool to have a clear view of the situation as satellite imagery provides data for analysing the impact of refugee movements to the islands.

SatCen started analysing the area making use of Sentinel-1 and Sentinel-2 images acquired between 2017 and 2018; in particular automatic change detection algorithms were applied on Sentinel-1 images. This made it possible to clearly see the situation in the island over time and detect the changes due to human activity. In particular it was possible to observe, the development timeline during which the camp was reconstructed.

Initially this was possible due to the first clearing of the vegetation and the increase of boat traffic from mainland. The activities continued with digging to construct a flood protection wall and also roofs of the completed houses in the refugee camp became visible. Sentinel-1 images were very useful during the monsoon period where clouds covered the entire areas, as the SAR observations allowed to define the flooded areas of the island.

The analysis on Char Piya supported the EU Common Foreign Security Policy (CFSP), the organised and agreed foreign policy of the EU for security and defence diplomacy. CFSP preserves peace and strengthens international security, in accordance with the UN charter principles.

This study falls within the SatCen activities for the Space and Security Community Activity, using Earth observation satellite data to address security issues aiming at protecting citizens’ safety. The analysis exercise was done in line with the GEO vision, using open data and fostering an open knowledge approach.
CHAPTER 8 | IMPACT ON PUBLIC HEALTH

The Global Observation System for Mercury (GOS4M), a GEO Flagship, provides monitoring data and modelling tools to support the implementation of the Minamata Convention (MC) on Mercury.

GOS4M aims to support the MC Secretariat, the UN Environment and all nations in the follow up of decisions related to the Effectiveness Evaluation and Global Monitoring framework. GOS4M aims to work closely with actions in providing assistance and promote capacity building for filling existing geographical gaps in the global monitoring. It is now exploring a formal agreement between the GEO and Minamata Convention Secretariats to formalize GOS4M’s support for the future activities of the Convention.

Other GEO activities to support public health include GEOHealth, which has developed geospatial surveillance and response system for vector borne disease in the Americas. AfriGEO has collaborated to produce cholera warnings using Earth observation data. GEO communities are actively monitoring wildfires and air pollution for public health.
GLOBAL MERCURY MONITORING SUPPORTS MINAMATA CONVENTION

The Global Observation System for Mercury (GOS4M), a GEO Flagship, provides monitoring data and modelling tools to support the implementation of the Minamata Convention (MC) on Mercury.

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During 2019, GOS4M has developed a conceptual Mercury Policy Knowledge Hub. The Hub includes a variety of tools for pre- and post-processing of observational data and modelling outputs. The Hub is designed to assist policy makers to assess the fate and transportation of mercury from emission sources to terrestrial and aquatic receptors, and to evaluate the relative contributions of different natural and anthropogenic sources on total mercury entering terrestrial and aquatic ecosystems. The Hub is in testing the possible link between past trends in atmospheric deposition fluxes with mercury concentrations found in top predators e.g. fish, marine mammals and birds. The Mercury Policy Knowledge Hub is expected to launch at the end of 2019.

GOS4M governance will be set by early 2020 as soon as the partnership will be completed. GOS4M builds on existing networks and observing infrastructures – currently it provides a link to the Global Mercury Observation System (GMOS), and includes existing regional networks, such as Atmospheric Mercury Network (AMNet), the National Atmospheric Deposition Programme (MDN), the Asia-Pacific Mercury Monitoring Network and other national sites.

"The mirror part of the GEOSS Platform, provides functionalities that enhance better use of EO data, foster data sharing and provide strong support to the implementation of Minamata Convention on Mercury."

Sergio Cinnirella, representing the GEO Flagship GOS4M at the 11th Symposium on Digital Earth.

GEOHEALTH PRODUCES A GEOSPATIAL SURVEILLANCE & RESPONSE SYSTEM FOR VECTOR-BORNE DISEASE IN THE AMERICAS

Despite decades old efforts to strengthen public health programmes for Visceral Leishmaniasis (VL) in Brazil, reduction in its incidence and geographical dispersion has not yet been successful. VL is in fact expanding its range to newly urbanized areas.

A geospatial surveillance system was tested using remote sensing data from Earth-observing satellites, geographic information systems and ecological niche modelling to characterize the environmental suitability and potential for spread of VL, a neglected tropical disease transmitted by the sand fly in Brazil.

VL risk models were constructed for Bahia state in Northeast Brazil. Additionally, Sao Paulo state in Southeast Brazil revealed similar patterns in VL and vector risk maps generated by Worldclim2 data and models generated using bi-monthly soil moisture data. Results suggest direct
measurement of soil moisture by (Soil Moisture Active Passive) SMAP data may be used in lieu of soil moisture values calculated from classic climate station data.

To promote these findings, SMAP L4 imagery was acquired covering the western hemisphere for year 2017 and incorporated in a GeoHealth data portal. A tutorial was prepared for online data access and analysis using ArcGIS and Maxent software. Open source satellite data, analysis and models from the GEO community helped to mitigate the high cost of collecting near-real-time data and information that would be a major barrier to progress on vector borne disease control in Brazil and other at-risk countries.

This project supports NASA and GEO initiatives. By providing coordinated Earth observations from satellites and integrating them with ground-based and other in situ measurements, GeoHealth contributes to generation of reliable, accurate, timely and sustained vector borne disease monitoring information and forecasts for public health decision makers.

It also is contributing to United Nations Sustainable Development Goal SDG3 Ensure healthy lives and promote well-being for all at all ages by providing better information for decisions on control of visceral leishmaniasis in Brazil.

**PREDICTION OF CHOLERA USING EARTH OBSERVATIONS**

Cholera is not a new disease, but the control and preparation for cholera using satellite data is unique. A new project using open satellite data is providing knowledge on global coverage of cholera risks, including knowledge of when and where this disease will strike.

Led by NASA’s Applied Sciences Programme, Veolia Foundation, Health Initiatives Foundation and team of advisors from NASA and NOAA, the project supports GEO Work Programme Public Health activities and capacity development in the AfriGEO region for transition, integration and sustained use of our algorithms for prediction of cholera.

Most systematic research on the ecology of cholera over the past several decades has focused on and derived from data collected in the Bengal Delta region of the world. However, analysis of the World Health Organization (WHO) cholera database indicates that Africa is seeing a rise in cholera. Cholera cases have been reported in nearly every country of the African continent. In fact, from 1995 to 2005, 66% of those outbreaks were reported in Sub-Saharan Africa. In 2011, 86% of the total reported cholera cases and 99% of the deaths from this disease were reported in Africa.

Satellite data from Global Precipitation Measures (GPM), Modern-Era Retrospective analysis for Research and Applications (MERRA), and Tropical Rainfall Measuring Mission (TRMM) was a joint space mission between NASA and the Japan Aerospace Exploration Agency (JAXA) was used to develop a cholera model which is capable to provide risk estimates for growth of bacteria in the environment by at least four weeks in advance.

This information will be provided to “Cholera Ready Nations” where satellite based prediction (of risk of trigger and likelihood of transmission of cholera in the human population) provides sustainable and resilient readiness to prevent outbreak of disease, saving lives and improving quality of life.
Cholera remains a disease of concern in those regions where human vulnerability and climatic extremes intersect. Therefore, prediction of cholera is perhaps the best way to develop a plan for mitigation and sustainability of water resources, as well as distribution for medicines.

Read the story as reported on the [BBC](https://www.bbc.com).

**COPERNICUS ATMOSPHERE MONITORING SERVICE MONITORS AMAZONIAN FIRES**

The summer of 2019 was characterized by widespread fires, including in the [Arctic Circle](https://www.bbc.com), Europe, Asia and North America. Unfortunately, despite its relatively high humidity, the world’s largest rainforest is not immune, and over three weeks, the Copernicus Atmosphere Monitoring Service (CAMS) monitored fires burning in the Amazon region.

Smoke from the fires can have a serious impact on the health of the three million known species of plants and animals in the Amazon, as well as the one million indigenous people who live there. CAMS actively monitored smoke from the fires travelling thousands of kilometres, affecting air quality across Brazil and the rest of South America. CAMS provides consistent and quality-controlled information related to air pollution and health, solar energy, greenhouse gases and climate.

Read the full story [here](https://www.bbc.com).
CHAPTER 9 | IMPACT ON REGIONAL COORDINATION

GEO’s regional initiatives provide the necessary framework for countries and organizations to access and leverage ongoing Earth observation projects and initiatives, creating synergies and minimizing duplication. The AfriGEO community is continuously growing and is establishing its presence in the region.

The AmeriGEO community have actively engaged in promoting data sharing and capacity development activities for the benefit of the region.

The Asia Oceania GEO promotes the Earth observation capacity of Asia-Oceania countries to confront the challenges facing the Asia-Oceania region.

EuroGEO is improving user uptake and to scale-up existing pilot applications based on Earth observation data and by doing so improving forecasting capabilities for decision-makers and governments for Europe’s benefit.
AFRIGEO

Protecting Farmers’ Livelihoods Using Satellite Imagery

More than half of Kenya’s nearly 50 million citizens work in the agricultural sector, underscoring the important role farming plays in Kenya’s economy and individuals’ livelihoods. Despite the importance of agriculture to the economy, until recently the Government of Kenya had been using outdated cropland maps (from 2000-2001) to conduct food security assessments.

To help address this problem, in 2017, SERVIR–Eastern and Southern Africa at the Regional Center for Mapping of Resources for Development (RCMRD) worked with the Kenyan State Department of Agriculture to release updated cropland maps that were co-developed with USAID’s Famine Early Warning Systems Network (FEWS NET) — a leading provider of early warning and analysis on food insecurity.

The completed cropland maps (or crop masks) provide information on the locations of the major and minor crops being grown, and if rain-fed or irrigation-systems are being used. This information allows for rapid identification of changes in crop development, helping the Government of Kenya better plan where to deliver village-level food assistance during droughts, flooding, and other food security crises.

To ensure the long-term availability of updated crop masks, several technical training sessions have been offered to equip key stakeholders in the agricultural sector with the necessary skills for developing updated maps and computing image changes from different periods. The Government of Kenya continues to view agriculture as a priority for national economic development. More accurate, timely, and cost-effective crop masks will help the government meet this objective by improving food security assessments to better protect vulnerable communities and to ensure a strong agricultural sector.

Supporting Kenya’s Crop Insurance with cost-effective yield measurements

Kenya’s State Department of Agriculture is using the co-developed crop masks in their recently established crop insurance programme that provides payouts to farmers during incidences of crop failure. To support this initiative, SERVIR–Eastern and Southern Africa and GEOGLAM researchers at the University of Maryland assisted the government in developing a methodology for determining harvest yield trends on a local level.

The project helped to guide the development of a stratified sampling frame (area frame) to determine where yield measurements would be done by Kenya’s State Department of Agriculture. Applying a methodology that had been tested in Tanzania, the area frame made the crop insurance scheme more cost-effective than the very labor-intensive list frame that was used initially.

This approach was successfully applied in Nakuru County and provided a significant cost savings as the government can now make detailed assessments with updated satellite maps rather than counting individual farmers on the ground. The successful use of these crop masks has created a new demand to expand this methodology to 20 additional counties where the crop insurance programme operates.

It was reported that at least 12,000 farmers had received payouts for maize crop failure in an insurance project aimed to help achieve food security. The Head of Crop Insurance at the Agriculture Ministry Jacinta Ngwiri said the farmers are from 20 counties with Meru, Uasin Gishu, Bungoma, Kilifi, Nakuru and Narok registering the highest population of farmers. The project
involves farmers insuring crops based on projected harvest with premiums calculated on production output in each region besides other risk factors.

**Monitoring illegal mining & charcoal production in Ghana**

As part of the SERVIR Programme in the sub-region the Centre for Remote Sensing and Geographic Information Services (CERSGIS) located in the University of Ghana is developing satellite image based monitoring services to support sustainable environmental management at local levels.

Two services for monitoring illegal mining and charcoal production sites are currently under development. CERSGIS is using high resolution satellite imagery in Google Earth to map the distribution of charcoal kilns in two pilot areas in Ghana. The data was then pushed onto a geoportal developed by CERSGIS which has a backdrop of annual composites of tree cover index maps of 2013 to 2018, derived from Landsat data. So far, a total of 1340 kilns have been identified in the pilot districts. Illegal mining endemic areas have also been identified and mapped with Sentinel-1 and Sentinel-2 image data.

**AmeriGEO**

**AmeriGEO Week strengthens regional collaboration**

In August 2019, AmeriGEO in partnership with the La Comisión Nacional de Investigación y Desarrollo Aeroespacial, (CONIDA) and the Pontificia Universidad Católica del Perú (PUCP) hosted the 5th annual AmeriGEO Week.

More than 150 participants from 75 organizations and governments gathered to strengthen collaborations in GEO activities and to build the capacity of their nations in use and benefit from EO. Trainings included Radar Remote Sensing (SAR) for ecosystem monitoring, GEOGloWS hydroinformatic services, Essential Biodiversity Variables (EBVs) Operationalization, and more.

**Building National GEOs the new regional priority**

After successful efforts of countries like Colombia, Canada, and the United States with robust national and subnational engagement in GEO activities, the AmeriGEO leadership is turning their attention to strengthen the National participation in GEO activities as a priority.

The Institute of Hydrology, Meteorology and Environmental Studies, also known by its acronym in Spanish, IDEAM, is a government agency of the Ministry of Environment and Sustainable Development of Colombia As the focal point of Colombia-GEO, engaged national organizations that are leading activities within GEOBON, GEOGloWS, and GEONETCast-Americas. In the U.S., at the AGU Fall Meeting, December 14, 2016, the White House Office of Science and Technology Policy presented selected achievements of the USGEO including GEOGLAM activities to promote sustainable agriculture and GEOBON, the global biodiversity monitoring network.

These lessons learned have been adapted by Peru, Chile, and the System for Central America Integration (SICA) who are working to engage national and subnational entities as well as GEO thematic Initiatives and flagships to build stronger National GEOs.
New Member State: El Salvador

In 2019, El Salvador joined the AmeriGEO family, improving the presence in Central America. GEO members in this region include Belize, Costa Rica, El Salvador, Honduras, and Panama.

Empowering Indigenous Peoples with Earth observations for the preservation of indigenous lands

Launched in April 2018, Earth Observation for Indigenous-led Land Management (EO4IM) is a NASA-funded project being implemented by a team from Conservation International (CI). The project strengthens the technical capacities of indigenous organizations in the Americas and globally. Through alignment with the Dedicated Grant Mechanism for Indigenous Peoples and Local Communities (DGM), the project harnesses the power of EO for enhanced sustainable land management.

Aligned with AmeriGEO, EO4IM is supporting regional capacity for sustainable land-use decisions and data infrastructure by promoting EO data, tools, and web platforms. The EO4IM team conducted its first remote sensing capacity building during the DGM Americas Regional Exchange in Junín, Peru. In-person capacity building was held on June 2018, and the first NASA ARSET webinar series targeted an audience of indigenous peoples and their representatives. Over 700 people representing 85 countries, 500 unique organizations, and 41 indigenous persons attended the webinar series, which was conducted live in both English and Spanish.

Access the ARSET webinar recordings: https://arset.gsfc.nasa.gov/land/webinars/GEO-EO4IM

AOGEO

AOGEO: The Asia-Oceania Group on Earth Observations

The Asia-Oceania region boasts nearly two-thirds of the world's population and is characterized by a diversity of regional landscapes that are facing numerous environmental changes as well as frequent disasters.

The Asia-Oceania GEO (AOGEO), previously named AOGEOSS, was launched at the GEO-XIII Plenary in St. Petersburg in November 2016. AOGEO is co-led by Australia, China, Japan, and Korea to establish an effective cooperation framework at the regional level and to promote the Earth observation capacity of Asia-Oceania countries to confront the challenges facing the Asia-Oceania region.

Integrated Priority Studies for EO (satellite and in-situ) for Mekong, Pacific, and Himalayan regions

The purpose of these Integrated Priority Studies is to identify and incubate evidence-based tools, services and solutions to support decision making related to environmental challenges in these areas. Integrated Priority Studies work on utilizing data from both satellite and in situ measurements to monitor environmental changes over the Mekong River Basin (MRB), Pacific Small Island States (PSIS) and Himalayan Mountain Region (HMR)
AOGEO Workshops

Every year, an AOGEO Workshop is held to bring together multiple agencies and GEO Members in the region to improve regional observing ability, technology cooperation network, regional applications and so on. The first one was held in Deqing, China in 2018, and the second one was in Jakarta, Indonesia in 2019. The 2020 AOGEO workshop will be held in China again in the first half year.

AOGEO Workshops in China and Indonesia

AOGEO Symposia (formally GEOSS-AP Symposium)

The AOGEO Symposium is a regional forum brings together the GEO community in Asia-Oceania to exchange scientific and technical views on Earth observations and their applications for regional and global priorities as well as to report of tasks in AOGEO. Historically known as the GEOSS Asia Pacific or GEOSS-AP Symposium, this year the 12th AOGEO Symposium will be held in Canberra, Australia, from 2 to 4 November 2019 to discuss the theme “Scaling up successful Earth Observation activities for all of Asia-Oceania - Share the results and design the future steps for three priority engagement areas.

AOGEO Capacity Building

The AOGEO Symposium is a regional forum brings together the GEO community in Asia-Oceania to exchange scientific and technical views on Earth observations and their applications for regional and global priorities as well as to report of tasks in AOGEO. Historically known as the GEOSS Asia Pacific or GEOSS-AP Symposium, this year the 12th AOGEO Symposium will be held in Canberra, Australia, from 2 to 4 November 2019 to discuss the theme “Scaling up successful Earth Observation activities for all of Asia-Oceania - Share the results and design the future steps for three priority engagement areas.
AOGEO Data Hub integrates global data for decisions

Collecting data from Gaofen, ALOS, Kompsat, Sentinel, Landsat and other sources, the AOGEO Data Hub is now under discussion to integrate EO from this region and other regions as a readily available online hub.

China’s ZY-3 satellites images used for high accuracy maps in Laos

Satellite remote sensing used for surveying and mapping has become an important means of basic geospatial information acquisition worldwide. Due to limited budgets and human resources, the first version of Laos 1:50000 base maps were using only 0.5-meter resolution digital aerial photography. Due to the fast economic development and intensive human activities, there is a pressing need to update maps in order to improve the capacity of spatial data infrastructure for local sustainable planning and development.

Utilizing China’s ZY-3 satellites stereo images ranging from 2012-2018 for high accuracy map production, the initiative contributes to reliable, accurate, timely geoinformation data acquisition and updating through improving satellite remote sensing data. Besides the basic geospatial information generation, satellite data has been deployed for the emergency information service. For example, in July 2017 data was provided for local dam break damage rescue evaluation in Laos. More than that, the applicability of the ZY-3 satellites multispectral and stereo imaging for local forest fires monitoring was demonstrated in March 2019. These activities significantly improved the local awareness of Earth observation for use during emergencies.

EuroGEO

EuroGEO: The European Group on Earth Observations

EuroGEO is the European component of the Global Earth Observation System of Systems (GEOSS). It is a shared initiative of the European Commission and the European Caucus Member States and Participating Organisations. It focuses on coordination, cooperation and scaling-up user-driven applications being developed in Europe.

At the heart of this GEO regional activity is improving user uptake and to scale-up existing pilot applications based on Earth observation data and by doing so improving forecasting capabilities for decision makers and governments for Europe’s benefit.

EuroGEO builds on assets from the Copernicus Programme

Copernicus is the European programme for the establishment of a European capacity for Earth Observation. Copernicus is delivering a unique space infrastructure that is available for the broad international community. More specifically Copernicus is characterised as a major European Union’s (EU) contribution to GEOSS and the GEO community benefits from the operational data and information products delivered by Copernicus.

EuroGEO pilot applications will take full advantage of the infrastructure, data and information products delivered by Copernicus and the core Copernicus Services, the EU operational programme for Earth observation. The selected pilots are or will be of direct relevance to the
GEO Engagement Priorities whilst leveraging global and European EO initiatives to improve/facilitate the implementation of European environmental policy.

European Research Infrastructures and EuroGEO

Research Infrastructures are facilities that provide resources and services for research communities to conduct research and foster innovation. The EU Commission cooperates closely with EU countries and countries associated to Horizon 2020. It also ensures that these research infrastructures are open and accessible to all researchers in Europe and beyond. EuroGEO is in touch with the major European Research Infrastructure and can utilise their data for the development of Earth Observation products and services e.g. LifeWatch, INTERACT, the International Network for Terrestrial Research and Monitoring in the Arctic, etc.

Horizon 2020: Opportunities for EuroGEO including collaboration with the Commercial Sector

Horizon 2020 is the largest EU Research and Innovation programme, with nearly €80 billion of funding available over 7 years (2014 to 2020) in addition to the private investment that this money will attract. It aims to promote more breakthroughs, discoveries and world-firsts by taking great ideas from the lab to the market.

Horizon 2020 is the financial instrument implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness. It has recently launched a EuroGEO project to increase user uptake of Earth observation data in the European region (e-shape). Further Horizon 2020 calls (2019 and 2020) will support EuroGEO notably to develop collaboration with industry for the development of EuroGEO services, to work on services on climate adaptation, to improve the collection of in situ data in the Arctic region and to develop a R&I strategy in Mountain research.

EuroGEO launches a pioneering new project, e-shape

To strengthen Europe’s contribution to the Global Earth Observation System of Systems (GEOSS), EuroGEO has launched e-shape. With a user-centric approach to Earth observation (EO) data sharing, the system aims to improve forecasting capabilities for sound decision making.

E-shape represents a major coordinated effort to showcase operational services in the field of environmental observation research in Europe. Coordinated by ARMINES and funded under the European Union’s Horizon 2020 Programme it allows Europe to position itself as global force in Earth observation through leveraging Copernicus, making use of existing European capacities and improving user uptake of the data from GEO assets.

Moving away from a data-centric approach to a user-driven era, e-shape is a unique initiative that brings together decades of public investment in Earth observation and cloud capabilities into services for the decision makers, the citizens, the industry and the researchers.

In this line of focusing on users’ needs, the European Commission has launched e-shape. The project currently includes 27 cloud-based pilot applications under seven thematic areas to address societal challenges, foster entrepreneurship and support sustainable development.

Read the full story on the GEO Observations blog here.
**EuroGEO monitoring SDG 11 to make cities & human settlements inclusive, safe, resilient, and sustainable**

The urban, land use and land cover action groups of EuroGEO have joined forces to develop a harmonised approach for the estimation SDG 11 indicators at the city level for European cities, and eventually for the world.

The database is built upon the Degree of Urbanisation, a definition used to outline the spatial extent of cities and settlements, to create the first global, harmonized, consistent database of Urban Centres.

The database is tied to the GEO Human Planet Initiative and uses the Global Human Settlement Layer (GHSL) data which comprise: multitemporal Global Built-up Grids (GHS-BU), multitemporal Global Population Grids (GHS-POP) and multitemporal Global Settlement Model (GHS-SMOD). The GHSL uses various input data including global, multitemporal archives of fine-scale satellite imagery, census data, and volunteered geographic information. The satellite archives and available census data allow generating information layers for four epochs: 1975, 1990, 2000, and 2015.

In addition to SDG11, there are a number of SDG indicators that require a disaggregation by urban or rural population. Nevertheless, the lack of harmonized definition of cities as opposed to rural areas makes it difficult to monitor the indicators and collect the measurements in a comparable manner across cities. A concrete guidance on definitions, measurements, and unified standards is necessary to make sure that we work with harmonized and mutually agreed concepts.

In order to remedy this, the EU has developed the Degree of Urbanisation, which introduces a new harmonised people-based definition of cities. The definition has been recently extended to the globe with the built-up and population grids of the Global Human Settlement Layer and as such, it represents a contribution of Europe to GEOSS. The definition allows outlining all the cities in the world (around 10 000) in a harmonized way. It also provides a standardized unit of measurement constituting ‘urban and rural areas’. This definition will prevent inconsistencies arising from the use of different definitions, when collecting and analysing information at city and sub-city level.
CHAPTER 10 | IMPACT ON UN 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

Earth observations play a major role in helping countries achieve the UN 2030 Agenda for Sustainable Development and the associated Sustainable Development Goals (SDGs). Earth observations are used for monitoring and reporting on the SDG targets and indicators, and helps countries to develop policies, track progress, make informed decisions and implement change.

GEO promotes the inclusion of Earth observation data in the methodologies that are used to measure and ultimately achieve the SDGs.

GEO members are working in close collaboration with United Nations bodies, including the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) and other GEO participating organisations including the Global Partnership for Sustainable Development Data (GPSDD), Sustainable Development Solutions Network (SDSN) Thematic Research Network on Data and Statistics (TReNDS).

Through the Global Work Programme, GEO is making an impact on UN 2030 Agenda for Sustainable Development.
IMPACT ON THE UN 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

Earth observations play a major role in helping countries achieve the UN 2030 Agenda for Sustainable Development and the associated Sustainable Development Goals (SDGs). Earth observations are used for monitoring and reporting on the SDG targets and indicators, and helps countries to develop policies, track progress, make informed decisions and implement change.

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EARTH OBSERVATIONS IN SUPPORT OF THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

‘Earth Observations in the support of the 2030 Agenda for Sustainable Development’ was published with contributions from the GEO community, including EO4SDG Initiative together with the Committee on Earth Observation Satellites (CEOS) and others. It explores the ways the EO supports the SDGs.

Download a copy of the report here.
THE EARTH OBSERVATION HANDBOOK

EO4SDG contributed input to the special edition of the CEOS Handbook on ‘Satellite Earth Observations in Support of the Sustainable Development Goals.’

While Earth observations can be used to address most of the 17 SDGs, assessments by GEO and the Committee on Earth Observation Satellites (CEOS) have identified nine goals where Earth observations can have the greatest impact: 2 (Zero Hunger), 3 (Good Health and Well-being), 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), 11 (Sustainable Cities and Communities), 12 (Sustainable Consumption and Production), 13 (Climate Action), 14 (Life Below Water) and 15 (Life on Land).

Satellite Earth Observations In Support Of The Sustainable Development Goals
Download the handbook here.

IMPACT ON SDG 2 : ZERO HUNGER

GEO Global Agricultural Monitoring supports a world with zero hunger. GEOGLAM provides a framework to strengthen the international community’s capacity to produce and disseminate relevant, timely and accurate forecasts of agricultural production at national, regional and global scales through the use of Earth Observations (EO) including satellite and ground-based observations.

This initiative builds on existing agricultural monitoring programmes and initiatives at national, regional and global levels and to enhance and strengthen them through international networking, operationally focused research, and data/method sharing.

“Taking into consideration the central role of agriculture towards food security and even global stability, and the heavy effects of extreme food price volatility on food security, we commit to continue to tackle the issue of price volatility. In particular, we commit to pursue the implementation of the concrete initiatives of the 2011 G20 Action Plan on Food Price Volatility and Agriculture in dedicated forums: Agricultural Market Information System (AMIS) and the Rapid Response Forum, GEO Global Agricultural Monitoring Initiative (GEOGLAM) for market and production international monitoring, and risk management tools, such as the Platform for Agricultural Risk Management (PARM), and the Wheat Initiative. We acknowledge the contributions of other initiatives including the Global Agriculture and Food Security Programme (GAFSP).”

G20 Agriculture Ministers Communiqué- Xi’an, China June 2016

Within this framework, GEOGLAM developed the Crop Monitor reports which provide global crop condition assessments in support of the AMIS market monitoring activities. The first issue of the Crop Monitor appeared in the September 2013 issue of the AMIS Market Monitor. Given the success of the AMIS Crop Monitor, in 2016, GEOGLAM developed the Early Warning Crop Monitor. The Early Warning Crop Monitor brings together international, regional, and national organizations monitoring crop conditions within countries at risk of food insecurity.
The important and ongoing roles of both GEOGLAM and AMIS to impact food security were reaffirmed by the G20 Agriculture Ministers during their 2016 meeting in Xi’an, China.

**IMPACT ON SDG 6: CLEAN WATER**

GEO and UN Environment revise indicator methodology for SDG 6 to support global monitoring of mangroves, wetlands and water quality.

EO4SDG is integrating Earth observations in national SDG monitoring, reporting and implementation processes for SDG indicator 6.6.1: change in the extent of water-related ecosystems over time.

In 2017-18, representatives from EO4SDG, AquaWatch and GEO Wetlands supported UN Environment and other stakeholders to explore the use of Earth observation data and tools for national monitoring and reporting. As a result of these activities a new monitoring methodology was developed.

In 2018 the indicator was upgraded to Tier II by the UN Inter-Agency and Expert Group on SDG Indicators in recognition that it has an internationally accepted process for tracking progress against it.

Piloted in Cambodia, Jamaica, Peru, Philippines, Senegal, Uganda and Zambia, and considered a best practice for measuring this indicator, the new methodology was developed by UN Environment in close consultation with UN-Water, and with input from the Ramsar Secretariat, the Integrated Water Management Institute (IWMI), the International Union for the Conservation of Nature (IUCN), the European Space Agency (ESA) and the Convention on Biological Diversity (CBD). Experts from the GEO Secretariat, EO4SDG, the European Commission’s Joint Research Centre (JRC), NASA, and Google Earth Engine provided additional scientific expertise and completed pilot activities that informed the methodology update process.

UN Environment, NASA and ESA in collaboration with EO4SDG have been working together to develop pilot testing to use satellite data for official monitoring on mangroves, wetlands and water quality which can provide insight for SDG 6. Based on consultations with countries in 2017, less than a quarter of countries currently collect national data which can be used to monitor water-related ecosystem extent or quality.

Currently, global data products on mangroves, wetlands and water quality are under development and will be added to the SDG 6.6.1 application. Technical briefings on the pilot projects have been prepared and shared with countries and have been used in a number of regional and national workshops hosted by UN Environment.
Globally, approximately 1.1 billion people lack access to modern energy sources, which poses a significant obstacle to social and economic development. For this reason, the United Nations Sustainable Development Goal 7 seeks to ensure “access to affordable, reliable, sustainable, and modern energy for all.” Furthermore, as a result of inadequate clean energy sources, an estimated 2.8 million people die prematurely each year because of the smoky environments caused by burning solid biomass in inefficient stoves or from combustion of kerosene or coal for cooking (IEA 2017).

These challenges require a solution that reconciles demand for modern and sustainable energy services with its impact on the environment in order to ensure that sustainable development goals are realized. Renewable energy (RE) can enable the development of sustainable local sources of energy with the least negative impact on the environment and human health.

The GEO Vision for Energy (GEO-VENER) informs renewable energy policy and planning.

GEO’s efforts in the energy and minerals resources support the development of Earth observation (EO) products and services for energy management and encourage the use of Earth observation data for informed renewable energy policy planning through the GEO-VENER initiative. Satellite-based EO data offer opportunities to advance understanding of global change, and to support assessments and provide other parameters relevant to energy resources or management more broadly. The GEO-VENER Initiative has sought to further these developments through the provision of tools and resources as well as convening stakeholders such as data providers, data end users, and others.

From 2015-2017, GEO-VENER contributed to the EU Horizon 2020 (H2020) ConnectinGEO project, to identify essential variables for renewable energies, produce gap analysis and outline industrial challenges on in situ measurements. While the project has been completed, the outcomes have contributed to the European Network of Earth Observation Networks.

In 2017, GEO-VENER supported the-operational COPERNICUS Atmosphere Monitoring Service for Solar Radiation and established a Sensor Observation Service capacity for in situ measurements. This component is openly available to the public and researchers on the webservice-energy.org community portal.

In 2018, GEO-VENER contributed to the Climate change Impacts to Energy Sector in collaboration with the Copernicus Climate Change Service.

In 2019, GEO-VENER released a first version of an improved end-to-end solar irradiance nowcasting system called MAD-WRF. Since 2013, GEO-VENER has contributed to capacity buildings efforts through workshops and trainings with diverse energy management end users, including solar energy professionals and electric utility end users. In 2016, a workshop was held with international energy management stakeholders to prioritize key areas within the sector.
To meet capacity building and networking goals, side events were facilitated at several recent GEO events, including GEO Weeks in Washington DC, Japan, and Australia (in November 2019). GEO-VENER members also participated in the annual GEO Symposium.

This initiative builds on existing agricultural monitoring programmes and initiatives at national, regional and global levels and to enhance and strengthen them through

“GEO VENER is the bridge between GEO and its stakeholders, co-designing and co-creating knowledge and information in renewable energies, sharing its outcomes to all, and contributing to the three main priorities of GEO (SDG7, Paris Agreement and Sendai Framework). Earth Observation Data and information from satellites, ground-based systems, and models are a key-enabler of the development and integration of renewable energies in the world.”

Dr. Richard S. Eckman, Programme Manager, NASA.

“Earth Observation Data and information from satellites, ground-based systems, and models are a key-enabler of the development and integration of renewable energies in the world.”

Dr. Richard S. Eckman, Programme Manager, NASA

IMPACT ON SDG 11 : SUSTAINABLE CITIES & COMMUNITIES

EO4SDG and Swedish National Authorities develop National Land Cover Database

EO4SDG supported a comprehensive mapping of Sweden's national land cover (NMD) using open satellite data as an essential component. NMD is based on analysis of Sentinel-2 and Sentinel-1 satellite data, Lidar data and national databases.

Developed with the Swedish Environmental Protection Agency in cooperation with 7 Swedish authorities including Statistics Sweden and other relevant organizations to create a new nationwide database. It is planned to continuously update the NMD. The project serves as an excellent showcase for other countries, on the use of Earth observations in the context of land cover assessment.

There are several Agenda 2030 goals linked to this project; in particular SDG 15 Life on Land, as it will contribute to the sustainable use of the ecosystem and its biological diversity, as well as SDG 11 Sustainable Cities and Communities and SDG 13 Climate Action.
IMPACT ON SDG 12: SUSTAINABLE CONSUMPTION & PRODUCTION

The European Product Award for commercial organizations monitoring the SDGs

The Earth observation industry provides data, information and services which can support the implementation of the SDGs by providing critical information on natural resources, government operations, public services, population demographics and other key areas. That’s why the European Association of Remote Sensing Companies (EARSC) decided to focus its Product Award on companies that are addressing implementation of the SDGs.

EARSC established the annual product award in 2016 and since then it has been well received by the community with evaluators from GEO, the United Nations, ESA and others contributing to the selection process. The first award was given to Jeobrowser for their Rocket application which allows users to use simple search terms to search millions of satellite images and helping to achieve SDG10 on reducing inequalities.

The “Waste from Space” product from Air and Space Evidence product won the 2017 EARSC Product Award for their use of open data from the Landsat and Sentinel satellite programmes to monitor unlawful dumping of waste in unsuitably prepared locations. The solution aimed to drive down the size of the waste crime problem to ensure that much more waste/hazardous waste is subject to environmentally sound management in its lifecycle (SDG 12.4), and push for more waste to be treated properly and sustainably within the circular economy (SDG 12.5). It can also contribute to combating organized crime (SDG 16.4).

“Waste crime can cause environmental damage to surrounding land, air and water, and poses a risk to human and animal health. Living near an unlawful waste site can also ruin people’s lives. We are aiming to use cutting edge space technology to significantly reduce the scale of the waste crime problem,” Prof. Ray Harris, Director at Air and Space Evidence.

The 2018 EARSC Product Award winner was the "Dust Frequency Maps" from SILEX CLOUDS which provides a historical analysis of dust storm occurrences over the last decade. This product is targeted at the management of PV Solar Parks under dust/sand conditions that affect the performance of solar power energy projections and effective production, contributing to clean energy reporting and monitoring (SDG7 and SDG9 on infrastructures).
“As a CEO of Silex Clouds S.R.L. I’m very glad and honoured that our solution on Dust Frequency Maps was recognized by EARSC and rewarded with the ‘European EO Product Award 2018’. I strongly believe that our service could support the accomplishment of the 2030 SDGs. I am convinced that this noticeable award will leverage our company, and that EARSC endorsement will enable us to bring our solution to its Final Users. Overall it is very innovative products for the MENA countries” Pablo Marzialetti, CEO SILEX CLOUDS.

The 2019 EARSC Product Award was awarded to EARS, a Dutch company producing an Agriculture Index Insurance, AgríIndex. This product already assists 18 countries with drought related crop yield losses supporting SDG2 on zero hunger and food security.

"Where drought has been felt most, coffee trees have dried up. Some have failed to flower due to lack of moisture... It becomes worse when the coffee beans are forming. Because this stage needs enough water and moisture for growth but when absent, these dry up...The problem is critical, the weather has become too harsh for coffee”

Joseph Nkandu, the executive director of the National Union of Coffee Agribusiness and Farm Enterprises (Nucafe) in Uganda.

IMPACT ON SDG 13: CLIMATE ACTION

Japan’s Forest Early Warning System expanded to 77 countries

As part of their contributions to GEO, the Japan International Cooperation Agency (JICA) and the Japan Aerospace Exploration Agency (JAXA) launched the ‘Forest Early Warning System in the Tropics (JJ-FAST)’, an online system that uses satellite data to monitor tropical forests every 1.5 months. In June 2018, the system’s service coverage was expanded to include 77 countries.

This system provides information to countries to track and meet SDG 15 (Life on Land) targets related to forests and biodiversity, as well as SDG 13 (Climate Action) and articles of the Paris Agreement. The Global Forest Observations Initiative (GFOI) and its partners are currently considering how the system can also be used by countries to detect illegal logging.
IMPACT ON SDG 14: LIFE UNDER WATER

GEO monitoring activities with UN Environment and IOC-UNESCO

GEO activities are contributing the achievement of SDG 14 by complementing efforts by various UN custodian agencies in their methodologies to track and measure life under water.

EO4SDG and GEO Blue Planet are working with UN Environment to measure marine pollution, including coastal eutrophication and marine litter (SDG 14.1.1). GEO Blue Planet recently led the drafting of a detailed technical background paper on data related to marine litter. Additionally, GEO Blue Planet is working with UN Environment to produce a global mapping of Chlorophyll-A which will be directly used to compute a sub-indicator of SDG 14.1.1 on chlorophyll-A deviations within the EEZ.

At the same time, GEO Aquawatch is developing an inventory of eutrophication monitoring methods and projects to address needs of UN Environment and the Intergovernmental Oceanographic Commission (IOC)-UNESCO for SDG 14.

IMPACT ON SDG 15: LIFE ON LAND

GEO LDN Initiative responds to UNCCD call to action for SDG 15

In September 2017, the UNCCD 13th Conference of the Parties invited GEO to support them in implementing the goals of the Convention by providing space-based information and in situ measurements. In response, UNCCD and GEO partners have developed the GEO Land Degradation Neutrality Initiative (GEO LDN). This initiative will advance the collaborative development, provision and use of Earth observation datasets, quality standards, and analytical tools to achieve Land Degradation Neutrality.

Land Degradation Neutrality is defined by the United Nations Convention to Combat Desertification (UNCCD) as “the amount and quality of land resources, necessary to support ecosystem functions and services and enhance food security, remains stable or increases within specified temporal and spatial scales and ecosystems.”

Countries need quantitative assessments and maps of degraded land to halt, and eventually reverse, current trends toward land degradation. The importance of this Earth observation-based information is recognized in SDG indicator 15.3.1 (proportion of land that is degraded over total...
land area), and by the adoption of Land Degradation Neutrality targets under the auspices of the UNCCD.

The strategic objectives of GEO LDN are to:
1) Facilitate access to space-based information and in situ measurements;
2) Provide expertise, tools and training to build national capacities; and
3) Assist with the further development of international standards and protocols for the indicator.

REMOTE SENSING PRODUCTS REVEALS RECOVERY OF FORESTS IN CHINA

In 2016, a report on Remote Sensing Monitoring of China’s Sustainable Development revealed the effects of the Three-North Shelterbelt Forest Programme on vegetation recovery, restoration and the regional ecological balance and has helped provide monitoring data for SDG 15 Life on Land and to combat desertification, and halt and reverse land degradation.

Based on results of GEO Multi-source Synergized Quantitative Remote Sensing Products (GEO MUSYQ) vegetation products and produced by the Institute of Remote Sensing and Digital Earth (RADI) under the Chinese Academy of Sciences (CAS) and commissioned by the State Council, the Ministry of Science and Technology and the Ministry of Ecological Environment of China, the report analysed the impact of the Three-North Shelterbelt Forest Programme, the world’s largest human-planted forest strips in the northern regions of China: the North, the Northeast and the Northwest. The project was launched in 1979 and the study showed the extent of vegetation recovery.

The long-time series GEO MUSYQ vegetation products were used to investigate the recovery of the plants in the areas where the Forest Programme was implemented. It is found that human-planted forestry plays an important role in the vegetation recovery in the Songliao Plain, the Taihang Mountain, the Southern of Qinling Mountain, and the Northern of Tianshan Mountains.

The positive results of GEO MUSYQ vegetation products proved the effects of China’s Three-North forests Shelterbelt Programme on tree planting, vegetation recovery, sandstorm prevention and as an agricultural safeguard, and they also reinforce China’s policy to implement a follow-up phase.
CHAPTER 11 | IMPACT ON TECHNOLOGY

Over the past decade, GEO has been working to build the GEO System of Systems (GEOSS). GEO has already made over 400 million open Earth observation data and information resources available via the GEOSS Portal and through the GEODAB API, both part of the GEOSS Platform, in order to contribute to global development efforts.

Efforts to reach new communities have resulted in GEO Community Portals developed using the GEOSS Platform technology.

NextGEOSS data hub and platform was unveiled to promote scalable transformation of Earth observation data into actionable information and knowledge across all 17 SDGs.

GEO and Amazon Web Services (AWS) announced the Earth Observation Cloud Credits Programme, a joint collaboration to offer GEO members and research organizations access to AWS Cloud services to help countries realize the potential of Earth observations for sustainable development.

Digital Earth Africa will provide a routine, reliable and operational service that will enable African
GEO COMMUNITY PORTALS DEVELOPED USING THE GEOSS PLATFORM TECHNOLOGY

In a move to better serve Earth observation user communities, the ever-evolving GEOSS Platform incorporates new and customisable instruments and services, as part of the continuous improvement of the Global Earth Observations System of Systems (GEOSS).

In the current era of big data, the number of Earth observation resources is growing exponentially. Despite the existence of more data, users often can't find or connect to the resources they need for their work and decision making. In response to this challenge, in 2017 the GEOSS Platform connected users with over 400 million open Earth observation resources from over 7,000 data providers, all accessible through a single portal. These numbers continue to grow as more data providers make their EO data and information discoverable through the GEOSS Platform.

In order to better serve data users, the European Space Agency (ESA) and the National Research Council of Italy (CNR –IIA) worked in close collaboration with the GEO Secretariat, the United States Geological Survey (USGS), and the University of Geneva to develop the GEOSS Platform to house customisable instruments and services for user communities.

The GEOSS Platform strengthened to serve users with diverse needs
In November 2018, enhancements and features of the GEOSS Platform were demonstrated in Kyoto, Japan. Managed by ESA as part of the EDGE project and co-funded by the European Commission and ESA, the platform offers improved discovery, access and use of all registered open Earth observation resources from all over the world via the GEOSS Portal and developed Community Portals.

The GEOSS Platform strengthens linkages with the GEO Flagships, GEO Initiatives and Community activities by leveraging reusable components on the Platform. The need to respond to diversified user categories, highlighted at various GEO Data Provider Workshops, urged the importance of bringing the GEOSS Platform to the community of users. Continued engagement and co-design with all the communities involved is fundamental to be able to provide tailored functionalities.

"These new GEOSS widgets could really easily be integrated into our wetlands portal" said Jonas Eberle of the GEO Wetland initiative. "Users can now directly access GEOSS data via our own portal and combine them with our own data."

Over the past decade, GEO has been working to build GEOSS. GEO has already made over 400 million open Earth observation data and information resources available via the GEOSS Portal and through the GEODAB API, both part of the GEOSS Platform, in order to contribute to global development efforts.

However, not everyone working with Earth observations has same access to this data. For example, this is not possible where high-speed landlines and/or Internet connectivity are not available, or in regions where terrestrial communication lines are not reliable or have been disrupted by disasters. In an effort to increase access to Earth observations, GEO delivers data and products on a routine basis using satellite Digital Video Broadcast (DVB) technology to a worldwide user community through its initiative GEONETCast.
GEONETCast is a global network of cost-effective satellite-based dissemination systems which broadcast Earth observation data, products and services (including space-based, air-borne and in situ data) to areas with otherwise limited access. Currently serving approximately 6,000 users in 169 countries, this user-driven and low-cost service operates through 3 GEONETCast Network Centres: GEONETCast Americas (US NOAA), EUMETCast (EUMETSAT) and CMACast (China), with established data exchange between them.

The cost of reception stations is kept to a minimum, resulting in an affordable solution for individuals, communities and businesses to ensure access to the Earth observations they need. A typical GEONETCast reception station includes a standard PC, a Digital Video Broadcast (DVB) reception device, and a satellite off-set antenna, and costs approximately $3,000 USD for all equipment and installation.

Read the full story [here](#).

**NextGEOSS Platform Helps Transform Earth Observations to Actionable Information for the SDGs**

In March 2019, the NextGEOSS data hub and platform was unveiled to promote scalable transformation of Earth observation data into actionable information and knowledge across all 17 SDGs.

**Copernicus**, Europe’s eye on Earth, is a major contribution to GEO and the Global Earth Observation System of Systems (GEOSS), providing vast amounts of open data about the Earth for European citizens and global communities. The European Commission funds activities that transform Copernicus data to actionable information. One of these activities is NextGEOSS, a centralised European Earth observation data hub and platform, where the users can access data and deploy applications.

Now open for public use, the [NextGEOSS data hub](#) enables users to easily explore European Earth observation data and services, and the platform services empower developers to build their own research and development or commercial applications with dedicated tools and support. External users can benefit from the tools being used to develop [NextGEOSS internal pilots](#), a suite of next generation technology, when building their own Earth observation-based applications and services. The solution is cloud agnostic, so users have flexibility to deploy their processing to any cloud providers.

Providing new services and technology are not enough to transform Earth observation data into actionable information - an engaged community contributing to system design is equally important. The integration and support processes that enable new and existing partners to contribute to NextGEOSS have been carefully developed, based on experience and feedback gained through internal NextGEOSS pilots. Various training and capacity development activities, including the NextGEOSS webinar series, have been integrated in the process.

Read the full story on the GEO Observations Blog [here](#).
CHAPTER 12 | IMPACT ON WATER & OCEANS

GEO Blue Planet is working around the globe to ensure sustained development and use of ocean and coastal observations for the benefit of society. Currently working with UN Environment, GEO Blue Planet is building a global platform for marine litter monitoring.

GEO Wetlands is mapping and monitoring wetlands globally to support sustainable management of these fragile ecosystems – from local ponds to global governance.

The GEO Global Water Sustainability Initiative (GEOGLOWS) provides coordination among the diverse freshwater activities within the GEO water community. The most significant element has been the application of Earth observations to create a system that forecasts flow on every river of the world while also providing a 35-year simulated historical flow.

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.
GEO BLUE PLANET BUILDING A GLOBAL PLATFORM FOR MARINE LITTER MONITORING

GEO Blue Planet is collecting information on existing marine litter databases and published datasets to support the United Nations Sustainable Development Goal SDG 14 Life Below Water Indicator 14.1.1 which aims to prevent and significantly reduce marine pollution of all kinds.

Marine litter (also referred to as marine debris) is a growing global concern. It’s estimated that over 8 million tonnes of plastic make their way into the ocean each year. Action on marine litter was put forward as a resolution on Marine litter and Microplastics by member states at the 2019 United Nations Environment Assembly (UNEA). This resolution extends the mandate of the Ad Hoc Open-Ended Expert Group on Marine Litter and Microplastics to build on its previous work and report on existing actions relating to marine litter, identify resources for supporting countries in addressing marine litter, build partnerships to further address marine litter challenges and analyse response options to solving the global problem of marine litter.

As the custodian agency of SDG 14.1.1, UN Environment is tasked with developing a global methodology to support marine litter monitoring. SDG indicator 14.1.1b, “marine litter” is currently labelled as Tier 3, meaning that internationally established methodologies or standards are not yet available. UN Environment is collecting information on monitoring mechanisms and methodologies in order to develop a framework for gathering and compiling data, as well as identifying approaches for capacity building around monitoring of marine litter.

GEO Blue Planet, IEEE Oceanic Engineering Society (IEEE/OES), World Wildlife Foundation (WWF) and partners are working to produce a white paper on a concept for a global monitoring platform for marine plastics. This white paper will include an inventory of major databases and datasets for marine debris/litter. IEEE/OES in collaboration with the GEO Blue Planet Initiative and UN Environment is leading a two-year funded initiative aiming to bring together experts and social agents to co-develop the information and modelling system.
René Garello of IEEE OES presents about the global challenge of marine litter at workshop on Technologies for Observing and Monitoring Plastics in the Ocean, held in Brest, France on 26 – 27 November, 2018. (Photo Credit: IEEE).

**OceanObs’19 and the Oceanscape Project**
GEO Blue Planet was part of the planning teams for breakout sessions at the major ocean conference OceanObs'19 (September 2019) on SDGs and Ocean Observing, Community Building and Dialogue, and Ocean Best Practices.

Ocean Obs’19 also saw the launch of the Oceanscape portal, a Blue Planet project and community effort, which will provide information on the many international, regional and national-level organisations working in ocean observing and related fields, and how they are connected to one another. The portal aims to serve a variety of stakeholders, including the scientific community, NGOs, private sector organisations, and government and funding agencies, by clarifying the ‘ocean space’, and helping to identify synergies, collaborative opportunities, or potential overlap/duplication.

EARLY WARNING SYSTEM FOR FLOODING OF REEF-LINED ISLANDS

The Wave-driven Flood Forecast of Reef-lined Coasts Early Warning System (WaveFORCE) methodology has been successfully tested in a case study at Roi-Namur, an island in the north part of the Kwajalein Atoll in the Marshall Islands. The WaveFORCE demonstration illustrates the usefulness of an wave-driven flood forecast Early Warning System globally.

WaveFORCE provides coastal flood forecasts from the existing situation at any given time up to 180 hours into the future at 3-hour intervals, with the forecasts being updated once every 6 hours. This means that every 6 hours a new set of forecasts will be generated, which provide the user with a set of forecasts for each point along the entire coast at 200 metre intervals.

Rather than using expensive wave-rider buoys for input data to the model, NOAA combines satellite data and hydrodynamic models to derive sea surface height and wave height, period and direction globally. Deltares and USGS have developed a simple model that predicts wave-runup given the input of wave and sea surface height outside the reef. This simple model successfully propagates the waves across the reef, through the lagoon and up onto the land, where the extent of the runup can be predicted.

Using this system, waves can be categorized into locally-derived storm waves that are generated by nearby storms or cyclones (i.e. short wavelength wind waves) and those waves that are generated by distant storms (e.g. long wavelength swell waves from storms in the Arctic and Antarctic or cyclones somewhere else in the ocean basin). The sea surface height is a combination of: tides, local sea level (which fluctuates on a daily to weekly time scale), storm surge (from nearby storms or cyclones), short-term weather, and long term climate change.

GEO WETLANDS COMMUNITY PORTAL & TOOLBOX

GEO Wetlands Community Portal now online

GEO Wetlands strengthens capabilities for mapping, monitoring and stocktaking of wetlands globally to support sustainable management of these fragile ecosystems – from local ponds to global governance.
The new GEO Wetlands Community Portal is the pilot for a global wetland observation system being developed in support of the Ramsar Convention on Wetlands and other policy frameworks. It builds on developments within the Satellite-based Wetland Observation Service (SWOS) European Union Horizon 2020 project, and will become a core part of the forthcoming GEO Wetlands Knowledge Hub.

The portal is designed to support wetland-related decision making at all levels, and to facilitate SDG monitoring and reporting processes. The portal provides guidelines and user stories to highlight the uses of Earth observations for wetland mapping and monitoring. It contains maps and results from projects, and allows discovery of and access to relevant satellite data.

**GEO Wetlands provides toolbox for Earth observations in Uganda**

GEO Wetlands is working with the Ugandan Ministry of Water and Environment to co-develop and pilot-design a user-friendly digital system for Earth observation satellite data for taking stock of, and monitoring, wetlands, a vital component of the global water resources ecosystem.

The system enables wetland practitioners and decision makers to generate spatial time series statistical data for inventorying and monitoring national wetland resources. This is a unique attempt to demonstrate the potential of satellite-derived EO data to provide a full national wetland inventory in Uganda and serving as a blueprint to other countries of East Africa.

The project is consistent with the upcoming monitoring requirements in the context of United Nations Sustainable Development Goal SDG indicator 6.6.1 “change in the extent of water-related ecosystems over time.” It also recognizes the critical importance of supporting developing countries in strengthening the capacity of national statistical offices and data systems to ensure access to high quality, timely, reliable and disaggregated data.

The project is funded by the Global Partnership on Sustainable Development Data (GPSDD) with support from the World Bank’s Trust Fund for Statistical Capacity Building (TFSCB). The workflow for generating statistics for display in the portal is included in the GlobWetland-Africa Toolbox, developed as part of the GlobWetland-Africa (GWA) project funded by the European Space Agency (ESA).

Major achievements and deliverables from the project include the creation of a toolbox for wetland inventory mapping, based on the GlobWetland Toolbox, with extended functionality for reporting on SDG 6.6.1; Creation of baseline wetland inventory map for Uganda based on Sentinel-1 and Sentinel-2 data for 2016 and 2017. Validation has been performed incorporating in situ data collected by the Ministry of Water and Environment and RAMCEA and online portal for SDG reporting on SDG indicator 6.6.1 on Wetland extent and training of national stakeholders in Uganda, as well as from the other RAMCEA countries.

Visit the GWA website and download the latest version of the toolbox here.

**FORECASTING THE FLOW ON EVERY RIVER OF THE WORLD: THE GEO GLOBAL WATER SUSTAINABILITY INITIATIVE**

Since the formal creation of the initiative in 2017, the most significant element of the GEO Global Water Sustainability Initiative (GEOGLOWS) has been the application of Earth observations to create a system that forecasts flow on every river of the world while also providing a 35-year simulated historical flow.
GEOGLOWS provides coordination among the diverse freshwater activities within the GEO water community, and helps to organize the international community engaged in the hydrologic sciences, observations, and their application to forecasting, and provides a forum for intergovernmental collaboration and engagement with the academic and private sectors.

The World Bank, with a current hydro-meteorological investment portfolio of around US$500 million, estimates that globally improved weather, climate, and water observation and forecasting could provide increases in global productivity up to US$30 billion per year and reduced asset losses up to US$2 billion per year. Hydrological stress, particularly in the tropics, has a major impact on economies owing to the devastating reconstruction costs as well as increased volatility in food prices.

The GEOGLOWS global streamflow forecast service uses a Hydrologic Modeling as a Service (HMaaS) approach, which centralizes the cyberinfrastructure, human capacity, and other components of hydrologic modeling using the best forecasts and expertise available, along with the latest advances in Information and Communication Technologies. It delivers reliable forecast information as a service, instead of all the underlying data that must be synthesized and computed locally to produce the necessary information.

The GEOGLOWS global streamflow forecasting service allows local stakeholders to focus on solving water management problems such as flooding, drought, and water/food security issues by providing the water intelligence they need to make decisions; and benefits the global economy by also providing water intelligence to sectors such as the insurance and reinsurance industry, and many others that need to make high-risk investment decisions.

The GEOGLOWS Hydrologic Modeling as a Service (HMaaS) approach allows users to optimise resources including human expertise, cyber-infrastructure and storage and operational support and maintenance to deliver an operational, 24/7 hydrological forecasting, dissemination and data service. The benefit is a world-class service delivered at an overall reduced cost, leveraging world-leading scientific expertise, knowledge and forecasting technology.

**GEOGLOWS GLOBAL STREAMFLOW FORECASTING PILOTS**

Led by researchers at Brigham Young University, GEOGLOWS Global Streamflow forecasting pilots have been undertaken in the Dominican Republic, Colombia, Bangladesh and Nepal in 2017-2018, in order to assist with the analysis of past floods, forecasting of future floods and damage, as well as other water resource uses based on local needs.

In the Dominican Republic, GEOGLOWS worked closely with the National Institute of Hydraulic Resources (INDRHI) to create customized applications for nationally-defined needs in the areas of flood protection, agricultural demand and reservoir management.

In Colombia, the customized GEOGLOWS application enables the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM) to visualize water levels and historical data from their 200+ monitoring stations, in order to both assess the European Centre for Medium-Range Weather Forecasts simulations and more accurately identify areas at risk of flooding.

In Nepal, GEOGLOWS partnered with the national Department of Hydrology and Meteorology (DHM) on a pilot application that increased capacity to identify and forecast flood events and their impact. In Bangladesh, the pilot application was developed in collaboration with the national Flood Forecasting and Warning Centre and the International Centre for Integrated Mountain Development (ICIMOD), and was customized to help decision makers forecast transboundary flows that were used to drive their national flood warning system.
GLOBAL FLOOD AWARENESS SYSTEM (GloFAS)

Global Flood Awareness System (GloFAS) provides global prediction of river flooding

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.

GloFAS provides flood forecasting in Bangladesh

Bangladesh is located downstream of three large river basins including the Ganges, Brahmaputra and Meghna. During the annual monsoon season, rainfall in the three basins causes 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 using 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 2019?, 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.

GloFAS improves the prediction of river flooding with novel approach to estimate flood warning thresholds

A recently published research paper, “Range-dependent thresholds for global flood early warning,” presents recent scientific advances focused on improving and extending the forecast skills of the Global Flood Awareness System (GloFAS). GloFAS is designed to forecast large-scale river flooding worldwide by detecting river reaches where predicted streamflow has significant probability to exceed model-consistent warning thresholds in a 30-day forecasting horizon. Therefore, detection of future flood conditions
depends not only on accurate streamflow forecasts, but also on the estimation of suitable flood warning thresholds.

This research shows the development of a new method to estimate thresholds for medium-range flood forecasting. It provides evidence that flood thresholds for medium-range forecasting can take on significantly different values from thresholds derived from a hydrological reanalysis based on ERA5, a state of the art meteorological dataset which is used to initialize the daily forecasts. Findings show that the use of constant thresholds for 30-day flood forecasting, as in the current operational GloFAS setup, is statistically correct only in 30% to 40% of the river network.

The project proposed a new framework for the early detection of floods, based on range-dependent flood thresholds, which are able to compensate for forecast drifts in the extreme values, particularly important over long forecast ranges. This represents a key step in the evolution of GloFAS and of similar systems, which may ultimately lead to the extension from the current 30-day range to a 6-week forecasting range. Upcoming work, ahead of the operational implementation, will involve extensive testing and skill evaluation of the operational ensemble forecasts, to assess the limits of predictability of the system and compare the system skills to the current operational version.