2021 Annual Summary of the EO4SDG Initiative

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The Earth Observations for Sustainable Development Goals Initiative

The Group on Earth Observations (GEO) Earth Observations for Sustainable Development Goals (EO4SDG) initiative is a growing global network of leaders from national and local governments, academia, research networks, multilateral organizations, nonprofit organizations, and entrepreneurial firms who work to accelerate the use of Earth science information in support of the Sustainable Development Goals (SDGs). EO4SDG is using both top-down and bottom-up approaches to organize its efforts. The top-down approach involves working with the United Nations (UN) Inter-Agency Expert Group on SDGs (IAEG-SDGs) (i.e., Working Group on Geospatial Information [WGGI]) and SDG custodian agencies[1] to support the development and refinement of EO-integrated indicator methodologies, and facilitate the definition of new SDG indicators/sub-indicators that can more effectively inform related goals and targets. The bottom-up approach involves partnering with countries to conduct applied research, perform feasibility testing, and develop and operationalize methods to enable the uptake of EO solutions into national SDG monitoring frameworks and eventually into development policies. Additional EO4SDG efforts involve improving the provision, access, discoverability, and applicability of Earth observations and derived knowledge to the SDGs. EO4SDG is establishing trusted portals across communities; engaging countries in capacity building and co-learning efforts (e.g., webinars, toolkits); and increasing awareness (e.g., via awards, scientific workshops, special issues of scientific journals) of effective uses of Earth observations to achieve benefits and positive impacts, thereby encouraging nations and stakeholders to pursue using Earth observations themselves.

The EO4SDG initiative promotes, partners with, and leads projects, communities, and programs that support its mission. EO4SDG maintains a dedicated website and social media accounts (Twitter, Facebook) to convey achievements and stories about how Earth observations and the Group on Earth Observation (GEO) serve SDGs. In 2021, the website brought in over 25,000 visitors, and the total number of pages viewed exceeded 85,000. Our Twitter account reached over 3,400 followers.

The sections below highlight key accomplishments carried about by the EO4SDG team of GEO member countries, participating organizations, and additional contributors in 2021.

Overview of 2021

[1] SDG custodian agencies include UN entities responsible for developing international standards, recommending methodologies for monitoring SDG indicators, and compiling and verifying country data and metadata for submission to the United Nations Statistics Division.

In 2021, EO4SDG members worked to identify and share best practices regarding: use of Earth science data and applications to achieve the SDGs; data discovery, access, and utilization; capacity development; and communications and outreach. The initiative collaborated with GEO on various activities (e.g., GEO Human Planet, Global Urban Observations and Information [GUOI]) and with other partners (e.g., UN Habitat, World Bank, Esri, Google) to strengthen linkages with stakeholders.

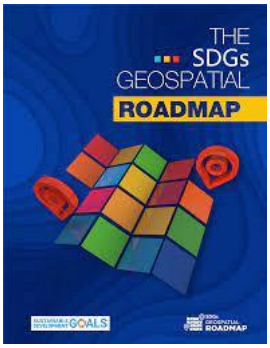
EO4SDG also supported open data access and the development of methods, tools, use cases, and capacity-development activities in the following thematic areas:

- SDG 6 (Water and Sanitation)
- SDG 11 (Sustainable Cities and Communities)
- SDG 14 (Life Below Water)
- SDG 15 (Life on Land)

EO4SDG members participated in and led sessions at numerous domestic and international conferences, events, and expert team meetings to raise awareness and showcase the importance of using Earth observations and derived knowledge to achieve the SDGs. For example, EO4SDG collaborated with the University of Strathclyde to lead a side event at the UN Climate Change Conference in Glasgow (COP26) on "Earth Observations to build sustainable and climate resilient cities and communities." EO4SDG also participated in the Space & Geospatial Virtual Pavilion for COP26, organized by the Knowledge Transfer Network in collaboration with more than 30 other partners, to explore the role of innovation, inclusive growth, and collaboration in supporting the climate emergency and meeting Net Zero targets using geospatial and Earth observation data.

Launch of the SDGs Geospatial Roadmap

As a member of the IAEG-SDGs' WGGI, EO4SDG provided substantial input to the SDGs Geospatial Roadmap, a resource to communicate, guide, and enhance the awareness of how geospatial information and Earth observations are used to achieve the SDGs. WGGI officially launched the SDGs Geospatial Roadmap at a UN Statistical Commission side event on February 11, 2022. The 53rd session of the Statistical Commission adopted the roadmap, recognizing that geospatial information, including Earth observations, serves as official data to aid countries in activities related to the SDGs.



The interactive storymap of the SDGs Geospatial Roadmap outlines how to "build the bridge" between the statistical and geospatial communities working within the global indicator framework. It illustrates examples of enabling environments for national and international reporting on the integration of SDGs—e.g., the Federated Information System for the SDG—and online knowledge resources that also enable partnerships among government, academia, non-profit organizations, and the private sector to help build skills and capacity—e.g., Earth Observations Toolkit for Sustainable Cities and Human Settlements. The Roadmap also shares case studies—e.g., Ghana's use of citizen science data to support monitoring of indicators such as SDG 14.1.1 (Marine Litter)—

and examples of tools and data infrastructures that make analysis-ready Earth observations available—e.g., Digital Earth Africa, an operational data infrastructure, which collaborates with the United Nations Food and Agriculture Organization (FAO) to produce and make openly available land cover and crop type maps and other analysis-ready data (from Landsat and Sentinels 1, 2).

Launch of the Earth Observations Toolkit for Sustainable Cities and Human Settlements

On February 25, 2021, at a United Nations (UN) Statistical Commission side event, EO4SDG launched the Earth Observations Toolkit for Sustainable Cities and Human Settlements in partnership with the UN Human Settlements Program (UN Habitat) and the Group on Earth Observation (GEO). The toolkit is a collaborative effort that improves countries' and cities' capacity to use and access Earth science resources related to human settlements indicators. It involves contributions from over 40 organizations, including representatives from national statistical organizations, city authorities, space agencies, academia, research institutions, the private sector, and independent Earth observation data producers. The toolkit contains resources such as data, tools, use cases, and learning opportunities that are related to four primary thematic areas: adequate housing, open spaces, access to public transport, and spatial urbanization.

This effort has actively contributed to, and is part of, the global urban monitoring framework that is designed by UN Habitat as a flexible framework for monitoring SDGs and other city objectives such as inclusiveness, resilience, and safety. During the 53rd session of the UN Statistical Commission held March 1-4, 2022, UN Habitat endorsed this monitoring framework and its implementation as part of a global urban UN strategy (read UN Habitat's report).

Given the broad applicability of this approach, EO4SDG is working with the GEO community to explore implementation of additional toolkits for other SDGs.

GEO SDG Awards 2021

Figure 1. Access a video of the 2021 GEO SDG Awards virtual awards ceremony here.

Another highlight this year involved the successful completion of the third cycle of the GEO SDG Awards program. EO4SDG launched this internationally recognized program in 2019 to recognize institutions, organizations, and countries that are applying Earth observations towards the achievement of the SDGs. In 2021, we received 24 nominations from countries and organizations from around the world. Nine panelists from different sectors and countries reviewed the nominations to assess the overall impact, quality, and soundness of the Earth observation endeavors, and gauge the potential of these efforts to be

replicated and scaled up. As a result, EO4SDG recognized eight organizations and countries for exemplary work in sectoral and special categories and highlighted one remarkable nomination for a special mention.

Sectoral category awards included:

- GEO Member Country: *Colombia*
- GEO Member Country: *United Arab Emirates*
- Intergovernmental: *United Nations Development Programme Colombia, Ecuador, Peru*
- SDG Custodian Agency: *Food and Agriculture Organization of the United Nations*
- Academia: *Stanford University*

Special category awards included:

- Innovation: *The Netherlands Space Office*
- Testimonial/Story: *Water@Reading Research Group, University of Reading*
- Collaboration: *UN-Habitat, National Aeronautics and Space Administration (NASA), ITC, University of Twente, United Arab Emirates (UAE) Federal Competitiveness and Statistics Centre*

In addition, the *International School of Milan (Viola Mascarucci)* received the Inspiring Hope for Youth special mention. Appendix A contains a summary of these award-winning projects.

Improving the Accuracy of SDG Indicator Monitoring

EO4SDG has been facilitating multi-stakeholder partnerships to monitor and implement SDGs at local, national, regional, and global levels. One approach has been to encourage GEO member countries to develop partnerships involving the Earth observation sector, national statistics offices, and relevant ministries to develop and apply methodologies based on Earth observations at the national or local level.

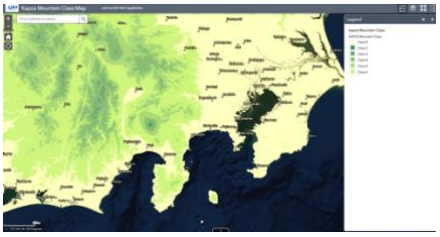


Figure 2. Kapos mountain classification map created from the Shuttle Radar Topography Mission (SRTM) digital elevation model (90m resolution).

As one of these efforts, Japan responded to a request to verify a new UN Food and Agriculture Organization (FAO) methodology for monitoring and reporting on SDG indicator 15.4.2, the Mountain Green Cover Index (MGCI). This new method leverages global-level land cover and mountain elevation range data resampled at 300 meters to compute the MGCI at national and elevation-range levels for all countries. The method advises countries to leverage their own national land cover maps, if they are of higher spatial resolution and comparable or better quality than the global data. In response to this request, Japan Aerospace Exploration Agency (JAXA), a co-chair of the EO4SDG initiative, joined forces with Japan's National Office of Statistics and related ministries to validate this FAO method at the country level. They compared the FAO's estimated values for indicator 15.4.2 for Japan with indicator values based on nationally available data, such as higher-resolution (100-m) land use and land cover data produced by JAXA and the 10-meter

resolution Fundamental Geospatial Data/high-resolution Digital Elevation Model produced by the Geospatial Information Authority of Japan. Their findings confirmed the FAO proposed methodology for 15.4.2. This effort also highlighted the importance of country validation efforts and the usefulness of national datasets to improve the accuracy of indicator monitoring, especially when monitoring small and highly heterogeneous landscapes.

Read about Japan's national experience to calculate SDG indicator 15.4.2 in this Storymap.

Featured Project Highlights

EO4SDG directly supports and pursues projects to develop, distribute, and adopt methods to meet the Global Goals. The initiative also provides technical and other guidance for projects developed under other GEO activities, serving as a coordinator in a federated approach to GEO's overall efforts to achieve the SDGs. Highlighted below are examples of activities developed through SDG EO projects in 2021.

Guinea Land Cover Mapping Project

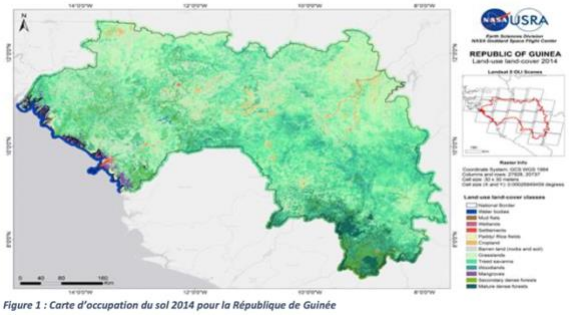


Figure 3. This land use change map shows forest loss in the Republic of Guinea from 2015 to 2020 and remaining forest land in 2020. Credit: Republic of Guinea's 2021 NDC report.

Launched in 2021 as a joint venture between the World Bank, the Universities Space Research Association (USRA), and NASA Goddard Space Flight Center, the project team has worked closely with the Government of the Republic of Guinea to develop a state-of-the-art remote sensing classification approach based on machine learning algorithms to derive a 30m resolution, 13-class land cover and forest cover maps for the year 2014—the first of its kind for Guinea. The forest classes in the land cover map follow Guinea's forest definition. Yearly forest extent losses for subsequent years were computed based on the 2014 forest/non-forest map, using a spectral index anomaly-based approach. In addition, the team leveraged Landsat imagery to develop annual (1996-2020) land cover and forest maps for the coastal zone of Guinea—including the coastal prefectures of Boffa, Boke, Conakry, Coyah, Dubreka, and Forecariah. The annual changes highlighted the downward trend in mangrove extent caused primarily by the conversion of forest into rice fields and the urbanization of the Conakry region.

The maps, based on United States Geological Survey (USGS)/NASA Landsat and NASA Global Ecosystem Dynamics Investigation (GEDI) data, inform Guinea's SDG 15.1.1 (Forest Area) and SDG 15.2.1 (Sustainable Forest Management) monitoring efforts. The government of Guinea used these maps to develop its National Determined Contributions (NDC), which will enhance Guinea's climate commitments to the UN Framework Convention on Climate Change (FCCC). This work was highlighted in the Twitter account of the head of the United Nations Framework Convention on Climate Change (UNFCCC) as well as in Guinea's NDC report. Guinea is using

the same maps to plan for 17 new national parks, including the the Moyen Bafing National Park, which was established in May 2021.

Applied Remote Sensing Training Program (ARSET) Webinar: Earth Observations Toolkit for Sustainable Cities and Human Settlements

This three-part, introductory webinar series included an overview of the Earth Observations Toolkit for Sustainable Cities and Human Settlements; demonstrations of toolkit resources (data products and tools) and how to apply them to measure and analyze SDG indicators; and an overview of three use cases from Colombia, Greece, and South Africa.

Development of this training was a collaborative effort involving NASA's Applied Remote Sensing Training Program (ARSET), UN Habitat, EO4SDG, the GEO Human Planet initiative, and the Committee on Earth Observation Satellites (CEOS) Working Group on Capacity Building & Data Democracy (WGCapD). Participating organizations included UN Habitat, Colombia's National Office of Statistics, South Africa's Space Agency, the National Observatory of Athens, Colombia's Center for International Earth Science Information Network, the European Commission's Joint Research Center and Costa Rica's Ministry of Environment.

Training Statistics
Participants: 1204 Organizations: 600 Countries: 102

Participant Highlights
"*Just finished the @NASAARSET's 3-part webinar on the #EOToolkit for Sustainable Cities and Human Settlements. Congratulations to the team! For this webinar, I hosted the Spanish sessions and presented on behalf of amazing colleagues from around the world. Wonderful experience*!"- Rafael Monge, Director at the Ministry of Environment and Energy, Costa Rica

"Will EO4SDG be able to provide any technical assistance and/or consulting on scoping a project for our city?" Representative from city of Orlando, Florida, USA

WorldWater Project: Surface Dynamics from Space

One of the main goals of the WorldWater project, funded by the European Space Agency (ESA), is to take advantage of the enhanced capabilities of the latest generation of open and free satellite data to advance the monitoring of surface water extent dynamics. In 2021, the project organized a round robin exercise to compare Earth observation algorithms for surface water detection using the latest generation of free and open satellite data from Sentinel-1, Sentinel-2, and Landsat 8.

Figure 4. The WorldWater pilot countries and test sites. https://worldwater.earth/pilot-countries/

In total, 15 organizations representing a mix of research institutions, private companies, government

agencies and non-governmental organizations participated in the WorldWater round robin. All participants were asked to produce monthly maps of surface water presence at 10-meter spatial resolution for two consecutive years over three mandatory sites located in Mexico, Colombia, and Zambia, and over two optional sites in Gabon and Greenland.

Initial results confirm that highly accurate surface water mapping can be achieved with optical and synthetic aperture data (SAR) data, and that optical data are better at capturing spatial detail, while SAR data provides better seasonal characterization. Currently, the full results of the Round Robin validation are being wrapped up and with the summary results and lessons learned being targeted for publication.

The round robin exercise is supported by a number of international organizations and initiatives including the Centre National d'Etudes Spatiales (CNES), the European Association of Remote Sensing Companies (EARSC), the CEOS Ad hoc team on Sustainable Development Goals (CEOS SDG-AHT) as well as EO4SDG.

Examples of Tools and Success Stories from 2021

Mangroves4SDGs

A team from the University of Maryland and NASA Goddard Space Flight Center launched the Mangroves4SGDs web portal to share results of their evaluation of primary global scale mangrove forest datasets. This information can be used to inform SDG targets and indicators and provide a pathway for global-scale mangrove accounting in the future. The site includes two Google Earth Engine applications—one that helps users select the mangrove dataset most applicable to their needs, and another that provides statistics from each dataset on a per country basis.

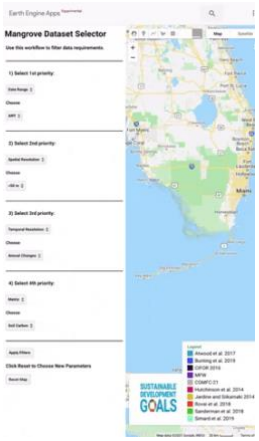


Figure 5. Mangrove Dataset Exploration App. https://www.mangroves4sdgs.com/explore-datasets

Maintaining Life on Earth Under Scenarios of Land Use and Climate Change in Colombia, Ecuador, and Peru (Life on Land Project)

This project team worked closely with leading scientific institutions and governmental ministries in Colombia, Ecuador, and Peru to help sustain forest ecosystems. The team used remote sensing and other spatial data to calculate comprehensive indicators, validated these indicators for national use, and made them available via a decision support system for policy development and reporting on SDG 15 (Life on Land).

Figure 6. Ecuador Landscape

In 2022, the team will incorporate all relevant datasets and indicators into an existing decision-support system based on UN

Biodiversity Lab, a geospatial information platform that maps and monitors natural resources and environmental risks in real time using the best available data and emerging digital technologies. Through the UN Biodiversity Lab, project data and indicators will be regularly updated through 2030 in response to requests from participating institutions in Colombia, Ecuador, and Peru.

For more information, access the related Storymap.

Learn more about additional featured projects and success stories by visiting the EO4SDG website.

Reflections on 2021

In 2021, EO4SDG partnered with a variety of organizations to assess progress towards SDG achievement at the national and local levels. The initiative specifically focused on enabling knowledge exchange on pressing topics such as urban resilience and SDG 11 (Sustainable Cities and Communities) and improving access to and use of EO data and tools to help stakeholders incorporate them into their applications. Towards this goal, EO4SDG engaged 19 new user organizations that contributed to the design, development, launch, and continuing evolution of the Earth Observations Toolkit for Sustainable Cities and Human Settlements. This effort also helped integrate different communities within GEO, including the GEO Programme Board Subgroup on Urban Resilience and teams working on GEO Work Programme activities such as the GEO Human Planet and Global Urban Observations and Information initiatives.

EO4SDG supported numerous community activities to enhance the use of Earth observations to achieve the SDGs, including international conferences and symposia that EO4SDG leadership and contributors attended and organized. The initiative improved its engagement with regional GEOs, including AmeriGEO and the Asia Oceania Group on Earth Observations (AOGEO). For example, EO4SDG collaborated with Mexico's National Institute of Statistics and Geography (INEGI) and AmeriGEO to organize events at regional conferences to share good practices from the Americas region and increase awareness about related efforts, such as the Regional Open Data Cube (see the report from a side event at the Twentieth Meeting of the Executive Committee of the Statistical Conference of the Americas of the Economic Commission for Latin America, available in English and Spanish). EO4SDG also contributed to the 13th AOGEO Symposium, co-hosting and participating in a session on partnerships between EO and statistical communities for SDGs (see session report). Additional collaboration efforts between EO4SDG and regional GEOs can substantially increase interactions between users and stakeholders in each region relating to the UN 2030 Agenda on Sustainable Development. Such efforts can extend good practices on EO for SDGs to regional GEO members and regional intergovernmental organizations and increase scaling of successful data products and decision support tools.

Our GEO SDG Awards program allowed us to recognize excellent and innovative use of EO to monitor and drive progress on SDGs. In 2021, EO4SDG recognized eight organizations and countries for their exemplary work through this awards program (see Appendix A). We

experienced, however, some challenges in broadening awareness about the program and increasing the total number of nominations compared to previous years. At year's end, we concluded that the program requires a strong communication and amplification plan to broaden the range and types of outreach platforms employed in 2022—both prior to and during the open call for nominations.

Finally, during this past year, we identified opportunities to expand the community of EO users that support SDGs to include private sector and commercial (for-profit) entities. We also observed a gap between GEO engagement with the commercial sector —such as via the Cloud Credits and License Programmes — and EO4SDG efforts to advance sustainable development in alignment with the UN 2030 Agenda on Sustainable Development. In the future, we will develop and pursue approaches to further engage with the private and commercial sectors and create use cases that illustrate specific applications and document the added value of public-private partnerships.

Looking Ahead

In 2022, EO4SDG will strengthen its connection with regional GEOs by assessing the existing and potential impact of regional-specific activities. Regional GEOs can play a key role in promoting exchange on best practices across GEO and upscaling or downscaling successful products, while also exploring funding opportunities at the regional level. This effort aligns with the findings of the GEO Midterm Evaluation, released in November 2021.

Building on the momentum from the GEO Week 2021 around the importance of the thematic integration of the GEO Work Programme, EO4SDG will collaborate with select GEO thematic initiatives to explore opportunities to apply each initiative's data, tools, and existing methods to one or more SDG targets or indicators that cut across multiple reporting frameworks. Examples of such frameworks include the Paris Climate Agreement, the Convention on Biological Diversity, the G20 Action Plan on Food Price Volatility and Markets, and the System of Environmental Economic Accounting (SEEA). We will document such synergies in a cohesive collection of short papers and policy briefs and share it with the GEO community.

EO4SDG will expand its engagement with the UN, multilateral organizations, as well as statistical agencies to support GEO's role of coordinating availability, access and use of Earth observations to support SDGs and other global policy agendas. Furthermore, EO4SDG will develop and share best practices with GEO members, partners, and the wider international community to illustrate the value of partnerships between public and non-private entities.

We will assess and document the impact and reach of the Earth Observations Toolkit for Sustainable Cities and Human Settlements, and share our findings with the GEO community to increase awareness and inform ongoing and future SDG toolkit development. We will also adopt substantive approaches to extend the toolkit to more cities and countries and related themes or indicators.

As described in the 'Toolkits for SDGs' pitch session from the GEO Symposium 2021, EO4SDG will collaborate with the Committee on Earth Observation Satellites (CEOS) and other organizations in the GEO community to explore implementation of the next SDG toolkit, as well as development of technical bridges between toolkits for integrated use (e.g., it may be useful to use the flood monitoring and urban toolkits together to address flooding in cities and disaster risk reduction (DRR) activities). The initiative will also support GEO in assessing the role of the Global Earth Observation System of Systems (GEOSS) and clarifying its connection to the GEO Knowledge Hub, the SDG toolkits, and other efforts related to data infrastructures and the sharing of data products, tools, user services and use cases.

With our partners, we will host and participate in multiple events in 2022 to provide the community with opportunities to learn about EO for SDGs. Planned events include sessions at the World Urban Forum, the Living Planet Symposium, the American Geophysical Union's Fall Meeting and the Pecora 22 conference.

Most importantly, EO4SDG will seek to increase diversity, equity, and inclusion in its membership and expand participation and leadership opportunities for EO4SDG members and contributors. To accomplish this objective, EO4SDG will establish a board that will provide corporate-level oversight and serve corporate interests of the initiative. In line with the GEO Statement on Equality, Diversity and Inclusion, EO4SDG will integrate geographic, gender balance and other diversity factors into its recruitment and selection processes.

We hope you will join us to help people around the world use Earth observations, models, and derived information to advance the United Nations SDGs and realize societal benefits for everyone on Earth.

Appendix A – GEO SDG Awards 2021

This Appendix includes a summary of the GEO SDG 2021 awarded projects.

GEO Member Country: Colombia

Colombia's National Administrative Department of Statistics (DANE) has been successful at showcasing the value of statistical and Earth observation data integration to produce Sustainable Development Goal (SDG) indicators for national monitoring and decision making. Earth observations are an essential source of information for the exploration and calculation of SDG 11-related targets (sustainable cities and communities) for Colombia. Between 2015-2020, DANE used Landsat and Sentinel-2 satellite images, as well as census data and population projections to calculate SDG indicator 11.3.1 (ratio of land consumption rate to population growth rate) for 63 Colombian cities. Based on this experience, Colombia then developed a methodology to calculate SDG indicator 11.7.1 in a sample of nine cities in 2021, which had a substantial component associated with the classification of satellite images.

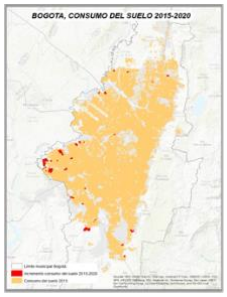


Figure 7. Using Earth Observation data to calculate the ratio of land consumption rate to the population growth rate (SDG 11.3.1) in Bogota, Colombia.

GEO Member Country: United Arab Emirates

SDG Data Hub represents a centralized platform to report SDGs progress, integrate with UN SDG Hub, and share best national practices from multiple sources.

Figure 8. UAE SDG Data Hub represents a centralized platform to report SDGs progress, integrate with UN SDG Hub, and share best national practices from multiple sources.

The United Arab Emirates' (UAE) Federal Competitiveness and Statistics Centre created the SDG Data Hub (the HUB), a centralized approach to sharing best practices and progress towards the SDGs in a geospatially-enabled manner. The HUB is a geospatial platform that tracks and reports progress towards SDG implementation to the UAE Cabinet as well as to the United Nations Department of Economic and Social Affairs through the integration with the UN Federated Information System for SDGs. On the backend, it leverages geospatial intelligence in indicators compilation. It integrates data and content from multiple sectors and entities into one webpage making it accessible and easy to visualize in an efficient manner while utilizing web-based GIS principles. It further serves as a tool to engage and build societal capacity towards SDG implementation with calls for actions to adopt sustainable living habits. In addition, the HUB establishes a two-way communication with users through online surveys to understand people's perceptions and preferences in order to better engage them. Select examples of how Earth observations/geospatial data can help advance the SDGs can be found in the HUB:

- UAE Urban Growth Through Night Lights and Satellite Imagery
- UAE National Red List for Mammals
- Rehabilitation of Coastal and Marine Habitat

Inter-governmental: UNDP Colombia, UNDP Ecuador, UNDP Peru

Colombia, Ecuador, and Peru are home to 17% of the world's last tropical forests with high ecological quality. These high integrity forests provide a suite of services including carbon sequestration, habitat for iconic vertebrate species, and water filtration that are essential for planetary health and human well-being. However, current monitoring and reporting for SDG 15 (Life on Land) focuses primarily on forest extent, not forest quality. Spatial data and indicators offer a powerful means to help nations prioritize action, monitor results, and hold actors across sectors accountable. This project brings together UNDP, NASA, Montana State University, University of Northern British Columbia, University of Northern Arizona, and University of Queensland with scientists and policymakers from 37 institutions in Colombia, Ecuador, and Peru to address this gap. It aims to better understand national needs related to SDG 15, develop and nationally validate data and indicators on forest integrity, human pressure, water risk, and vertebrate species using Earth observations to analyze trends over time; forecast changes to 2,100 under various land use and climate change scenarios to inform SDG 15 planning and implementation; and make data indicators available to the UN Biodiversity Lab decision support system. The data and indicators developed by the project can support monitoring for the quality of tropical forest ecosystems and the services they provide around the world. To learn more, visit the "SDG 15: Maintaining Life on Land" story maps (English) | (Spanish).

Figure 9. The 'last of the best' tropical forests provide invaluable services to humans — they sequester carbon support water provisions, and provide habitat for key species. How can we monitor the health of these essential ecosystems?

SDG Custodian Agency: Food and Agriculture Organization of the United Nations

FAO has developed a new Earth observation-based methodology to measure and monitor SDG 15.4.2, the Mountain Green Cover Index. The Food and Agriculture Organization of the United Nations (FAO) developed a new method to measure and monitor SDG indicator 15.4.2 (Mountain Green Cover Index, MGCI) leveraging free and open Earth observation data sets from land cover time series, ground truth land cover, and mountain elevation range. By integrating Earth observation data into the official methodology, the FAO achieved a series of important results including the standardization of input and methodology that has allowed for internationally comparable results. The use of validated input layers, in turn, has allowed for accuracy measures associated with the MGCI estimates, leading to increased transparency. The MGCI computation is based on a quantitative model of spectral and textural characteristics of satellite time series data. This ensures objectivity of the MGCI estimation, as opposed to the subjectivity of visual interpretation that was used for the previous reporting cycle. Countries that have national land cover maps and digital elevation models with higher accuracy compared to global products can use this as inputs into the new FAO methodology. The FAO has supported countries in the validation of the MGCI estimates

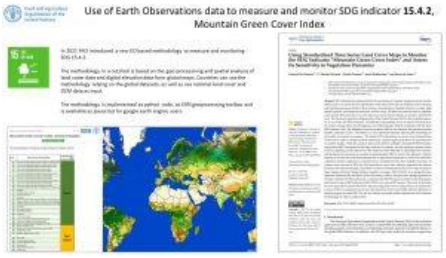


Figure 10. FAO has developed a new Earth observation-based methodology to measure and monitor SDG 15.4.2, the Mountain Green Cover Index.

for 2021 by sharing their estimates with countries and asking to validate them using a WebGIS App, which facilitates the assessment of green vegetation cover in mountain areas.

Academia: Stanford University

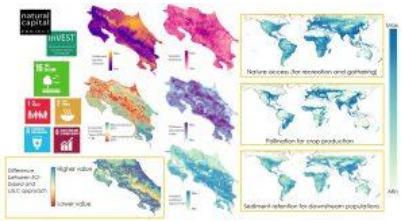


Figure 11. Mapping biodiversity and ecosystem services at national and global scales: using Earth Observation-based indicators of ecosystem productivity or condition (SDG 15) instead of categorical land-use/land-cover produces different (and more accurate) spatial patterns of biodiversity and ecosystem services (contributing to SDGs 1, 2, 6, and 8).

Mapping biodiversity and ecosystem services at national and global scales: using Earth Observation-based indicators of ecosystem productivity or condition (SDG 15) instead of categorical land-use/land-cover produces different (and more accurate) spatial patterns of biodiversity and ecosystem services (contributing to SDGs 1, 2, 6, and 8). Nature supports us in myriad ways, many of them invisible. Society makes decisions on a daily basis that impact nature, and if those decisions are made without accounting for the values of nature to people, we risk losing many of those values. Stanford University's work with Costa Rica's Ministry of Environment, Energy and Telecommunications (MINAE), Central Bank and PRIAS Lab has aimed to make information about the values of nature more accessible, relevant, and accurate by advancing the integration of Earth observations into biodiversity and ecosystem service modeling. The project has produced national maps of 30+ data products hosted on MINAE's SINIA data portal, including vertebrate and pollinator diversity as well as ecosystem functional diversity (SDG 15), which drive ecosystem services like wildlife-based tourism, crop pollination, and sediment retention (contributing to SDGs 1, 2, 6, and 8). These advances are being integrated into their free and open-source software, InVEST, and helping improve their global modeling, making these approaches more accessible to anyone anywhere in the world.

Figure 12. Lead farmer in the field supports a Burundian farmer (image credit: Auxfin Burundi).

Innovation: The Netherlands Space Office

Lead farmer in the field supports a Burundian farmer (image credit: Auxfin Burundi, Geodata for Agriculture and Water, Good Agricultural Practices for All project). The Netherlands Space Office's work on the Geodata for Agriculture and Water (G4AW) programme supports private investments for large-scale, demand-driven, and satellite-based information services targeted at vulnerable actors in food production. The agency has facilitated 25 public-private partnerships in 15 developing countries. Innovative solutions based on Earth observations provide actionable advice and financial services to smallholder farmers and (agro)-pastoralists. Organizations with different backgrounds work together to achieve SDG 2 (Zero Hunger). NGOs and extension officers play an essential role in engaging with food producers for gathering their information needs, building trust, and providing training. Entrepreneurs focus on customer satisfaction, affordability, business planning, and service provision. Examples of services include: weather information and forecasts, good agricultural practices, crop calendars, crop management (crop monitoring, pest- and disease warning, and nutrient advice), insurance, inclusive finance, and navigation services for (agro)-pastoralists. Geodata-based services are often bundled with market information, health information (ref. COVID-19), and training videos. Insights and lessons

learned are shared via the agency's website to inform and inspire other stakeholders to take action and invest.

Testimonial/Story: Water@Reading Research Group, University of Reading

Figure 13. The Bangladesh Red Crescent Society supports communities to act early before flooding in July 2020, based on flood forecast information (image credit: Bangladesh Red Crescent Society).

The Bangladesh Red Crescent Society supports communities to act early before flooding in July 2020, based on flood forecast information (image credit: Bangladesh Red Crescent Society). The Water@Reading research group uses state-of-the-art, global-scale forecasting models for humanitarian organizations to take early action ahead of flood events, in alignment with SDG target 13.1 that aims to strengthen resilience and adaptive capacity to climate-related hazards and disasters. The group nurtures partnerships between national hydrometeorological services (NHMS), humanitarian organizations, and global forecasting centres like the European Centre for Medium-Range Weather Forecasts. This enables the NHMS to inform the scientific development of global flood forecasting systems, and supports these state-of-the-art systems to reach their full potential as sustainable solutions embedded in national forecasting capacity. Through anticipatory humanitarian approaches developed in partnership with organizations like the Red Cross Red Crescent Climate Centre, these forecasts can support decisions which benefit the people most vulnerable to climate-related hazards before they strike. As an example of how Earth observations had an impact on the Government of Bangladesh, PhD researcher Sazzad Hossain joined the group from the Flood Forecasting and Warning Centre (FFWC) in Bangladesh. His research addresses how the Copernicus Emergency Management Service's Global Flood Awareness System (GloFAS) can be used to inform FFWC and humanitarian operations to support communities in Bangladesh before an imminent flood. In 2020, over $5 million of humanitarian aid reached 200,000 people in advance of the highest water level ever recorded, based on the combined GloFAS and the FFWC forecast trigger.

Collaboration: UN-Habitat, NASA, ITC, University of Twente, UAE Federal Competitiveness and Statistics Centre

Figure 14. The EO Toolkit is an online knowledge hub promoting open science, open data, and open tools. It incorporates local participation and enables the use of Earth observations to advance Sustainable Development Goal 11 and the New Urban Agenda.

The Earth Observations Toolkit for Sustainable Cities and Human Settlements is an online resource that can assist countries and cities interested in applying Earth observations to advance their SDG 11 monitoring needs. Launched in February 2020, the Toolkit allows users to access ready-to-use data and develop indicators by combining data and tools found in the Toolkit with local data and knowledge. In addition, there is technical documentation and an array of use cases that can help support cities and countries with the implementation of SDG 11. Users can also contact Earth observation experts around the world if they want more one-on-one advice. The success achieved to date can be attributed to diverse partnerships, consistent communication, openness and transparency, continuous innovation, and clear added value of the

resources available through the Toolkit. To enhance the replicability and usefulness for future Earth observation SDG Toolkits, four elements are essential: (1) a good understanding of the diverse data needs of users (especially non-Earth observation experts); (2) capacity development; (3) data review and documentation based on FAIR data principles; (4) purposeful and impactful data. Also needed is a clear implementation path and a strategy for partner and stakeholder coordination. For an overview of the Toolkit, please see the EO Toolkit for Sustainable Cities and Human Settlements story map.

"Inspiring Hope for Youth" Special Mention: Viola Mascarucci, International School of Milan

The International Baccalaureate Primary Years Programme Exhibition encourages students to learn to appreciate knowledge, conceptual understandings, skills and personal attributes as a connected whole. It culminates in an Exhibition, which takes place in year six where primary school students explore, document and share their understanding of an issue or opportunity of personal significance. For Viola Mascarucci's (age 11, grade 7) Primary Years Programme Exhibition, she chose to explore how space innovation can help achieve several of the SDGs, highlighting in particular how Earth observations can benefit SDG #2 (Zero Hunger) and SDG #8 (Decent Work and Economic Growth). Viola researched the theme of how the future of innovation affects technology and how this connects to our everyday life and humanity. Her main lines of inquiry were: 1) space and SDGs, and; 2) satellites in everyday life. In addition, she conducted a number of interviews with highly-qualified female scientists and engineers working at the National Aeronautics and Space Administration and at the European Space Agency to learn about Earth observations applications, SDGs goals and targets, and how space agencies use space data to help achieve the UN 2030 Agenda on Sustainable Development. What was the most interesting thing Viola learned during her research? Watch her talk about it in this video.

Figure 15. How space technology, observations and innovation contribute to the Sustainable Development Goals.