2022 Annual Summary of the EO4SDG Initiative

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1.0 THE EARTH OBSERVATIONS FOR SUSTAINABLE DEVELOPMENT GOALS INITIATIVE

The 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, non-profits and entrepreneurial firms who work to accelerate the use of Earth science information in support of the Sustainable Development Goals (SDGs). EO4SDG is organizing its efforts using a combined top-down and bottom-up approach. 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, or facilitate the definition of new SDG indicators/sub-indicators that can more effectively inform related goals and targets. The bottom-up approach involves applied research, feasibility testing, development, and operationalization of methods in partnership with countries, with the objective to enable the uptake of EO solutions into national SDG monitoring frameworks, and eventually development policies. Additional efforts involve improving the provision, access, discoverability, and applicability of Earth observations and derived knowledge with the SDGs through trusted portals across communities; engaging countries in capacity building and co-learning efforts (e.g., webinars, toolkits); and increasing awareness of the effective uses of Earth observations to achieve benefits and positive impacts, thereby encouraging nations and stakeholders to pursue uses themselves (e.g., awards, scientific workshops, special issues).

The initiative promotes, partners with and leads projects, communities and programmes that support the EO4SDG mission. EO4SDG has a dedicated website (https://eo4sdg.org) and social media (Twitter, Facebook) accounts to convey achievements and quality stories about roles of Earth observations and GEO to serve development goals.

The below sections highlight key accomplishments carried about by the EO4SDG team of GEO Member Countries, Participating Organizations, and additional contributors in 2022.

2.0 OVERVIEW OF 2022

2.1 EO4SDG BOARD

In 2022, EO4SDG formed its inaugural Board, initiating a call for nominations and following a review and evaluation process to select ten inaugural EO4SDG Board Members.

The EO4SDG Board provides support to the EO4SDG initiative spanning strategic direction-setting to tactical aspects. Board members and the Board lead serve a two-year term with a maximum of two terms. Duties of Board Members include:

1. Strategic Planning: Provide recommendations on strategic direction to EO4SDG leadership and oversight of initiative activities. This includes contributing to the development of, and regularly reviewing and monitoring, EO4SDG's long-term goals and strategic planning process.

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

2. Active Participation: Actively support one or more major initiative activities per year or serve on at least one EO4SDG standing body or ad hoc group. Motivate involvement by initiative members in activities.

3. Community Reach: Raise visibility and connections to relevant activities of each member's community, with a focus on providing ties to Earth observation user communities.

4. GEO Work Programme (GWP) Integration: Serve as ambassador to a GWP activity to increase SDG-related knowledge sharing and create opportunities for integration across GEO, with support from the GEO Secretariat SDG Coordinator.

5. Reporting: Contribute to Board reporting to the Initiative, including EO4SDG's annual report.

6. Meetings: Attend EO4SDG annual meetings and Board quarterly meetings, with one meeting in conjunction with the EO4SDG annual meeting.

Additional information is available in the Terms of Reference.

The Board is composed of the following members:

- **Lisho C. Mundia**, Ministry of High Education, Technology and Innovation, Government of the Republic of Namibia
- **Marwa Farouk ElKabbany**, Federal Competitiveness and Statistics Centre (FCSC), Ministry of Cabinet Affairs, United Arab Emirates
- **Sandra Liliana Moreno**, National Administrative Department of Statistics of Colombia (DANE)
- **Rafael Monge**, Ministry of Environment and Energy, National Center for Geo-environmental Information, Costa Rica
- **Amadou Moctar Dieye**, Centre de Suivi Ecologique, Senegal
- **Lorenzo de Simone**, United Nations Food and Agriculture Organization (FAO)
- **Anusuya Datta**, Geospatial World
- **Maryam Rabiee**, United Nations Sustainable Development Solutions Network
- **Monika Kuffer**, ITC University of Twente
- **Philip Thigo**, Senior Advisor, Data, Innovation & Open Government. The Presidency, Government of Kenya

Lorenzo de Simone, United Nations Food and Agriculture Organization (FAO), is the current Board Chair.

2.2 STRATEGIC IMPLEMENTATION PLAN 2023-2025

EO4SDG updated its strategic implementation plan for the 2023-2025 time period.

Key items for consideration and EO4SDG priorities for the 2023-2025 period include:

a) The recognition of the need for a stocktake to evaluate where we are, mid-way to 2030, regarding the use of EO to track, monitor, report, and drive progress on the SDGs.

  ⇒ Towards this end, EO4SDG is planning to conduct a mapping survey, in collaboration with the FAO, to identify and map how GEO Members are using – or planning to use – EO data for the SDGs, mid-way to 2030. Survey results will help gain insights on the current use of EO for SDG analysis and reporting, and to define areas where EO4SDG and GEO, in coordination with UN custodian agencies like FAO, should reinforce these efforts. Responses will also enable the documentation, and promotion, of case studies and best practice examples, updating a 2018-2019 EO4SDG survey led by Japan (JAXA), EO4SDG Co-chair.

b) EO4SDG's role during the post-2025 GEO Work Programme (WP), which will emphasize objectives of integration and collaboration, open knowledge, operationalization, and user

orientation, as defined by the GEO Plenary-17. Collaboration with other GEO Work Programme activities to effectively support numerous SDG targets, while avoiding duplication of efforts, has always been at the core of the EO4SDG mandate. In addition, EO4SDG recognizes that EO support the understanding of the interactions among different SDGs, which can help countries maximize synergies to achieve multiple SDGs and resolve existing trade-offs. Looking at SDG interactions, while integrating knowledge from different GEO WP activities to support multiple SDGs, will be a challenge that EO4SDG will handle in close collaboration with other GEO activities to be post-2025 ready, and to participate in the GEO strategic direction towards delivering more and broader impact.

⇒ Towards this end, EO4SDG is planning to conduct a mapping survey in 2023 to gather information about GEO WP activities, with the scope of mapping their relationships, direct and indirect, with SDG work to help identify and enable cross-programme collaboration for delivering accelerated impact and avoid duplication of efforts and resources. This survey may also be used to develop recommendations on collaboration in nexus areas and to improve communication, as well as mapping of GEO's portfolio, in future GWP cycles.

⇒ EO4SDG is planning to participate in the post-2025 incubators, including the Climate – Urban - Health and Nature-Based Solutions ones. We also plan to explore opportunities for engaging with the Ocean – Pollution incubator. A potential activity in 2023 includes the organization of an EO4SDG workshop to discuss EO4SDG's role and engagement with the post-2025 GEO Strategy.

⇒ EO4SDG plans to continue to promote data and knowledge sharing and integrations for SDGs by offering "Toolkit bridge solutions." This includes continuing to expand the impact of the Earth Observations Toolkit for Sustainable Cities and Human Settlements and collaborating across GEO to initiate new solutions in support of nexus areas (e.g., ocean – pollution – climate).

2.3 EO4SDG At GEO Week 2022

The GEO Week 2022 focused on "global action for local impact," illustrating how GEO can deliver actionable information to users and stakeholders. The GEO Plenary elaborated on the future direction of GEO that is being developed in time for the 2023 GEO Ministerial and the next phase of GEO post-2025. The GEO Plenary also approved the GEO Work Programme 2023-2025 with a total of 48 activities, including five flagships, nineteen initiatives, twenty pilot initiatives, and 4 regional GEOs.

2.3.1 EO4SDG Side Event

EO4SDG held a side event on "The Impact of Earth Observations for the 2030 Agenda". The event highlighted progress to date including efforts to make the global community aware of effective ways to use Earth observations (EO) relative to the SDGs; improve skills and capabilities of countries and stakeholders to employ smart practices and solutions that use EO in SDG planning, tracking, and reporting; highlight real, value-added benefits of EO to fill data gaps and support positive social, economic, and environmental impacts; and share demonstrated progress against the SDGs to prompt broad desire for more practical EO solutions.

The event also illustrated opportunities to power progress towards the SDGs and build integrated solutions that are driving progress towards 2030. Such opportunities included scaling up existing EO applications to measure and make progress on SDGs and identified new areas where EO can help countries make progress and meet relevant development targets.

Examples of such opportunities included:
- Developing the capacity of countries to produce national land cover maps accurately and to update them regularly. The United Nations (UN) Food and Agriculture Organization (FAO) highlighted that SDG monitoring activities and policies related to reaching many SDG targets with a geospatial component often require a land cover or land use geospatial layer.
- Promoting better integration of statistics and geospatial data, e.g., use of Earth observation (EO) data for agricultural census design and use of best practices in georeferencing.
- Stregthening communications, advocacy and resources on translation and curation of EO-enabled solutions by bringing the ecosystem of development practitioners, government, local and scientific communities, and funding partners together to promote increased knowledge support, partnerships exploration, and extensive capacity building.
- Promoting data integration for multiple SDG targets/ indicators and exploring links to GEO's post-2025 incubators, e.g., the nature-based solutions and urban-heat-climate incubators. EO4SDG can play a role in building synergies among existing GEO initiatives to achieve wider outreach and deliver maximum impact.
- SDG 15, life on land, is by far the least invested SDG as it can be difficult to demonstrate the return on investment in the land sector. Land resources are the basis for fierce competition among the demands being made by different sectors, each of which is represented by one or more SDGs (Barron Ott, Chief Scientist, UN Convention to Combat Desertification (UNCCD)). An opportunity exists to develop a roadmap where the inevitable tradeoffs represented by SDG ambitions might be navigated with the support of EO.
- Improving the user-responsiveness of indicator development
  - Connecting more with potential users and stakeholders, defining their profiles, status, data capacities and needs.
  - Conducting user needs assessments to better understand how the proposed indicators may help our stakeholders in their decision-making processes and to understand what additional indicators, or modifications of existing indicators, may be useful for users.
  - Mapping SDG targets/ indicators with national or local -level level actions.

2.3.2   EO4SDG Board Meeting

The EO4SDG Board met during the GEO Week 2022 (in person and virtually) and shared impressions of GEO Week conversations of relevance to the EO4SDG Initiative. The Board also brainstormed on next steps for Board actions including a 2023 survey, which aims to map the relationship between EO4SDG and relevant GEO Work Programme activities and to identify and describe how these initiatives contribute to the SDGs, to the production of relevant geospatial layers, ongoing collaborations at country level, and how they can benefit from the work of EO4SDG.

Board recommendations and actions included:
- The GEO Land Degradation Neutrality flagship has a lot of synergies with EO4SDG.
- EO4SDG could/should be the main convener of all SDG-related activities across GEO – there are many SDG-related activities going on
- GEO WP Mapping Survey: Board members agreed with the approach of conducting a survey of GEO WP activities, with a timeline of finalizing the survey by the end of 2022 and distributing it in early 2023 in coordination with the GEO Secretariat.

3.0   2022 GEO SDG Awards
This year, we recognized six organizations and countries for their exemplary work in five Sectoral and one Special Categories.

SECTORAL CATEGORY AWARDS
1. **GEO Member Country:** Reforestamos México
2. **GEO Participating Organization:** United Nations Satellite Centre (UNOSAT) and United Nations Institute for Training and Research (UNITAR)
3. **GEO Work Programme Activity:** Digital Earth Africa
4. **Academia:** KTH Royal Institute of Technology
5. **Commercial Sector:** EOS Data Analytics

SPECIAL CATEGORY AWARDS
6. **Collaboration:** Costa Rica Ministry of Environment and Energy and the United Nations Development Program (UNDP)

Figure 1. 2022 GEO SDG Awards Announcement Ceremony, Accra, Ghana

Appendix A presents a summary of the awarded projects.

3.1 METRICS, FINDINGS AND RECOMMENDATIONS

In 2022, EO4SDG received 20 nominations in eight out of the nine award categories: Custodian Agency (1); Civil Society (1); GEO Member Country (3); GEO Participating Organizations (2); GEO Work Programme Activity (4); Academic Institution (4); Inter-governmental (1); and, Commercial (4).

The call for nominations was open from May 15, 2022 – July 1, 2022, with an extension through July 15, 2022. The EO4SDG team, in coordination with the GEO Secretaritat, conducted a promotional campaign to help generate enthusiasm and interest ahead of the May 15 opening call for nominations. New for 2022, we conducted a "Tour of Winners" promotional campaign on Twitter to highlight past winning organizations, their methodologies, and accomplishments. We received positive engagement from past winners and other individuals and organizations that follow the EO4SDG accounts.

Social media posts, graphics, and promotional videos were updated prior to the open call for nominations and shared with the GEO Secretariat, which helped promote the 2022 awards program. New for 2022, EO4SDG hosted two live promotional webinars prior to the nomination deadline, called "GEO SDG Awards 101." The webinars provided an overview of the EO4SDG initiative, the GEO SDG Awards program, the application process, and featured a Q&A session with past winners and evaluation panelists.

Based on the 2022 experience, we have garnered the following lessons learned and recommendations for future award cycles:

Individual organization outreach was fruitful. Encouraging specific organizations 1:1 via personal email to nominate a project for the awards resulted in approximately six additional nominations. However, individual outreach was done only a few weeks before the closing of the nomination window.
> ⇒ **Recommendation:** Maintain a list of organizations and projects that leverage EO for SDGs throughout the year, and conduct individual outreach well in advance of the nomination deadline.

EO4SDG hosted two webinars to provide information on the awards program and process. While the promotion of these webinars was robust, attendance was limited, and the process required a significant amount of time to develop and organize.
> ⇒ **Recommendation:** Recycle the 2022 webinar recordings instead of developing a 2023 live webinar series.

Suggested edits to the nomination form in the 2021 Awards Lessons Learned worked well. We refined questions to make them more specific, or changed fields from "optional" to "required", which resulted in more thorough nominations.
> ⇒ **Recommendation:** Maintain nomination form questions from 2022.

Promotion of awards and generating interest was challenging. While we heavily advertised the program on social media and via our networks, we received a total of 20 nominations in 2022, in comparison to 24 nominations in 2021.
> ⇒ **Recommendation:** Identify an organization to co-promote or sponsor the awards. Consider providing in-kind resources such as training or expenses paid to GEO Week for winners, as an additional incentive to generate interest.

3.2 EVALUATIONS

Each year, the EO4SDG Initiative Team, in consultation with the GEO Secretariat, identifies a diverse set of representatives to serve on the Evaluation Panel including subject matter experts, SDG specialists, Earth observation and geospatial experts. The Evaluation Panel reviews the nominations and selects Finalists for each of the Sectoral Categories and Finalists for each of the Special Categories. Subsequently, the Evaluation Panel selects 0-2 Finalists from each Sectoral category and 0-3 from each Special Category to receive an award. In 2022, seven panelists supported the awards review and evaluation process.

Key findings and recommendations:

Suggested edits to the evaluation form in the 2021 Awards Lessons Learned worked well. We refined questions and criteria to make them more specific, which resulted in a more consistent evaluation process across panelists.

⇒ **Recommendation:** Maintain evaluation form questions from 2022.

The compliance process for applications could be more robust. During the compliance phase of the evaluation cycle, the nomination for "Reforestamos Mexico" submitted under the Member Country sectoral category should have been identified as better suited for the "Civil Society" sectoral category. We recognized this issue late in the process and an exception was made to award the organization for Member Country.

⇒ **Recommendation:** Develop specific criteria for each sectoral and special category to help facilitate a more robust compliance check for all nominations.

Confirming and scheduling panelists was challenging. Panelists from the 2021 Awards Programme were invited to serve as panelists for 2022; some accepted but others declined. Some panelists accepted but then backed out during the evaluation process due to time conflicts. Additionally, the evaluation cycle coincided with the summer break for many individuals and it was challenging to complete the evaluations between work and annual leave. During the review panel meetings, some panelists found it difficult to recall the specifics of the nominations due to the elapsed time between evaluation and selection; a more compressed timeline could help alleviate this challenge.

⇒ **Recommendation:** Identify and confirm panelist participation early in the nomination cycle. Send out calendar holds for general evaluation time (individual assessments) and the evaluation kickoff and review panel meetings well in advance so individuals can plan around the events. Avoid scheduling evaluation panels in the month of August and conduct evaluations by the end of July.

Data compilation from the nominations was time consuming. Aggregating all of the nomination data from 20 nominations into a spreadsheet was very time consuming and prone to mistakes. Similarly, the evaluation spreadsheet was time consuming to create.

⇒ **Recommendation:** Consider using automated forms for the nomination that automatically aggregate data into a central spreadsheet. AdobePro has this capability, for example. Using Google Forms for both the nomination and scoring and evaluation could also be considered.

Award selections were made too close to the GEO Week, which could have created some difficulty in securing funding in time to attend the award ceremony.

⇒ **Recommendation:** Explore the option for the GEO Secretariat to "hold" funding for some "at need" organizations that might be selected as winners for the GEO SDG Awards program.

3.3 GEO SDG Awards Ceremony: Findings and recommendations

The 2022 GEO Week and accompanying awards ceremony was the first in-person gathering of the GEO community since 2019 and was held in Accra, Ghana, the first time the event had been held in the country.

Trophy coordination. The U.S. (NASA) provided the artwork/design schematics for the award trophies from the 2021 awards cycle and the GEO Secretariat identified a local vendor in Ghana to develop the trophies.

⇒ **Recommendation:** It will be helpful if during future cycles, the GEO Secretariat team engages the EO4SDG team much earlier in the event planning process to help identify funding and coordination regarding the production and dissemination of the award trophies early in the process.

Award ceremony coordination. The GEO Secretariat and EO4SDG teams coordinated to plan the run-of-show for the awards. One of the challenges we encountered was the difficulty for awardees that were attending the event virtually to join the award ceremony. The Zoom links for virtual attendance to provide winners not physically present at the ceremony were difficult to track down and shared with winners very close to the time of the award ceremony.

⇒ **Recommendation:** It will be helpful if the GEO Secretariat team engages the EO4SDG team much earlier in the event planning process, and holds regular tagups with the planning team in the months prior to the event. A run-of-show should be developed early on, and populated by the GEO Secretariat and EO4SDG teams, in parallel, as more details become available. It is also recommended that for GEO SDG awardees not able to attend in person, the opportunity to have them record a video to be played at the ceremony in lieu of a trophy presentation is considered.

Post-Awards promotion. The EO4SDG promotion plan provided robust digital winner toolkits (new for 2022), which included a sample press release, social media guidelines, digital badges, and other graphics to help promote their award. EO4SDG also developed a formal blog post, which was shared via the GEO and EO4SDG webpages. The GEO Secretariat team also developed a summary video featuring award winners; this promotional video, however, did not include award winners that were not able to attend the GEO Week and Award ceremony in person.

⇒ **Recommendation:** It will be helpful if the GEO Secretariat team engages the EO4SDG team much earlier in the event planning process, and holds regular tagups with the planning team in the months prior to the event, to allow for EO4SDG input to the awards' promotion plan. Award-related promotional activities in the future could involve a detailed interview, inn article or video form, with each winner.

4.0 Select EO4SDG Highlights

4.1 EO Toolkit Training at World Urban Forum

This training illustrated how example datasets within the Earth Observations Toolkit for Sustainable Cities and Human Settlements (https://eotoolkit.unhabitat.org) can be applied to inform local efforts to increase equity in access to open/ green urban spaces and also combining urban extent data with the analysis of exposure and hazards, e.g., earthquakes, floods, and storms. In addition, hands-on training activities focused on the utility of built-up densities as a proxy indicator for informal settlements/ deprivation. The discussion also included the ethical challenges of producing maps on vulnerable population groups and the appropriate aggregation level to protect vulnerable population groups (minimizing stigmatization). Another mapping activity focused on leveraging a Google Earth Engine application for SDG 11.3.1, land use efficiency, to automatically define city extent and calculate land use efficiency. Discussions focused on the challenges of defining the extent of cities in a consistent way and linking the city extent with open data (EO-derived urban data and population data collected in the EO Toolkit) that allow measuring land-use efficiency and its secondary indicators for any city around the world. Lastly, the training also covered how cloud-based data can be used to assess the air quality of any city and region (SDG indicator 11.6.2). The discussion addressed patterns of air quality across central Europe – showing high nitrogen dioxide pollution levels, derived by Senitnel-5P, in the Katowice region as well as very urbanized agglomerations in Germany and in the Netherlands. Moreover, the training also addressed the phenomenon of urban heat island over Warsaw, as an example of a location where a river implies a cooling effect on the surrounding areas. Finally, technical issues related to use of cloud-based platforms for Earth science data and analysis, like Google Earth Engine, were addressed.

Figure 4. EO Toolkit Training, World Urban Forum, June 29, 2022

Training Statistics
- Approximate number of attendees: 40
- Number of female attendees: 16
- Number of male attendees: 24

Figure 5. Members of the training team, including EO4SDG Board and Team members Monika Kuffer (ITC), Yifang Ban (KTH Sweden), Nale Mudau (SANSA) as well as Dennis Mwaniki (UN Habitat), Thomas Kemper (JRC and GEO Human Planet Initiative) and Michele Melcchiori (JRC and GEO Human Planet Initiative), June 29, 2022

4.2 AGU PUBLISHES BOOK ON EARTH SCIENCE APPLICATIONS LED BY EO4SDG

The book titled "Earth Observation Applications and Global Policy Frameworks" is the result of collaborations between EO4SDG and many other GEO WP activities, as well as partners and users from different sectors and Earth science disciplines, all coming together to share knowledge on how Earth science addresses critical global challenges including sustainable development, disaster risk reduction, and climate change. The book shares case studies from local, national, regional, and

international initiatives that showcase how insights from Earth observations help serve society. Examples include use case scenarios of Earth observation-based water quality monitoring applications that facilitate reporting of related development indicators; case studies on climate and disaster risk reduction in growing urban settings, where the applications of Earth observations enable the development of risk-informed systems; and technology solutions, such as the Open Data Cube, that offer a strong potential to streamline data distribution and management for providers while lowering the technical barriers for end-users.

It also presents work from multiple Group on Earth Observations (GEO) initiatives that are fostering user communities to identify needs and gaps, and co-develop Earth observation-based products needed by users including the GEO Global Agricultural Monitoring Initiative (GEOGLAM), GEO Blue Planet, Earth Observations for Sustainable Development Goals (EO4SDG), Global Observation System for Mercury (GEO4S[4]M), and GEO Data Access for Risk Management (DARMA).

Read about it in this AGU EOS article and listen to a related TerraWatch Space Podcast.

4.3   EO TOOLKIT RESOURCES NOW AVAILABLE IN GEO KNOWLEDGE HUB

New resources including data sets, tools, case studies, and methodologies in support of SDG 11, Sustainable Cities and Human Settlements, are now available in the GEO Knowledge Hub (GKH). The GKH is a central cloud-based digital library providing access to Earth Observations applications developed by the GEO Work Programme Activities.

Teams from both the GKH and the Earth Observations Toolkit for Sustainable Cities and Human Settlements (EO Toolkit) worked together to cross-walk EO Toolkit resources and tag applications and files to sort them into Knowledge Resources (individual resources) or Knowledge Packages (individual resources in support of an overall theme). All knowledge resources of a registered EO application are openly shared, curated and organized into a knowledge package, including research papers and reports describing methods and results; software algorithms and cloud computing resources used for processing; in situ and satellite imagery data used and results for verification. The intent of the GKH is to promote the replicability and re-usability of EO applications by sharing them with end users, but to also provide all of the context and associated knowledge resources, including user guides, essential to fully understand and re-use them.

Users can perform thematic searches e.g., "Human Settlements" or "Sustainable Cities", as well community-based searches by GEO Work Programme activity e.g. EO4SDG. It is also possible to search EO applications linked to the GEO engagement priorities, e.g., SDGs, Paris, Sendai or other international frameworks such as the Minamata Convention.

The newly listed resources also allow GKH users to interact directly with the Knowledge provider, using the dedicated Question and Answers section to pose specific questions and receive dedicated guidance and support in the process of re-using the EO Application.

4.4 2022 EO TOOLKIT STRATEGY MEETING

In November 2022, 26 members of the Steering Committee for the Earth Observations (EO) Toolkit for Sustainable Cities and Human Settlements met to assess the current state of the toolkit and identify potential future focus areas. EO4SDG launched the EO Toolkit in partnership with the UN Human Settlements Program (UN Habitat) and the Group on Earth Observation in February 2021. Facilitated by the EO4SDG Executive Director, the Steering Committee used a virtual whiteboard, Miro, to assess progress to date, successful strategies and accomplishments, challenges, and potential opportunities.

The Steering Committee endorsed the continued relevance, importance, and success of the EO Toolkit to date. The group noted the success of the EO Toolkit community itself, which has brought together a diverse set of experts across geographies and focus areas related to SDG 11 that can discuss ongoing challenges and opportunities related to sustainable cities and human settlements. The Committee also applauded the successful engagement with a number of cities and the resulting uses cases which have provided a tangible and clear way of communicating the benefit of Earth Observations (EO) to potential users. One Committee member noted that the use cases allow for a pragmatic connection with planners and decision makers in other cities that are considering the use of EO and geospatial information in decision-making. The Committee also discussed some past and ongoing challenges, particularly around resources. As a mostly all-volunteer effort, the EO Toolkit community expressed challenges related to limited time and bandwidth with other competing priorities. A summary of short- and medium-term recommendations has been developed to inform the 2023 work plans of the four working groups of the EO Toolkit Steering Committee. Inputs generated from the Miro board during the strategy exercise can be found in Appendix B.

4.5 INTERNATIONAL COMMUNITY LEADERSHIP

EO4DSG members represented the program at many conferences and events, building briges and creating channels of collaboration with potential partners and stakeholders. The EO4SDG team hosted sessions and events that allowed project teams and EO4SDG members to showcase their work and publicize their findings, such as the American Geophysical Union's Fall meeting, Google's "GEO for Good" Annual Event, the UN DESA Regional Symposium, "Effective Governance and Digital Transformation for Accelerating the Implementation of the 2030 Agenda for Sustainable Development and Addressing Global Challenges", the GEO Week 2022, and the NOAA/WMO RA IV Satellite Applications Virtual Workshop, among others.

4.6 PROJECT HIGHLIGHT

Title: Extreme Heat, Air Pollution, Human Health, Vulnerability, and Cooling Infrastructure
Principal Investigator: Chris Uejio, Florida State University.
Co-Investigator: Leiqiu Hu, University of Alabama at Huntsville
Partners: Michael Hess, Brittany Sellers, City of Orlando
Relevant SDGs:
⇒ **SDG 3.9**, reduce the number of deaths from air pollutio

⇒ **SDG 11.5**, reduce the adverse effects of natural disasters

⇒ **SDG 11.6.2**, annual mean levels of PM2.5 in U.S. cities weighted by population

⇒ **SDG 11.7.1**, provide universal access to green and public spaces

⇒ **SDG 13.1**, strengthen resilience and adaptive capacity to climate related hazards

⇒ **SDG 13.3**, improve education on adaptation, impact reduction and early warning

Background on Engagement with City of Orlando

Following the web training, Earth Observations Toolkit on Sustainable Cities and Human Settlements, on January 27-February 10, 2022, representatives from Orlando's Office of Resilience and Sustainability reached out to EO4SDG and NASA colleagues to explore opportunities for applying the Toolkit's products to support their local Sustainable Development Goal (SDG) efforts and other initiatives relating to climate change and resilience. Through visioning sessions between City of Orlando officials and NASA-funded PI, Chris Uejio, two primary thematic areas emerged where Earth observations could enhance Orlando's sustainability and resilience efforts: urban heat and air pollution.

Highlights

In 2022, the project team has held several listening and working sessions with the City of Orlando to understand the city's decisions and challenges relating to extreme heat, air pollution, and flooding. Based on these sessions, the project team has identified two primary objectives:

● Objective #1: Evaluate the health benefits of green/cooling infrastructure installation by blending multi-source public satellite and ground-based observations to characterize spatially explicit urban heat exposure maps (2 m vertical height), which is most consequential for health

● Objective #2: Build the evidence base linking air pollution and extreme heat to health outcomes.

To meet these objectives, the team has compiled and is now processing surface (from NetAtmos and Wunderground, and NOAA's standard weather stations over the domain) and satellite (ECOSTRESS Land Surface Temperature (LST) products, land cover maps from the national land cover database from Landsat) data over the city of Orlando for high-resolution thermal data construction. In addition, the team has developed a visualization tool that enables interactive inquiry of existing ground data. This tool allows users to visualize the spatiotemporal variation in temperature of a given dataset within a given year. The tool is user-friendly and supports easy exploration of the data, enabling users to better understand and analyze the data obtained from ground-based sensors.In the future, the team will expand this tool to create an independent web-based dashboard app that will allow any user to obtain animation plots and investigate variability in data visually, including satellite and ground data, to promote greater understanding and analysis of ground-based data.
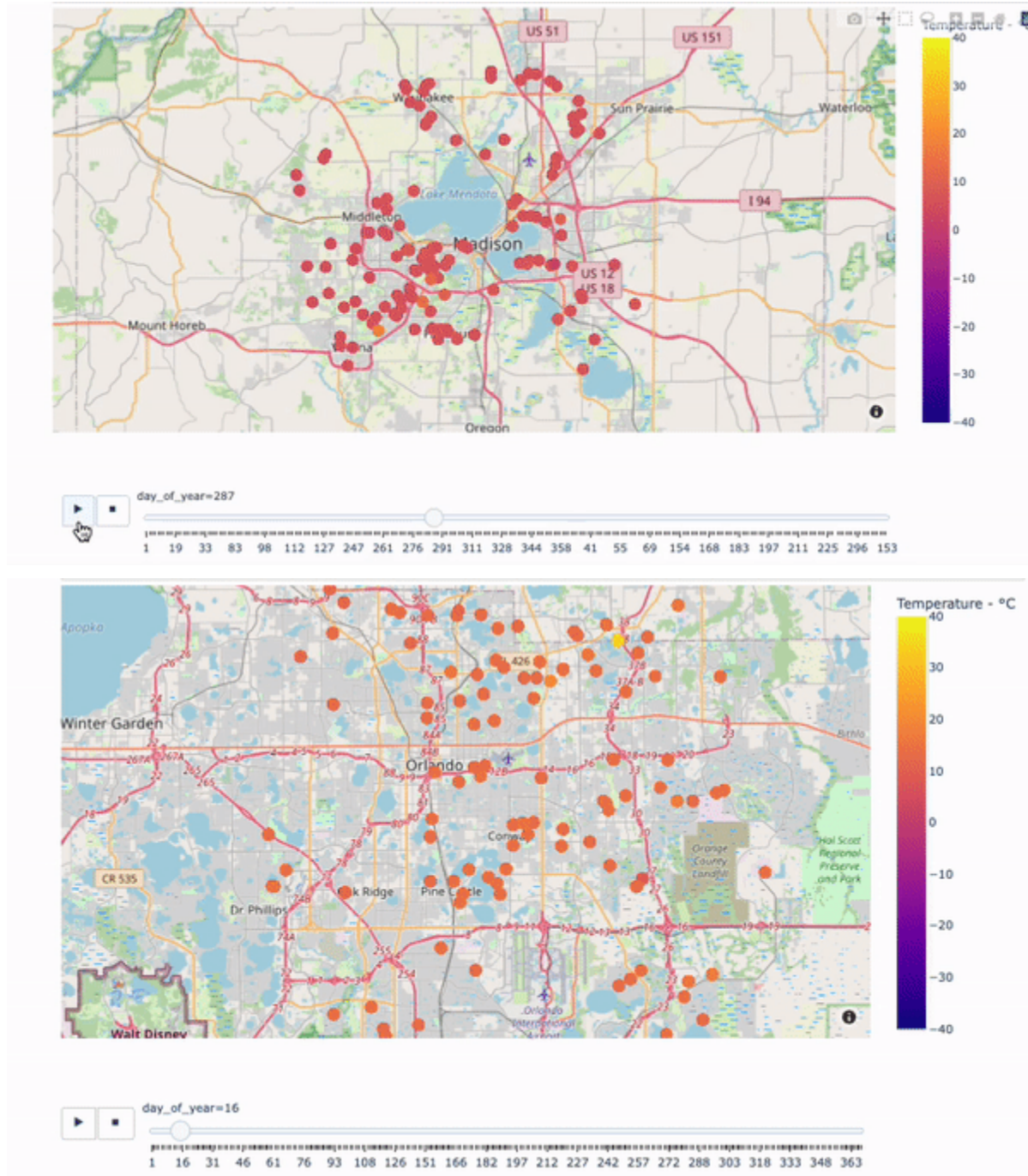
Figure 8. Visualization tool showing the animation of wunderground stations over Madison WI and Orlando FL.

Public Health Data

The team filled the appropriate human subjects paperwork and data use agreements to analyze: a) all-cause mortality and b) extreme heat emergency room department visits and hospitalizations.

The highest heat related illness emergency department visits have been located in the majority Black/African American resident zip code 32805.
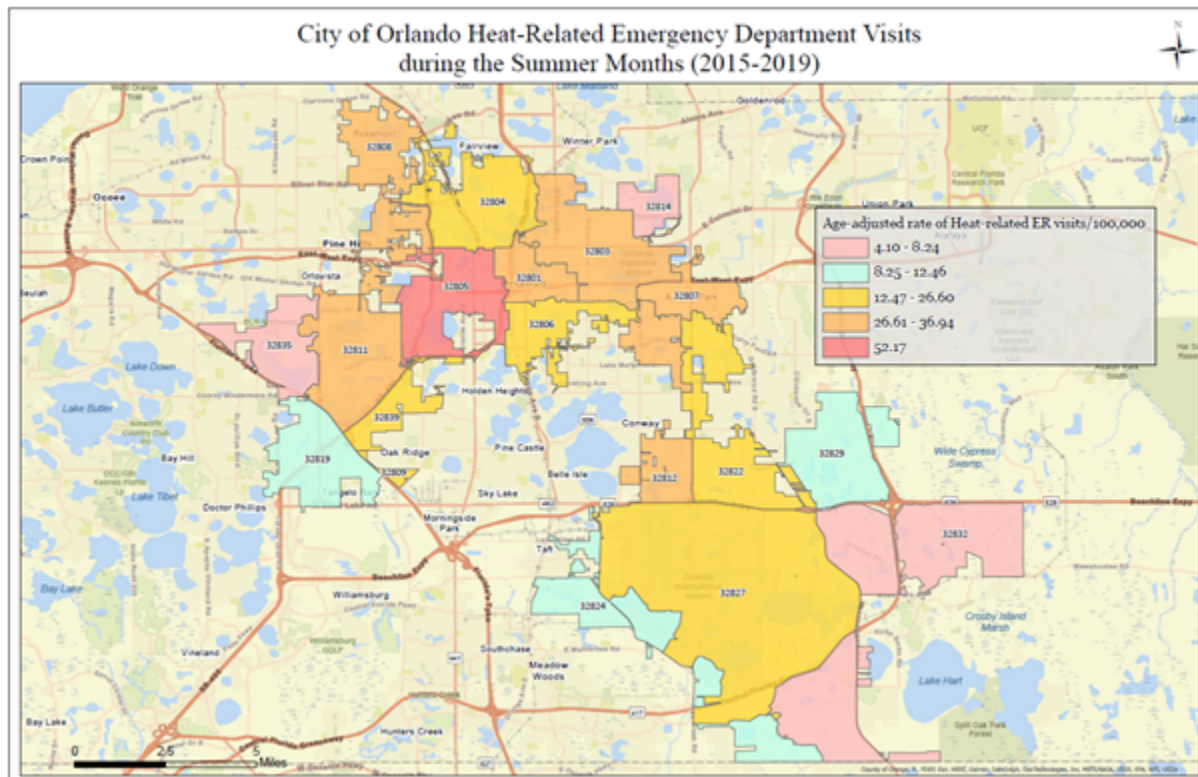

Figure 9. Maps extreme heat related emergency department visits rates over 2015-2019.

Looking ahead, this effort will create a city-specific Earth Observations Toolkit for Sustainable Cities and Human Settlements. Mirroring the structure of existing tutorials, this Toolkit will provide step-by-step guidance using open source software, datasets, and code to complete two main objectives, a) evaluating the health benefits of green/cooling infrastructure installation, and b) building the evidence base linking air pollution and extreme heat to health outcomes. In addition, the project team will provide a brief summary of alternative workflows that may be more applicable to a global setting.

5.0   APPENDIX A. 2022 GEO SDG AWARDED PROJECTS

GEO Member Country: Reforestamos México[2]

Territorial analysis of 8 forest connectivity corridors in Mexico to determine potential restoration, conservation, and forest management activities to increase environmental services to the population
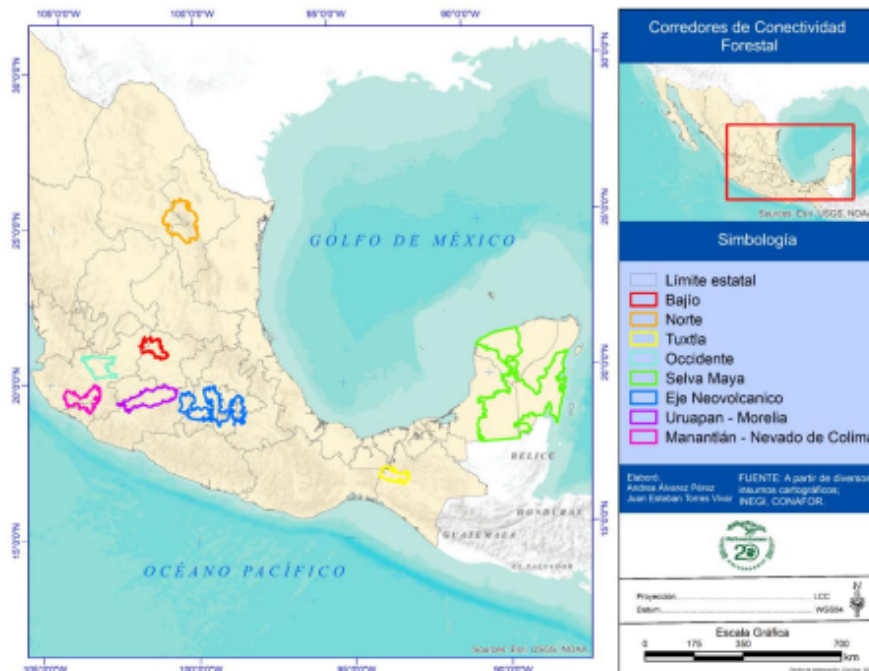
Caption*: Location of forest connectivity corridors across Mexico.*

Reforestamos México has 20 years of experience in which it has implemented projects on conservation, restoration, and forest management issues to achieve its objectives of stopping deforestation, increasing sustainable forest management, restoring degraded lands, and planting trees in cities. Reforestamos generated updated spatial information across 8 forest connectivity corridors across 16 states of Mexico using Landsat 8 satellite images between 2019-2020 to generate Land Use and Land Cover (LULC) layers. The process consisted of identifying the potential areas of work using Geographic Information Systems, local site visits, coordination with the owners of the land, planning, financing, development, and monitoring. Reforestamos created updated layers of vegetation types and land use in areas that have high biological diversity and support ecosystem services across the states. These corridors add up to an area of 11,088,004.79 hectares, with a population of 18,791,448 inhabitants, and where there are 2,800 agrarian nuclei, or ejidos and indigenous communities. The outcomes of the project are supporting local decision makers regarding land management conservation, biodiversity, and ecosystem services (SDG 15.2, progress towards sustainable forest management). The project has enhanced local partnerships and built new alliances to support better local land management.

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[2] During GEO Week, we realized that Reforestamos Mexico is an NGO and this nomination shouldn't have been included under the GEO Member Country category. For future award cycles, we will develop award category definitions to avoid similar confusion/ errors.

Caption: *Community forestry brigade working on reforestation in Mexico and locally trained students.*

GEO Participating Organization: United Nations Satellite Centre (UNOSAT) and United Nations Institute for Training and Research (UNITAR)

UNOSAT Emergency Mapping Service
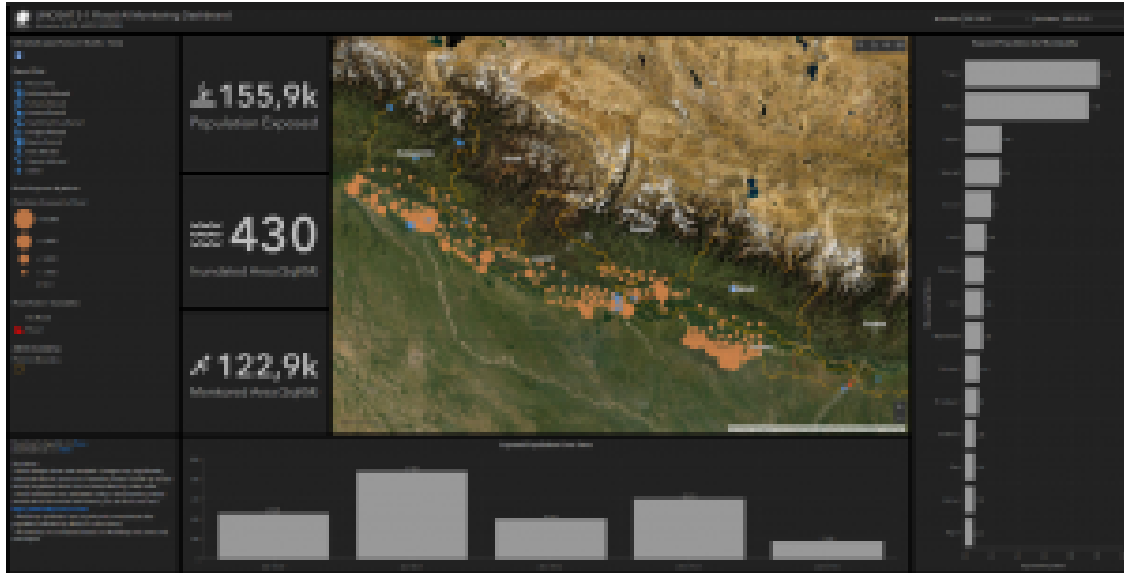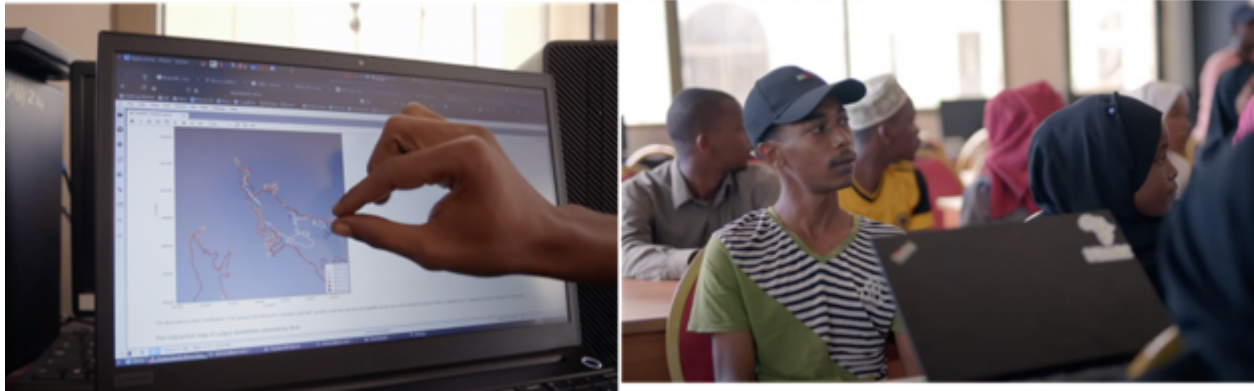
Caption:
UNOSAT food AI Dashboard for Nepal.

UNOSAT's Emergency Mapping service provides satellite image analysis during humanitarian emergencies related to disasters, complex emergencies, and conflict situations. With a 24/7 year-round availability to process requests, the team of experienced analysts ensure timely and tailored delivery of satellite imagery derived maps and products, as well as GIS data for evidence-based decision making and operational planning. These outputs range from GIS ready data (e.g., flood extents and damage assessments), statistics, reports, and web applications. All these products are made available, free of charge, and can be downloaded on the UNOSAT website. The emergency mapping service activation sharing mechanism follows 5 simple steps, which include situation, users, activation, process, and product. In 2021, UNOSAT supported fellow UN agencies in Nepal to aid the country in better monitoring flooding during monsoon season. During one emergency activation request, UNOSAT deployed its FloodAI system to create a dashboard that visualized the number of people potentially affected by the floods (SDG 11.5). In December 2021, a category 5 Tropical Cyclone struck the Philippines. Following a request from the Regional Office for Asia and the Pacific in Bangkok, UNOSAT's Emergency Mapping service was activated to support the planning and coordination of emergency response operations with satellite imagery analysis (SDG 13.1, 17.6).

GEO Work Programme Activity: Digital Earth Africa
How data and community can save Zanzibar's mangroves

Chwaka Bay mangrove count
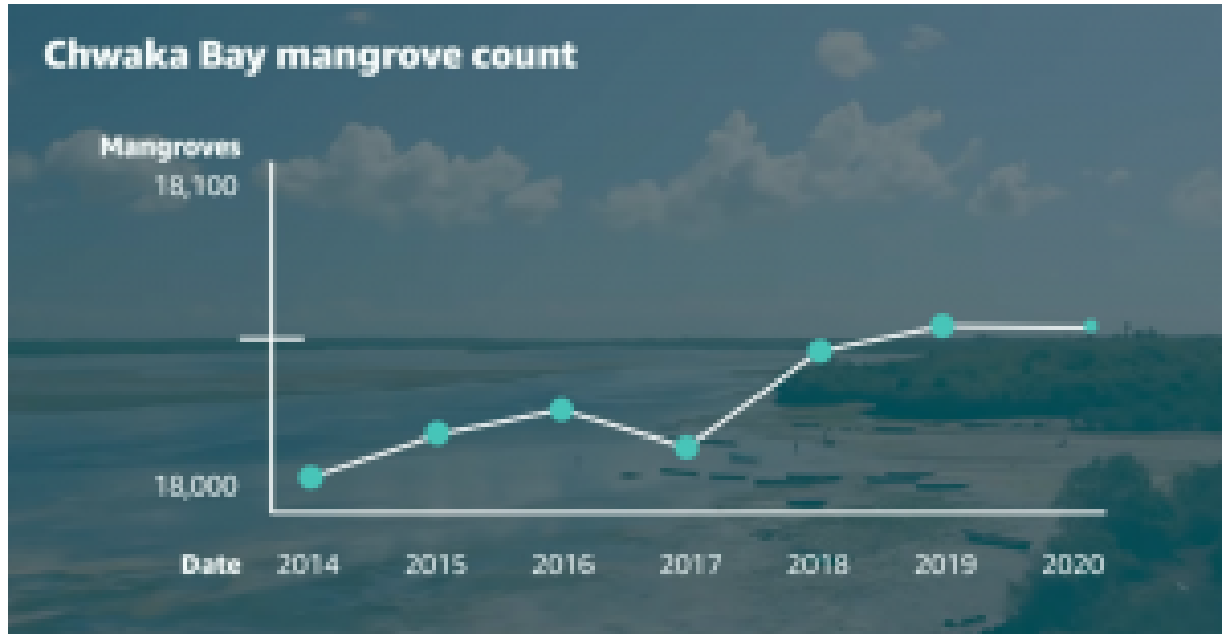
Caption: Through DE Africa, researchers and students show the changes in mangroves in Chwaka Bay, Zanzibar to inform policy regarding climate action.

In Zanzibar, Tanzania, the local communities rely on mangroves to stabilize the shorelines, protect the land and people from natural disasters and to provide habitats for marine life. Sadly, these mangrove habitats are regressing at an alarming rate. Coastal erosion, rising sea levels and human activity have not only contributed to the degradation of mangroves on the Island, but have led to loss of suitable fish along the shoreline. UN Sustainable Development Goal 14.5 endeavors to conserve these important coastal and marine areas, and the Tanzanian government has been taking protective measures to help achieve this target. Researchers from the State University of Zanzibar (SUZA) are using Digital Earth Africa (DE Africa) to obtain insights into the trends of mangroves in Zanzibar and empower the community to make better informed decisions regarding the impacts of climate change. The researchers have empowered their students to use DE Africa to monitor and assess changes in mangroves and, in turn, collaborate with the Youth Mappers SUZA chapter to validate the results. Further, the local populations are now planting more mangroves through volunteer organisations such as Zanzibar Volunteers for Environmental Conservation. As a result of the project, the community is more prepared to make decisions regarding rising seas (SDG 13) and has engaged with the Office of Government Statistician to support climate action and complement data gaps leveraging the DE Africa partnership. Restoring mangrove forests also supports progress towards many other SDGs including eliminating poverty and hunger (SDG 1, 2), ensuring livelihoods and economic growth (SDG 8), taking actions against climate change impacts (SDG 13) and halting biodiversity loss (SDG 15).

Caption: (Left) *Students at State University of Zanzibar, Tanzania are able to visualize changes in mangroves using Digital Earth Africa.* **(Right)** *Through DE Africa, researchers and students show the changes in mangroves in Chwaka Bay, Zanzibar to inform policy regarding climate action.*

Academia: KTH Royal Institute of Technology
The Google Earth Engine App for Interactive City Definition and Automatic SDG Indicator 11.3.1 Calculation
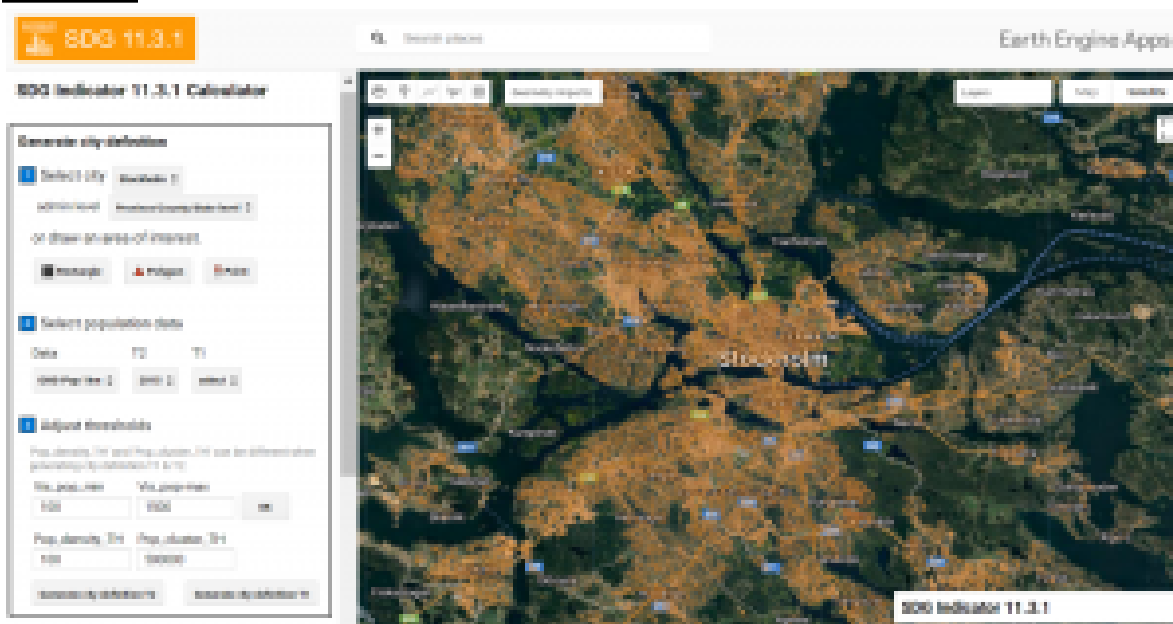
Caption: *SDG Indicator 11.3.1 Calculator tool.*

KTH Royal Institute of Technology in Stockholm, Sweden has played a leading role in leveraging Earth observation big data for urban mapping and urbanization monitoring to support sustainable and resilient urban development. KTH developed the Google Earth Engine App for Interactive City Definition and Automatic SDG Indicator 11.3.1 Calculation. The City Definition Tool can automatically or interactively generate city definitions based on the Degree of Urbanization, endorsed by the UN to make the performance of different cities comparable. The Degree of Urbanization is a method that relies on a population grid to classify local units into three classes: cities, towns & suburbs, and rural areas. The SDG 11.3.1 Calculator computes and visualizes the primary and secondary indicators of SDG indicator 11.3.1, Land Use Efficiency, following the global indicator methodology. The application was designed on a Google Earth Engine backend and is fully functional on a web browser without the need for additional installations. The app not only enables users to compare different population and EO-based built-up datasets directly within a web browser, but also offers users the possibility to input their own data and

adjust boundaries of their city definition when needed. The app for city definition and SDG indicator 11.3.1 calculation is easy to use and can be utilized by any city in the world for their SDG 11.3.1 monitoring and reporting.
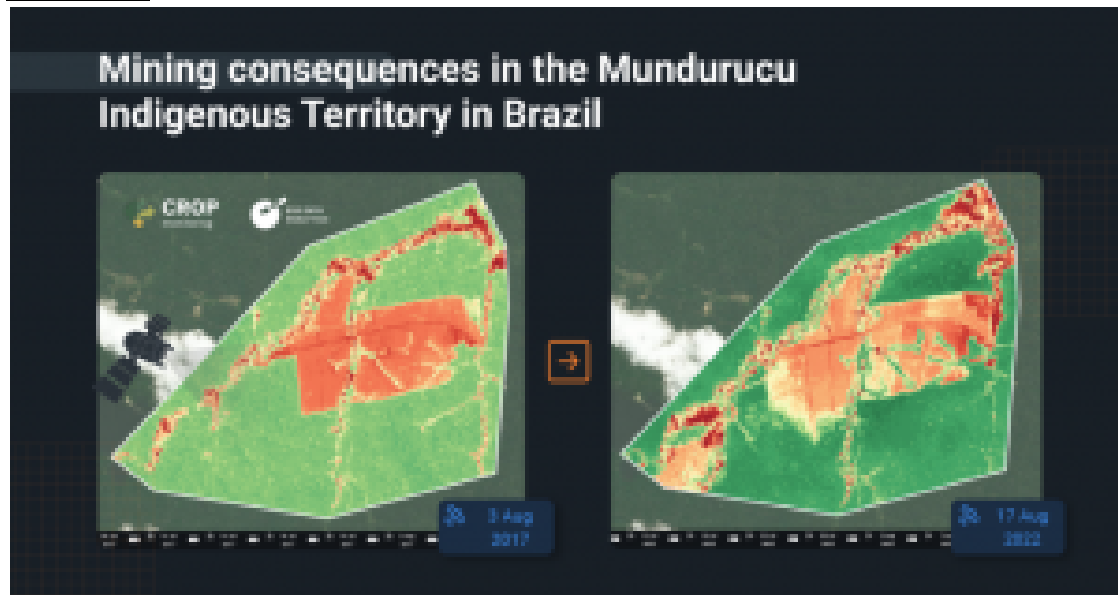
SDG11.3.1 App:

https://eo4sdg11.users.earthengine.app/view/sdg-1131-indicator

Comparison of Urban Data app:

https://eo4sdg11.users.earthengine.app/view/urban-comparison

Commercial Sector: EOS Data Analytics

AI-powered satellite imagery analytics: EOSDA Crop Monitoring, EOSDA Forest Monitoring, EOSDA LandViewer

Caption: EOSDA case study in Brazil.

EOS Data Analytics (EOSDA) generates satellite-driven insights across 22+ industries and in support of 10 of the 17 Sustainable Development Goals. EOSDA is part of the Noosphere space group and partners with governmental, commercial, and scientific organizations. EOSDA primarily supports the agriculture industry via the EOSDA Crop Monitoring product, a digital precision agriculture tool that helps farmers remotely assess the health of their crops, cut costs on scouting, soil testing, farm management, and use seeds and fertilizers more efficiently, particularly important to SDG 2.4 and SDG 12.4 Additionally, EOSDA Forest Monitoring is an online satellite-based software for forestry management. Using satellite imagery, the software enables landowners, logging companies, and research institutes, among others, to remotely monitor forest health. The EOSDA LandViewer is an online GIS-assistant that provides a set of specific geospatial technologies to extract valuable information from big data to meet the needs of sustainable business practices. It provides on-the-fly searching, visualizing, and processing of data by applying more than 10 indices available on the platform. EOSDAs products support resilience and adaptive capacity to climate-related hazards and natural disasters for its users (SDG 13.1, Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries).

Caption: EOSDA case study in Chad.

Collaboration: Costa Rica Ministry of Environment and Energy and the United Nations Development Program (UNDP)
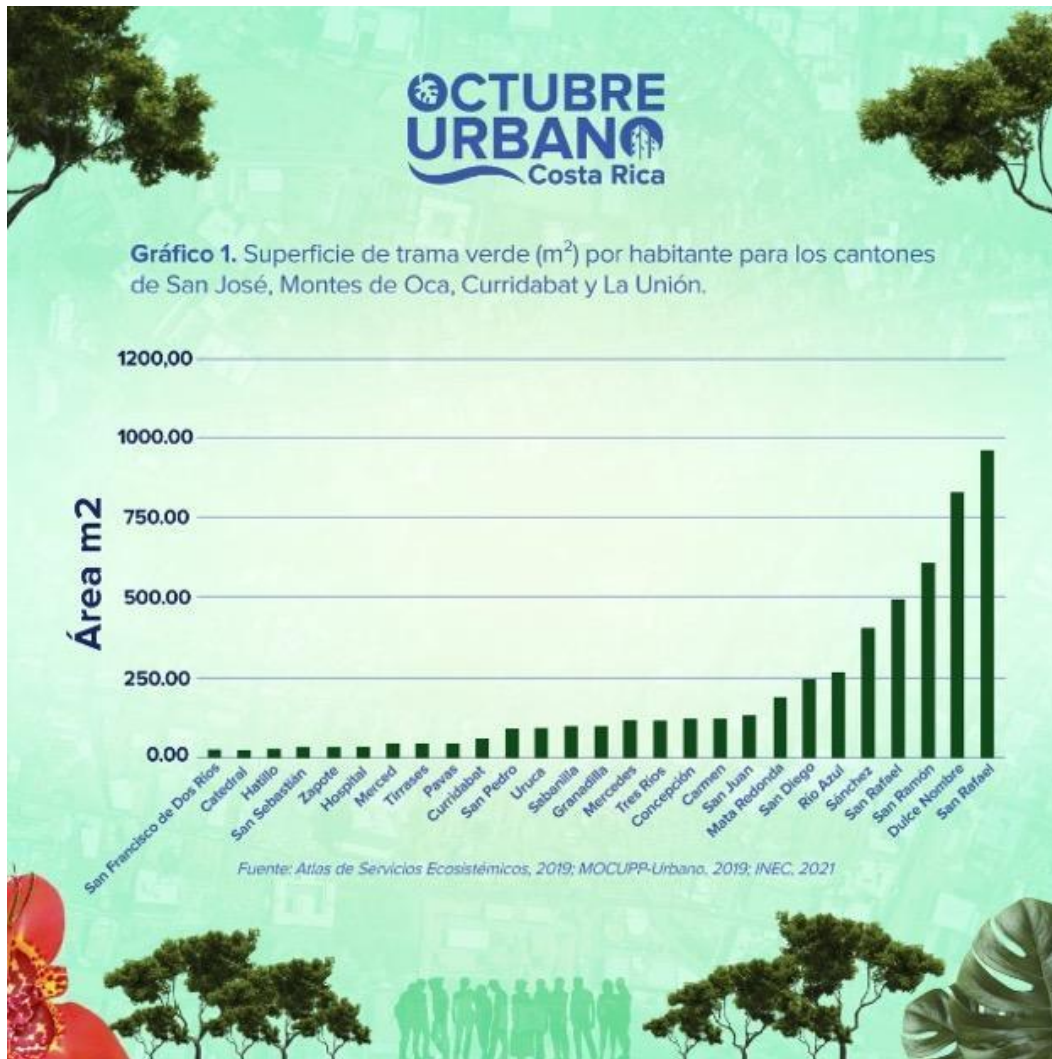

Caption: MOCUPP Collaboration.

Monitoring of Land Use Change in Productive Landscapes (MOCUPP)
The Costa Rica Ministry of Environment and the United Nations Development Program developed the "Monitoring of Land Use Change in Productive Landscapes – MOCUPP" tool to support the sustainable management of key productive landscapes (SDG 2.3, 2.4, 12.2) where agricultural export crops are grown

nationally, including pineapple, oil palm and cattle pasture, and also to monitor green cover (SDG 11) in the Maria Aguilar Urban Corridor, which crosses four municipalities in the Greater Metropolitan Area of Costa Rica. Annually, MOCUPP produces maps and reports of these coverages and related tree cover loss and gain, using digital identification techniques by processing satellite images and field data, with the contribution of public academic institutions. The geospatial information generated by MOCUPP is publicly available in Costa Rica's Spatial Data Infrastructure and the reports are available on the project's website. The MOCUPP generates data to be used in the environmental and productive sector demonstrates deforestation-free production practices. The data can be used in initiatives such as the Nationally Appropriate Mitigation Action strategy, as well as in different national regulations and international climate agreements and for any land management process focused on agricultural and environmental landscapes in the country. Costa Rica is developing MOCUPP under the leadership of the Ministry of Environment and Energy, through the National Center for Geoenvironmental Information, and the United Nations Development Program Office in Costa Rica, within the framework of the National System for Monitoring Land Use, Land Cover and Ecosystems – SIMOCUTE. In the coming years, the project is expected to increase the types of productive landscapes monitored by MOCUPP, including coffee and banana plantations.

Gráfico 1. Superficie de trama verde (m²) por habitante para los cantones de San José, Montes de Oca, Curridabat y La Unión.

6.0 Appendix B. Miro Board Findings from EO Toolkit Strategy Meeting in November 2022

What has worked well?

- Engaging with each other and continuing to innovate

- Spontaneous contact and conversations to strengthen the feedback around EO toolkit issues

- Engagement with cities

- Citizen and public activities to socialize EO positive impacts on society

- Availability of high-level tools, data and human resources

- A Great group of contributors to learn from and with

- EO toolkit makes sense – this enables us to bring it up and make connections in all other interactions

- The use cases allow for a pragmatic connection with a potential city

- Diverse experiences and perspectives

- Having a concrete platform to contribute information to

- Creating real proposals with cities

- To test and propose the final propositions of solutions for cities

- Directed outreach to cities for relevant trainings

What has not worked well? What has been a challenge?

- Limited travel and face-to-face meetings

- Competing priorities which reduce time and resources for SDG 11 toolkit

- Lack of resources, people, and general funding

- Common understanding of the long-term objectives of the initiative

- Limited availability to work on the initiative during certain periods of the year

- Mostly a volunteer model – especially problematic for working group leadership

- The focus on SDGs is useful for starting a discussion but at the end of the day, cities will choose daily needs if resources are limited

- Time and effort need to engage with stakeholders in a substantive way

- Limited time commitment and funding

- Limited funding/resources to support those who need to use the resources

- Mismatches between spatial/temporal resolution and timeliness of available data vs. need, as well as other uncertainties and constraints, both technical and organizational

- Scaling up

- Problems with funding

- Leadership challenges within working groups

- Time conflicts with other GEO activities (overlapping meetings)

Future focus areas and opportunities

- Working more directly with cities/countries and supporting them through capacity enhancements/direct measurement of indicators

- Create consortia/partnerships to support cities to create and deliver projects

- Create transferable business cases for each priority policy area

- Identify priority policy areas/issues that cities care about

- Create an international academic collaborative program based on EO technologies

- Link with city networks and other horizontal entities (e.g. ICLEI, SDSN, ITU-T) or other thematic city cohort initiatives. Some examples convened by WRI: Cities4Forests, UrbanShift

- Reach National leadership of the goodness of the SDG efforts with stories about saving their citizens' lives and property to gather more support = resources

- Develop guidance on data options to calculate each SDG 11 indicator

- Identify similar needs/challenges in multiple cities and develop a cohort to tackle the one common challenge using the toolkit

- Survey cities to identify needs

- Leverage ARSET surveys to local governments to identify needs

- Focus on the users – analyze their needs and define the ways to reach out to them

- Leadership opportunity for WG4 leadership – pitch opportunities for networking and leadership

- More end-to-end user scenarios and case studies

- Collaborative training events and creation of shared training resources (multi-lingual)

- Create/identify resources/funding mechanisms to support cities to use the toolkit

Next steps, milestones, and deliverables

- Test and propose the final propositions of solutions for cities and other end users

- Call for participation: independent quality evaluation of urban data (reliability) and tools (usability), recommendations on data/tools

- Development of use cases that engage with cities with local actions

- Pilot use of specific component of toolkit with cohort of cities

- Develop outreach plan to one or more urban smart city networks/organizations to expand awareness and scale up impacts

- Set up an ICLEI: Europe webinar in 2023

- Explore ITU-T standard for Smart and Sustainable Cities and how the EO toolkit can be part of the standard

- Create a small number of groups of cities – each group focused on a specific issue of interest to that group of cities

- Identify priority polity areas/issues that cities care about

- Impact assessment of the urban data and tools included in the toolkit – who used what, for which purpose?

- Coordinate training events and resources, including open platform for creating multilingual versions of existing materials

- Create/identify resource/funding mechanisms to support cities to use the toolkit

- Develop a call for new volunteers/contributors

- Call for new members to join

- Redefine and clarify the roles of the people who participate in the initiative

Big Ideas

1. Audiences with National leadership

2. "rebrand" to clearly include supporting SDGs and perhaps even official statistics

3. Consider multiple branding (perhaps see these as sales channels) – focused on specific groups of applications of EO by cities

4. Develop and publish a flagship knowledge product to demonstrate the value of EO for urban SDGs

5. Regular SDG 11 training opportunities with a certificate

6. Lobby and promote the SDG products as official statistics and its vital role in spatial planning

7. Create multiple lighthouse projects with significant partner cities (and other types of partners)

8. Create scalable lighthouse project replication mechanisms to duplicate the work solutions that work for multiple cities

9. Create a "super" tool that quite simply matches city challenges with existing tools – like a game for city stakeholders

10. Provide direct funding grants or matching/in-kind funds to city projects

11. Find appropriate sponsor/host organization that would allow great operationalization and integration of toolkit into urban planning processes and decision-making

12. Create a team to support cities develop and implement their ideas/priorities