GROUP ON EARTH OBSERVATIONS

Mapping the Engagement of the 2020-2022 GEO Work Programme

in Climate Action, Disaster Risk Reduction, and Capacity Development

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Contents

Overview of the 2020-2022 GEO Work Programme activities

GEO ACTIVITY	GEO ACTIVITY TITLE	GEO ACTIVITY TYPE
GEO BON	GEO Biodiversity Observation Network	Flagship
GEOGLAM	GEO Global Agricultural Monitoring	Flagship
GFOI	Global Forest Observation Initiative	Flagship
GOS4M	Global Observation System for Mercury	Flagship
AQUAWATCH	Aquawatch	Initiative
BLUE-PLANET	Oceans and Society: Blue Planet	Initiative
DE-AFRICA	Digital Earth Africa	Initiative
DIAS	Data Integration and Analysis System	Initiative
EO4EA	Earth Observations for Ecosystem Accounting	Initiative
EO4HEALTH	Earth Observations for Health	Initiative
EO4SDG	Earth Observations for Sustainable Development Goals	Initiative
GDIS	Global Drought Information System	Initiative
GEO-CRADLE	GEO Capacity Building in the North Africa, Middle East, Balkans and Black Sea Region	Initiative
GEO-DARMA	Data Access for Risk Management	Initiative
GEOGLOWS	GEO Global Water Sustainability	Initiative
GEO-LDN	GEO Land Degradation Neutrality	Initiative
GEO-MOUNTAINS	Global Network for Observation and Information in Mountain Environments	Initiative
GEO-VENER	GEO Vision for Energy	Initiative
GEO-WETLANDS	GEO Wetlands	Initiative
GOS4POPS	Global Observation System for Persistent Organic Pollutants	Initiative
GSNL	Geohazard Supersites and Natural Laboratories	Initiative
GUOI	Global Urban Observation and Information	Initiative
GWIS	Global Wildfire Information System	Initiative
HUMAN-PLANET	GEO Human Planet Initiative: Spatial Modeling of Impact, Exposure and Access to Resources	Initiative
AFRIGEO	Africa Group on Earth Observations	Regional GEO
AMERIGEO	Americas Group on Earth Observations	Regional GEO
AOGEO	Asia-Oceania Group on Earth Observations	Regional GEO
EUROGEO	European Group on Earth Observations	Regional GEO
ACIS	Advancing Communication Infrastructure and Services	Community Activity
AFRICULTURES	Enhancing Food Security in African Agricultural Systems with the Support of Remote Sensing	Community Activity

AGRI-DROUGHT	Global Agricultural Drought Monitoring	Community Activity
ARCTIC-GEOSS	Arctic GEOSS	Community Activity
ATLANTIC-EO	Earth Observations for the Atlantic Region	Community Activity
C3S	Copernicus Climate Change Service	Community Activity
CAMS	Copernicus Atmospheric Monitoring Service	Community Activity
CLIMATE-OBS	Climate Observation, Simulation and Impacts	Community Activity
CROP-PEST-MONITORING	Global Crop Pest and Disease Habitat Monitoring & Risk Forecasting	Community Activity
CSDR	Chinese High-resolution Satellite Data Resources	Community Activity
DELTA-ESTUARY	Global Observation of Deltas and Estuaries	Community Activity
DE-PACIFIC	Digital Earth Pacific	Community Activity
EO4DRM	Earth Observations for Disaster Risk Management	Community Activity
EO4MIN	Earth Observations for Managing Mineral and Non-renewable Energy Resources	Community Activity
EO4SENDAI-MONITORING	Earth Observation and Copernicus in Support of Sendai Monitoring	Community Activity
EO4WEF	Earth Observations for the Water-Energy-Food Nexus	Community Activity
EO-IIP	Earth Observation Industrial Innovation Platform	Community Activity
GEOARC	Global Ecosystems and Environment Observation Analysis Research Cooperation	Community Activity
GEO-CITSCI	GEO Citizen Science	Community Activity
GEODESY4SENDAI	Geodesy for the Sendai Framework	Community Activity
GEO-ECO	GEO Global Ecosystems	Community Activity
GEO-EV	GEO Essential Variables	Community Activity
GEO-TREES	Forest Biomass Reference System from Tree-by-Tree Inventory Data	Community Activity
GEO-VALUE	Understanding the Impacts and Value of Earth Observations	Community Activity
GFRM	Global Flood Risk Monitoring	Community Activity
GLOFAS	Global Flood Awareness System	Community Activity
IN-SITU-ESC	In-Situ Observations and Applications for Typical Ecosystem Status of China and Central-Asia	Community Activity
LAND-COVER	Global Land Cover	Community Activity
MUSYQ	Multi-Source Synergized Remote Sensing Products and Services	Community Activity
NEXT-EOS	Next Generation Earth Observation Services	Community Activity
NIGHT-LIGHT	Night-time Light Remote Sensing for Sustainable Development Goals	Community Activity
OEA	Open Earth Alliance	Community Activity
SCO	Space Climate Observatory	Community Activity
SPACE-SECURITY	Space and Security	Community Activity
TIGGE	The International Grand Global Ensemble	Community Activity
UHCO	Urban Heritage Climate Observatory	Community Activity

Acronyms

BUR – Biennial Update Report

CAS – Chinese Academy of Sciences

CC-WG – Climate Change Working Group

CD-WG – Capacity Development Working Group

CEOS – Committee on Earth Observation Satellites

CGMS – Coordination Group for Meteorological Satellites

CMCC – Euro-Mediterranean Center on Climate Change

CNR – National Research Council - Consiglio Nazionale delle Ricerche

COP – Conference of the Parties

DRR – Disaster Risk Reduction

DRR-WG – Disaster Risk Reduction Working Group

EARSC – European Association of Remote Sensing Companies

ECMWF – European Centre for Medium-Range Weather Forecasts

EO – Earth Observation

ESPOL – European School of Political and Social Sciences

EWEA – Early Warning, Early Action

FAO – Food and Agriculture Organization

GBIF – Global Biodiversity Information Facility

GCOS – Global Climate Observing System

GEO – Group on Earth Observations

GFDRR – Global Facility for Disaster Reduction and Recovery

GHG – Greenhouse Gas

GRAF – Global Risk Assessment Framework

GWP – GEO Work Programme

IP – Implementation Plan

IPCC – Intergovernmental Panel on Climate Change

JRC – Joint Research Centre

LDC – Least Developed Country

NAP – National Adaptation Plan

NASA – National Aeronautics and Space Administration of the United States

NASA ARSET – NASA Applied Remote Sensing Training

NDC – Nationally Determined Contribution

NFMS – National Forest Monitoring System

NGO – Non-governmental Organization

MHEWS – Multi-Hazard Early Warning System

MOOC – Massive Open Online Course

MRV – Measurement, Reporting and Verification

OECD – Organisation for Economic Co-operation and Development

PB – Programme Board

RCMRD – Regional Centre for Mapping of Resources for Development

REDD+ – Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and forest carbon stock enhancement

RiX – Risk Information Exchange

SDG – Sustainable Development Goal

SIDS – Small Island Developing State

SFDRR – Sendai Framework for Disaster Risk Reductions 2015-2030

UNDRR – United Nations Office for Disaster Risk Reduction

UNEP – United Nations Environment Programme

UNESCAP – United Nations Economic and Social Commission for Asia and the Pacific

UNFCCC – United Nations Framework Convention on Climate Change

UN-Habitat – United Nations Human Settlements Programme

UN-SPIDER – United Nations Platform for Space-based Information for Disaster

UNOOSA – United Nations Office for Outer Space Affairs

USAID – United States Agency for International Development

USGS – United States Geological Survey

WCRP – World Climate Research Programme

WFP – World Food Programme

WG – Working Group

WMO – World Meteorological Organization

Executive Summary

The mapping of the 2020-2022 GEO Work Programme (GWP) was aimed to identify the engagement of the GWP activities with users and decision makers in two of the four Group on Earth Observations (GEO) engagement priorities, Climate Action and Disaster Risk Reduction (DRR), and one cross-cutting area, capacity development.

The findings of the mapping exercise and resulting recommendations should be received in the context of the Mid-Term Evaluation of the GEO Strategic Plan 2016-2025, as well as the ongoing development of the Post-2025 GEO Strategic Mission.

Thematic and geographic scope and policy areas

Overall, the 64 GWP activities cover a wide range of relevant thematic domains, with many GWP activities contributing to multiple domains simultaneously. However, there is a stronger focus on land-related issues in comparison to water-related and cross-cutting issues.

GWP activities operate and have an impact across all geographical levels, primarily regional and global. Some activities already have concrete engagements with national and regional stakeholders to implement projects and facilitate action, but it is challenging to identify the level or type of engagement or the impact as most GWP activities did not provide specific information to support their claim.

All GWP activities are engaged at least in one of the global policy drivers and GEO engagement priorities across Sustainable Development, Climate Action and DRR. While almost all GWP activities support Sustainable Development, there is large overlap across the three global agendas that have resilience building, adaptation and loss and damage as intrinsic cross-cutting elements.

Despite the different levels of engagement and maturity of the current GWP activities, there is clear interest to continue improving and strengthening the work under GEO, and the bridging of thematic gaps, expanding aspects of regional collaboration and representation, enhancing access to funding, improving the trustworthiness of Earth observation (EO) data and products, as well as developing user-customized capacity development.

Climate Action

According to the mapping results, climate change is one of the top engagement priorities overall across the GWP. However, only few activities provide input to the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, collaborate with UNFCCC national focal points, or are involved in Intergovernmental Panel on Climate Change (IPCC) process and assessments. As such, the link between the GWP and the international climate policy process can be improved. This should be done through promoting more engagement by GWP activities and coordination support by GEO Secretariat. Also, collaborations seem to be predominantly driven by space agencies and UN agencies, which makes the case for promoting more varied partnerships, including with the private sector.

Upon further analysis, many GWP activities relate to numerous workstreams under the UNFCCC and Paris Agreement, particularly climate change adaptation. However, the number of dedicated GWP activities does not necessarily reflect the actual delivery, with these GWP activities showing mostly potential or partial contribution. This makes the case for additional support to be provided to the GWP activities related to Adaptation, Means of Implementation, and Loss and Damage for effective implementation and scaling up. Mitigation-related activities in the GWP are fewer and mostly led by space agencies but appear to be providing more concrete contribution proportionally. Any future GWP activities in this workstream should build on existing good practice.

The inventory of EO data, tools and products generated by GWP activities highlighted a variety of outputs and different levels of maturity across the GWP. GEO supplementary technical guidance for National Adaptation Plans (NAPs) is regarded as a good opportunity to channel existing contributions of relevant GWP activities that expressed interest and are at the adequate level of maturity, to feed into the adaptation policy process especially in support of Least Developed Countries (LDCs).

The content of the work of GWP activities mostly include developing EO applications as well as promoting EO technology development and transfer, and related capacity building in developing countries. These are followed by monitoring and assessing local climate risks, impacts and vulnerability, supporting early warning systems and emergency preparedness, addressing linkages between climate change and disaster risks, climate and sustainable development, and climate and food security. There is a potential to strengthen other sub-areas that benefit from the application of EO, through new and revived GWP activities in the 2023-2025 cycle.

Notably, the need for EO to support climate finance has been expressed by several GEO partners and was a key message from the GEO Climate Policy and Finance Workshop in 2021. Many decision makers have a limited understanding of the EO value chain and opportunities for using EO data. In collaboration with potential users from the business and sustainable finance sectors, GWP leads should investigate the role and opportunities for EO to support climate risk assessments of assets, operations, and investments.

Disaster Risk Reduction

The mapping results clearly showed that GWP activities have strong alignment with Sendai Framework priorities. However, when it comes to specific Sendai Framework targets and indicators at national scales, the alignment was weaker. Approximately half of the DRR-related activities stated that they work with DRR partners in countries, not many have been engaging with relevant national government agencies, especially Sendai Framework National Focal Points. A smaller number of activities have provided input to the national monitoring/reporting mechanism using the Sendai Framework indicators, and none have managed to contribute directly to national DRR policy documents.

As nearly 60% of the GWP activities have no or limited connections with users, especially at the national level, GWP activities are encouraged to start developing or strengthening their connection with at least one country, ideally Small Island Developing States (SIDS) and/or LDCs, while involving specific national DRR users. For this, Regional GEOs and Participating Organizations including disaster-related regional organizations such as the Asian Disaster Preparedness Center, can play important roles in connecting GWP activities with potential partner countries and organizations.

Another key vehicle in finding countries and users is to take advantage of the relevant GEO platforms, such as the EO Risk Toolkit, to which most GWP activities are willing to contribute. Being an integral part of the Risk Information Exchange (RiX) under the United Nations Office for Disaster Risk Reduction (UNDRR) flagship initiative called the Global Risk Assessment Framework (GRAF), the EO Risk Toolkit is designed to help inform GEO's product offering to the DRR users on the ground. In doing so, it is critical for the GWP activities to articulate what they can possibly offer to countries, for example, down-scalable datasets, analytical tools, services and methodologies, applicable at national or local level, for instance for monitoring and reporting of their implementation of the Sendai Framework. This will be a prerequisite for the activities to start engaging potential users for policy contributions.

It should be noted that GWP activities can build on their strengths in the areas of climate-related hazards such as flood, drought and wildfire. Meanwhile, to address gaps and weaknesses, the GEO community is encouraged to contribute to the next GWP cycle with activities that address systemic risk and multiplier effects of multi-hazards, such as tsunamis and earthquakes, which are common among SIDS and LDCs.

Photo credit: Renaldo Matamoro

Capacity Development

The mapping results showed that GWP activities have an emerging capacity development-centred approach meant to strengthen the quality of the activities from the formulation stage through to implementation. Considerable alignment with other GWP activities will be needed to ensure the activities foster sustainable results by building relevant national capacities. It is also recognised that GWP activities need to evolve with time and therefore need to be addressed in a strategic and coherent way by identifying priorities, guiding decisions, and targeting other GEO activities to build full capacity across the community.

Drawing from the data, currently research and academic institutions, as well as public administration, are the most common target users for capacity development resources across GWP activities, while many other stakeholders such as non-governmental organizations (NGOs), private sector, consortiums and GWP activity consortia, and Indigenous groups are gaining increasing importance to be considered. Targeted outreach and engagement with relevant groups, such as the GEO Indigenous Alliance and private sector organisations who are GEO Associates, is recommended to ensure inclusivity and diversity.

Generally, traditional channels of communication such as websites, geoportals and social media are seen as effective ways to disseminate relevant information and reach target users. Use cases are considered the most effective and efficient method of delivery, which should be included along with the dissemination of new scientific tools and co-design of EO products and tools currently reported across the GWP. Expanded strategic communication efforts, including social media, should be considered in order to ensure the GEO community is aware of these tools and resources.

Most GWP activities consider capacity development significant to connecting with other each other and with the GEO engagement priorities, notably Climate Action (focusing on adaptation) and DRR (focusing on climate-induced hazards such as floods, droughts, and wildfires). As only a few GWP activities include capacity development activities to support countries to produce their national DRR or climate policies, it is recommended to integrate capacity development considerations into each GWP activity's strategic communications plan that specifically strengthens capacity to use GWP-produced resources to inform future policy development and design in these sectors.

Overall, the collaborative aspect of capacity development is highly relevant, and issues of inclusivity of stakeholder groups, integration of target users with different skill levels, and customization of content through use cases and national/local languages seems critical.

Photo credit: Geodata for Agriculture and Water Facility (G4AW), Africultures

Priority Recommendations

Priority recommendations are a selection of the long list of recommendations based on the findings of the GWP mapping. These recommendations are meant to inform the effective development of the 2023-2025 GWP, through inclusion of considerations and relevant targets in Implementation Plans (IPs) submissions by GWP leads, as well as through potential improvements to the GWP structure and processes by GEO governing bodies and the GEO Secretariat.

1. Future GWP activities should consider prioritizing thematic domains such as **Arctic/Cryosphere and Small Islands** that entail cross-cutting EO activities between land and water, as well as leverage the **strengths of existing water-related activities**, to bring relevant initiatives together and capitalize on knowledge and products.

2. More mature GWP activities, and ideally all GWP activities, should have concrete targets for **on-the-ground implementation and collaboration with user communities** for user uptake, particularly national governments as well as value chains and business sectors.

3. Future GWP activities should be delivering **EO data, knowledge and products** that directly **support global policy agendas** for Climate Action, DRR and Sustainable Development, as well as Sustainable Urban Development. This could be promoted through the revision of **selection criteria of GWP activities** to align more closely with global policy agendas and GEO engagement priorities.

4. Existing and future GWP activities should aim at identifying and establishing collaboration with relevant **UNFCCC and IPCC national focal points**, especially through national and local GWP activity partners, to provide input to international climate policy and science processes.

5. The GWP can build on its strength in the area of **resilience building** which cuts across global Climate Action, DRR, and Sustainable Development agendas. Future GWP activities should develop or improve **tools, services and methodologies** that contribute to **Adaptation** and **Loss and Damage,** notably include knowledge products targeting **support to developing countries for NAPs**, while continuing to provide EO needed for climate science.

6. Future GWP activities that address the use of EO in climate finance to implement the Paris Agreement should focus on supporting businesses and financial institutions in running **climate risk assessments**, as well as supporting LDCs and SIDS in improving the **climate rationale of project proposals for adaptation and mitigation** with EO data.

7. Existing and future GWP activities should seek opportunities for collaboration with other GWP activities, Regional GEOs and the Climate Change Working Group (CC-WG) in **nexus areas** where they can develop an integrated approach to address **climate change impacts across key sectors**, such as climate-health-cities, climate-energy-infrastructure, climate-ocean-biodiversity.

8. Existing and future GWP activities should aim at establishing collaboration with at least one specific **national stakeholder for DRR**, such as Sendai Framework national focal points and civil protection agencies.

9. Existing and future GWP activities should develop or improve **tools, services and methodologies** that contribute to **specific Sendai Framework Targets and Indicators**, notably on Early Warning (Target G) and the Sendai Framework for Disaster Risk Reductions 2015-2030 (SFDRR)/ United Nations Sustainable Development Goals (SDGs) common indicators.

10. Existing and future GWP activities should seek opportunities for collaboration with other GWP activities, Regional GEOs, and the Disaster Risk Reduction Working Group (DRR-WG) in **nexus areas** where they can develop an integrated approach to address increasingly systemic nature of disaster risk where events overlap and interplay with **multiple risk** drivers.

11. The **concept of "capacity sharing"** and other more inclusive and culturally sensitive terminology and practices should be considered in recognition of the diversity of the GEO community. The Capacity Development Working Group (CD-WG) should support events and other initiatives for sharing of current resources and good practices, as well as fostering diverse and inclusive engagement with under-represented user groups, such as Indigenous communities.

12. Existing and future GWP activities should tailor tools and resources to their current **target users** and consider strategies for including and engaging with less targeted user groups, alongside strategies for strengthening **effective dissemination and delivery**. This includes clarifying and systematizing the resources' purpose and the users, with plans, templates, and good practice examples, and making use of existing GEO dissemination channels and targeted community sharing opportunities.

13. The GEO Secretariat should work with the CD-WG to make available an **inventory of capacity development resources**, potentially as a function of the GEO Knowledge Hub, whereby existing resources can either be modified or repurposed, or serve as an example of good practices.

Introduction

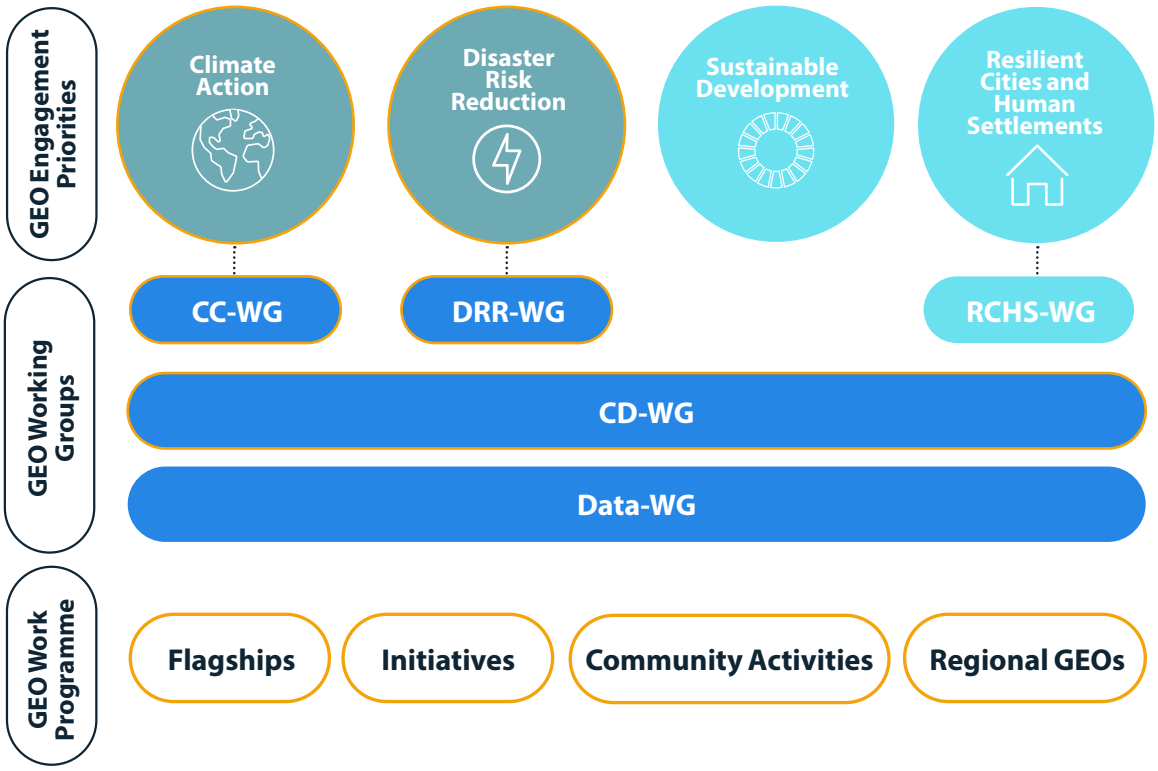
Background

The 2019 Group on Earth Observations (GEO) Ministerial Summit, held in Canberra, Australia, recognized the success the GEO community has had in driving progress in sustainable development, disaster risk reduction (DRR) and climate action. The Canberra Declaration also resolves to enhance our efforts to help GEO members to develop institutional capacity to promote the use of Earth observations (EO) for national benefit. In 2020, new GEO Working Groups (WGs) were established to develop strategies for advancing GEO's support to its members in engagement priorities and technical and institutional capacity building.

The GEO Climate Change, DRR and Capacity Development WGs have been collaborating to assess the current 2020-2022 GEO Work Programme (GWP) across key policy areas and cross-cutting issues.

Designed and undertaken over 2020-2022, the assessment or "mapping" of the existing GEO Flagships, Initiatives, Community Activities and Regional GEOs aimed to identify the engagement of the GWP activities with users and decision makers in two of the four GEO engagement priorities (Climate Action, DRR), and one cross-cutting area (capacity development). The mapping also identified related needs, gaps or synergies in delivery workflows, as well as technical capacity and resources. The other two GEO engagement priorities, Sustainable Development Goals (SDGs) and Resilient Cities and Human Settlements (RCHS), did not have a dedicated WG at the time the mapping was conceived. Nevertheless, RCHS and SDGs have been implicitly covered in the mapping exercise as they relate to Climate Action and DRR and relevant input was collected. The Data WG has conducted a separate mapping exercise in parallel.

Fig.1 - Mapping of GWP activities as part of the wider GEO foundational task



The GWP mapping covers 64 activities, consisting of 4 GEO Flagships, 21 Initiatives, 34 Community Activities, and 4 Regional GEOs. The four GWP activity categories are defined as follows.[1]

- **GEO Flagships:** GEO Flagships are Initiatives that exemplify the kind of impact and support to global, national, and local decision making that GEO aims to encourage and replicate. GEO Flagships have developed and continue to implement reliable, ongoing services in response to defined policy mandates from international organizations, conventions, agreements or other bodies. In doing so, GEO Flagships serve as models and guides for other GWP activities. Often GEO Flagships establish their own secretariats.
- **GEO Initiatives:** Within their defined domains, GEO Initiatives help to transition innovative results and prototypes from the research community into EO-based products and services to support a wide range of users. GEO Initiatives also build communities of stakeholders that work together to identify needs and gaps and develop capacity with these communities to maximize the value of the products and services being developed. GEO Flagships and Initiatives are expected to interact closely with the GEO Secretariat and the GEO community and, in return, receive a greater degree of visibility, support and guidance from them.
- **GEO Community Activities:** GEO Community Activities range from communities of practice to early-stage projects or pilots, to well-established services. GEO Community Activities offer an opportunity for GEO Members and Participating Organizations to collaborate and to contribute to realizing GEO's Vision and Mission with minimal requirements or structure. GEO Community Activities serve as an entry point for new activities which may go on to become GEO Initiatives. They may also include established services that find benefit from collaboration with other GWP activities, but which may not require the closer interaction typical of GEO Initiatives.
- **Regional GEOs:** Regional GEOs are a new category of activity in the GWP although they emerged from GEO Initiatives. Regional GEOs were officially recognized at the GEO-XV Plenary as distinct components of the GEO governance structure. Regional GEOs act as the implementing arms of the GEO Caucuses, which are groups of GEO Members within five defined regions of the world. The roles of Regional GEOs include engagement of countries and organizations within their region, including those which may not yet be GEO Members or actively involved; coordination of GEO activities within their region, including subsets of global Initiatives and Flagships; and initiation of new activities to serve regional needs.

In 2022, the GEO Programme Board (PB) and the GEO Secretariat invited existing GWP activities and the broader GEO community to submit new IPs for the 2023-2025 GWP.

For the first time, the IPs of new or renewed GWP activities will be collected through an open call via an online information collection process. This inclusive process also defines an improved structure of the GWP, which will consist of revised categories for GWP activities, namely GEO Flagships, Initiatives, Pilot Initiatives, as well as Regional GEOs. This categorization better reflects the potential development of GWP activities from pilots to flagships, and it is based on updated criteria for acceptance.

Objectives and target audience

The main objective of this report is to summarize the outcomes of the GWP mapping that provides insights on the current GWP activities and their needs, gaps and synergies. The report also aims to give guidance to the GEO community to advance the design and priorities of the next GWP 2023-2025 vis-a-vis current efforts to address relevant "nexus areas".

The target audience of this report includes the GWP activity leads and their teams, as well as the GEO WGs, GEO PB, and the GEO Secretariat.

Overall, the outcomes of the GWP mapping will support a path forward for climate, DRR, and capacity development-related activities, which will fill the identified gaps and take advantage of synergies, and scale up and connect relevant activities to decision makers.

The findings and recommendations contained in the report should be received in the context of the Mid-Term Evaluation of the GEO Strategic Plan 2016-2025 conducted in 2020-2021, as well as the ongoing development of the Post-2025 GEO Strategic Mission. In this light, nexus areas implying integrated EO solutions to address multiple challenges are to be prioritized for GEO going forward.

Ultimately, this will contribute to the effective implementation of the Paris Agreement on climate change and the Sendai Framework for Disaster Risk Reduction with EO, and improved use of GEO assets through increased skills.

[1] More information can be found in the 2020-22 GEO WP Summary document (Version 4).

UN 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs) which are an urgent call for action by all countries - developed and developing - in a global partnership. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.

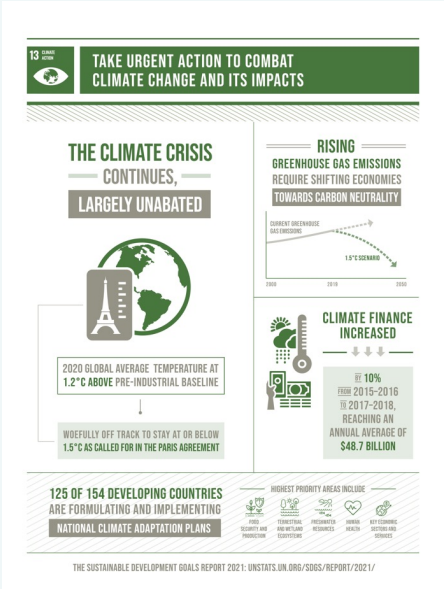
GEO is instrumental in integrating EO data into the methodology of measuring indicators and achieving the SDGs. Notably, EO, geospatial data, and derived information play insightful roles in monitoring targets, planning, tracking progress, and helping nations and stakeholders make informed decisions, plans, and on-going adjustments that will contribute toward achieving the SDGs. Combined with demographic and statistical data, these sources enable nations to analyze and model conditions, create maps and other visualizations, evaluate impacts across sectors and regions, monitor change over time in a consistent and standardized manner, and improve accountability.

Photo credit: Angela Benito

PARIS AGREEMENT ON CLIMATE CHANGE

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

The international political response to climate change began at the Rio Earth Summit in 1992, where the resulting "Rio Conventions" included the adoption of the UN Framework Convention on Climate Change (UNFCCC). This convention set out a framework for action aimed at stabilizing atmospheric concentrations of greenhouse gases (GHGs) to avoid "dangerous anthropogenic interference with the climate system". The UNFCCC which entered into force on 21 March 1994, now has a near-universal membership of 197 parties. In December 2015, the 21st Session of the Conference of the Parties (COP21/CMP1) convened in Paris, France, and adopted the Paris Agreement, a international agreement which aims to keep a global temperature rise for this century well below 2 degrees Celsius, with the goal of driving efforts to limit the temperature rise to 1.5 degrees Celsius above pre-industrial levels, by reaching global peaking of GHG emissions as soon as possible to achieve a climate neutral world by mid-century.



The Paris Agreement also provides a framework for means of implementation, namely financial, technical and capacity building support to those countries who need it. The implementation of the Paris Agreement requires economic and social transformation, based on the best available science. The Paris Agreement works on a 5-year cycle of increasingly ambitious national efforts, whereby countries submit their plans for climate action known as nationally determined contributions (NDCs). A Global Stocktake is conducted at five-year intervals, starting in 2023. The outcome of each Global Stocktake is then used to enhance the collective ambition towards achieving the long-term goals of the Agreement and strengthen international cooperation for climate action.

GEO makes available EO in support of effective climate policy responses, working with partners to enhance global observation systems for climate action. The data and knowledge derived from EO helps governments and other stakeholders at regional, national and sub-national levels to respond in many workstreams, including mitigation, adaptation, loss and damage, Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and forest carbon stock enhancement (REDD+) and other provisions of the Paris Agreement on means of implementation.

Notably, EO contributes near real-time data on GHG concentrations and emissions for carbon accounting in relation to mitigation responses. EO data is also key to assess impact, vulnerability and risks and to develop solutions that increase resilience and help adapt to climate change, including National Adaptation Plans (NAPs). When EO is combined with other critical socio-economic information at the local scale and over extended timescales, efforts to monitor progress on adaptation responses can be enhanced. Also, EO provide input to the overall process including through reporting of national action and the Global Stocktake.

An overview of the relevance of GEO for national climate action, collective climate ambition, and climate finance decisions can be found in the Outcomes Report of the GEO Climate Policy and Finance Workshop that was hosted by the GEO Climate Change Working Group (CC-WG) in 2021. The 2021 GHG Monitoring from Space report provides an overview of the current and upcoming satellite missions that monitor GHGs.

SENDAI FRAMEWORK FOR DISASTER RISK REDUCTION

SENDAI FRAMEWORK
FOR DISASTER RISK REDUCTION **2015-2030**

The Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) is a 15-year global agreement, adopted by the United Nations member states at the World Conference on Disaster Risk Reduction held in Sendai Japan in March 2015 and endorsed by the UN General Assembly in June 2015. Developed in parallel with the Paris Agreement and the 2030 Agenda for Sustainable Development as a part of the post-2015 global agendas, SDFRR provides Member States with concrete actions to protect development gains from the risk of disaster. It outlines 4 Sendai Framework Priorities for Action to prevent new and reduce existing disaster risks:

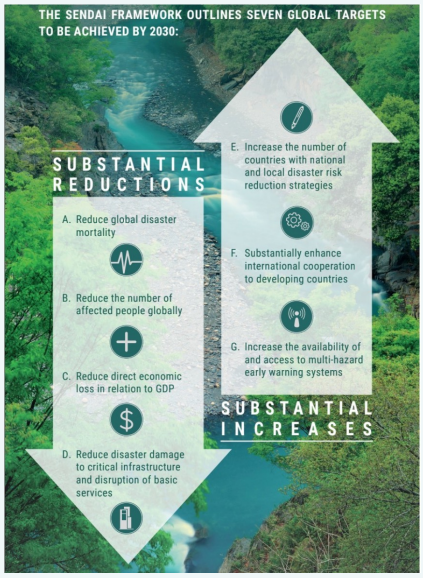
- Understanding disaster risk;
- Strengthening disaster risk governance to manage disaster risk;
- Investing in disaster reduction for resilience and;
- Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction.

The accompanying 7 Sendai Framework Global Targets are a guide to assess progress. The Sendai Framework Monitor is an online tool that captures self-reported progress data by member States against a set of 38 Sendai Framework Indicators towards the 7 Sendai Framework global targets. The indicators measure progress and determine global trends in the reduction of risk and losses. Reporting responsibility is with designated Sendai Framework National Focal Points, many of whom are disaster management agencies.

The United Nations Office for Disaster Risk Reduction (UNDRR) is mandated to support the achievement of the outcome and goals of the SFDRR. UNDRR serves as the custodian agency for a set of targets and indicators of the SDG goals 1 (Poverty), 11 (cities) and 13 (climate change) as these are synchronized with the 7 targets and 38 global indicators set by the SFDRR.

In 2018, the head of UNDRR expressed her hope of GEO's contribution to DRR strategies.[2]

In 2019, UNDRR launched its flagship initiative called the Global Risk Assessment Framework (GRAF) with the aim to improve risk analytics around



interconnected and systemic risk, including the multiplier effect climate change has on vulnerability and risk landscape. By engaging with government partners, the UN development and humanitarian system and other global and national partners, GRAF aims to support countries to strengthen their risk data ecosystems.

GRAF is currently focused on offering risk assessment services to its pilot countries, particularly Least Developed Countries (LDCs), Small Island Developing States (SIDS) and some middle-income states that are prone to repeated loss and damage from disasters. The GRAF pilot countries receive the common basket of services, including the Risk Information Exchange (RiX), a portal site with data to support the country's risk reduction efforts.

In 2022, the UN Secretary General called for equipping all countries with early warning systems by 2027.[3]

EO contribute to disaster preparedness, early warning and better mitigation and response. GEO has been collaborating with UNDRR in its efforts on GRAF to build a new online resource called EO Risk Toolkit. As an integral part of RiX, EO Risk Toolkit aims to provide DRR users direct links to a collection of open and free disaster risk analytical tools and services to be used at country level.

[2] In her keynote speech at GEO Plenary hosted by Japan in 2018, Ms. Mizutori, the head of UNDRR "said that as more countries put in place national and local strategies for disaster risk reduction by 2020, in line with the Sendai Framework, "earth observation data can greatly assist countries in assessing current risk trends with a view to determining the most pressing priorities that their disaster risk reduction strategies need to address".

[3] On World Meteorological Day 2022, Secretary-General António Guterres anounced that "the United Nations will spearhead new action to ensure every person on Earth is protected by early warning systems within five years".

Approach and methodology

Since the end of 2020, a cross-WG task team has been established to conduct the mapping exercise. It was led by GEO Secretariat coordinators and the co-chairs of the CC-WG, the Disaster Risk Reduction Working Group (DRR-WG) and the Capacity Development Working Group (CD-WG). It also included several members of the three WGs involved throughout the design, data collection, data analysis, and follow-up phases.

Design phase

Over several months, a mapping interface was designed by the cross-WG task team, with technical support from the United States Geological Survey (USGS) and Esri. The digital survey format via "Survey123 for ArcGIS" allowed a dedicated access link for each GWP activity, providing an opportunity to integrate and update data.

The GWP mapping was structured into 6 sections with 45 qualitative and quantitative questions, as follows:

- Section 1: GEO Activity Identification
- Section 2: Scope and Area of Impact
- Section 3: Climate Action
- Section 4: Disaster Risk Reduction
- Section 5: Capacity Development
- Section 6: Further Information

Data collection phase

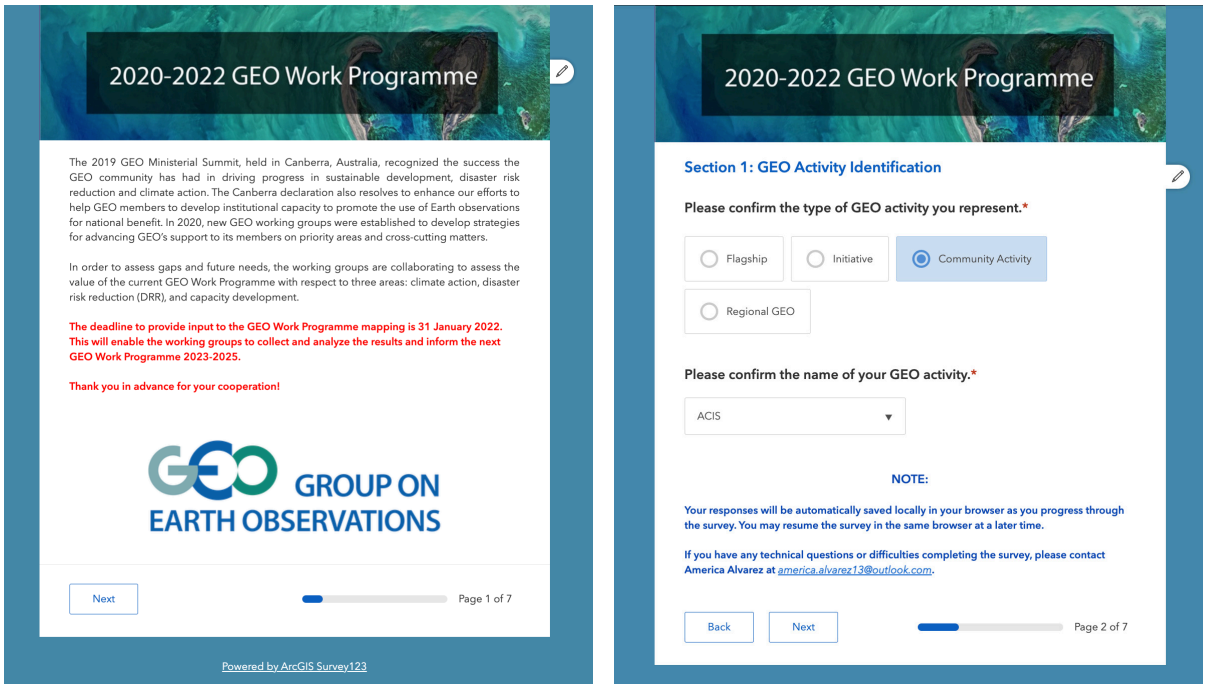
The GWP mapping was officially launched on 31 August 2021 through individual invitations to GWP leads. A first deadline was set on 10 September 2021 to allow early analysis of results in view of the GEO Climate Policy and Finance workshop taking place at the end September. The cross-WG task team made itself available for on-demand consultations to walk respondents through the mapping. Initial results of the mapping were presented at various GEO meetings and in publications during the course of 2021.[4] The final deadline to provide input to the GWP mapping was set on 31 January 2022 to enable the WGs to collect and analyze the results in the present report.

Data analysis phase

The analysis provided in this report addresses the collective feedback of GWP activities and supports the final recommendations drawn from this exercise. Some qualitative answers were amplified with further insights from the WG leads on currently ongoing efforts such as specific engagements with partners or countries, input on current gaps, opportunities and envisioned planning.

The summary overview of the GWP mapping results is based on a detailed data analysis, which is available in a separate technical document. The analysis approach has been streamlined across all sections of the GWP mapping (45 questions), and sections and questions are indicated in the analysis for reference.

Fig.2 - GWP mapping survey interface



[4] Esri, Feb 2022, On Guard: Group on Earth Observations Collaborates with Esri and Other Organizations to Better Understand and Combat Disaster Risks.

Some specific methodological choices include the following.

- **Data visualization**: All data points were gathered and visualized in an interactive dashboard, supported by Survey123 for ArcGIS. The data was processed in an Excel database, which formed the basis for all graphs and charts.
- **Data completeness**: In case of anomalous missing data, incomplete survey entries were edited in coordination with respondents. Answers marked with one asterisk (*) indicate responses that were filled on behalf of the related GWP activity.
- **Data coherence**: In case of inconsistent data in an individual entry, survey entries were cross-checked with the respondents to identify the most accurate input according to the overall feedback provided.

Follow-up phase

The mapping exercise was carried out for the first time as a cross-WG effort to establish baseline information on the current GWP activities. As part of this report, the cross-WG task team concluded some lessons learnt on the mapping design and content for future survey efforts.

Following the report finalization, the outcomes of the GWP mapping will feed into the GWP 2023-2025 online information collection process. Notably, an online module that ties into the relevant mapping questions gathering baseline data of GWP activities is expected to be integrated into the GWP 2023-2025 online form. When submitting their IPs for the period 2023-2025, GWP activity proponents will be able to update their answers to the mapping or answer for the first time in the case of new activities. As such, the GWP mapping could become a standing component of the biannual call for IPs, whereby baseline data is collected on an automated basis.

Future analysis should build on the lessons learnt from this mapping exercise and include the GEO RCHS and SDGs engagement priorities, complementary to the existing engagement priorities.

Photo credit: University of Lagos

Outcomes of the 2020 – 2022 GEO Work Programme mapping

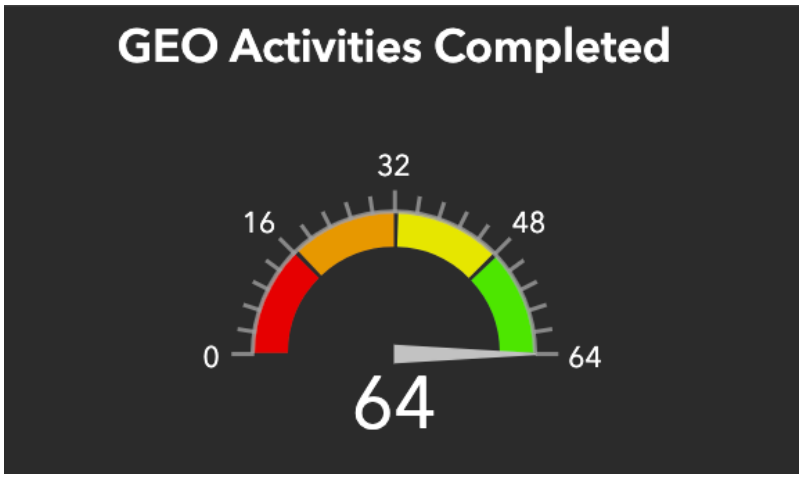
The GWP mapping covered 4 GEO Flagships, 21 Initiatives, 34 Community Activities, and 4 Regional GEOs, for a total of 64 activities. All 64 activities responded to the survey, except for one which was completed by the cross-WG task team on their behalf based on information publicly available. The findings of the GWP mapping illustrate the status of activities and engagement across Climate Action and DRR, as well as capacity development.

Thematic and geographic scope and policy areas

Overall, the 64 GWP activities cover a wide range of thematic domains, with many GWP activities contributing to multiple topics simultaneously. However, there is a stronger focus on land-related issues in comparison to cross-cutting and water-related issues.

Over half of the GWP activities (35) address the thematic domains of Urban Areas and Cities / Settlements (35), followed by Croplands (33), Coastal Zones (32), Freshwater (32), and Land (32). The thematic domains least addressed by GWP activities are the Arctic/ Cryosphere (18) and Small Islands (18).

Fig.3 - Total of GWP activities that completed the mapping



When clustering the thematic domains by broader themes, it appears that the focus of GWP is on land-related issues with about 55% of total engagement (including Croplands, Land, Forests, Grassland, Mountain Systems, Wetlands, Drylands), 28% on cross-cutting issues (including Urban Areas and Cities, Coastal Zones, Arctic/Cryosphere, and Small Islands), and about 15% on water-related issues (including Freshwater, and Ocean and Marine Systems).

Based on the feedback received, 7 activities did not identify any specific sectors/topic as relevant or applicable to their work, while they could relate to some additional thematic domains, such as air/atmosphere, or socioeconomic sectors, such as energy and health.

Fig.4 - GWP activities engaged in thematic domains

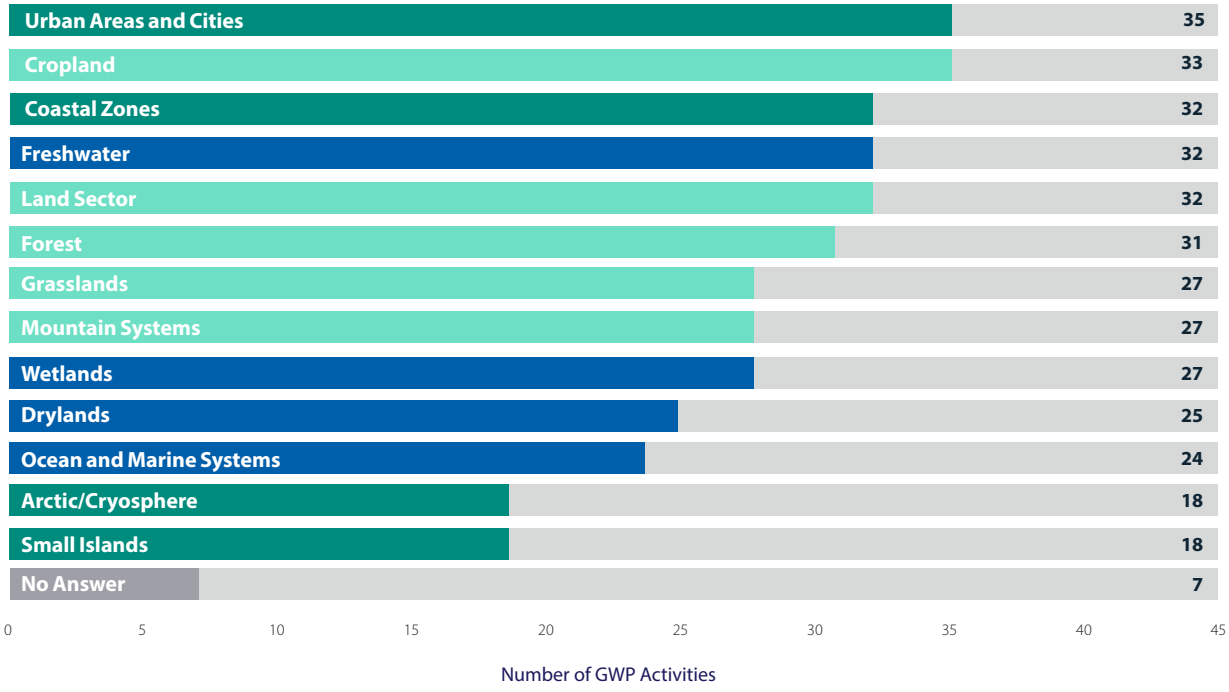
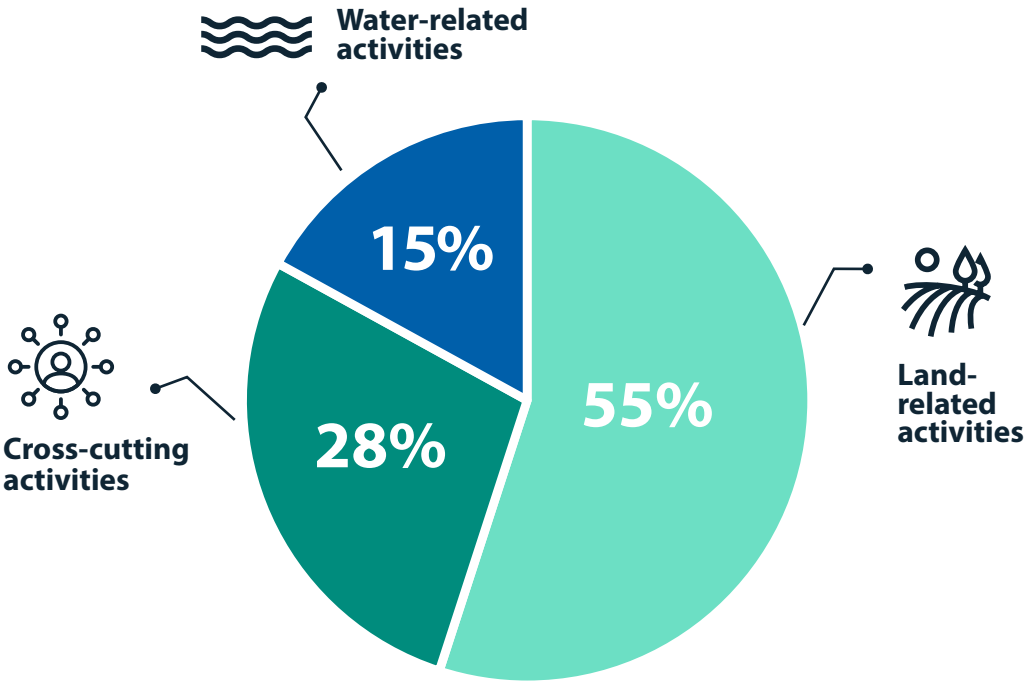


Fig.5 - Overview of GWP activities engaged in thematic domain clusters



GWP activities operate and have an impact across all geographies, primarily regional (over 84%) and global (over 80%). More than 50% of all activities also have a geographical interest and impact on a subregional and national scale, while only around 35% of all GWP activities work and accelerate impact locally.

Leaders of GWP activities were asked to indicate their engagement across 5 different scales (Global, Regional, Subregional, National and Local) considering the geographical coverage associated with the area of interest or impact that these activities have (rather than the membership).

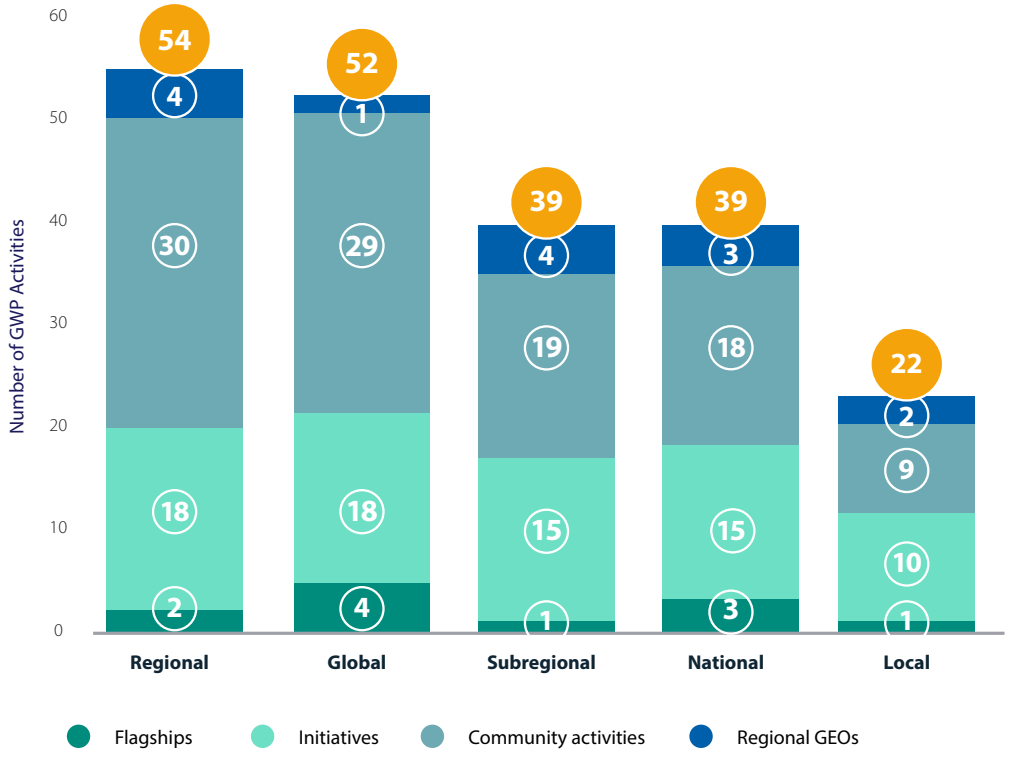
52 GWP activities indicated that their work has an interest or impact on a global level (over 81%). Of these, 11 GWP activities appear to engage on all five geographical levels: global, regional, subregional, national and local level; while 4 GWP activities have selected global coverage only, without further specifying any other level in the following answers.

Both responses can be interpreted as global engagement or impact. That is, the work carried out or proposed in the activity has the potential to provide information relevant on a global level beyond any specific national or regional scale (e.g., atmospheric monitoring or global models, which can be replicated on different scales or for different stakeholders) or it is relevant at all levels (e.g., monitoring of health variables).

Generally, the GWP activities have an elected geographical area of interest or impact depending on the type of activity:

- All 4 Flagships have a lobal focus which reflects their intended nature.
- Initiatives and Community Activities have an equally global and regional scope, with lesser focus on activity at a subregional, national or local level.
- All 4 Regional GEOs have a regional and sub-regional focus, however, some of them also act at national and local scale given their close connections with relevant stakeholders.

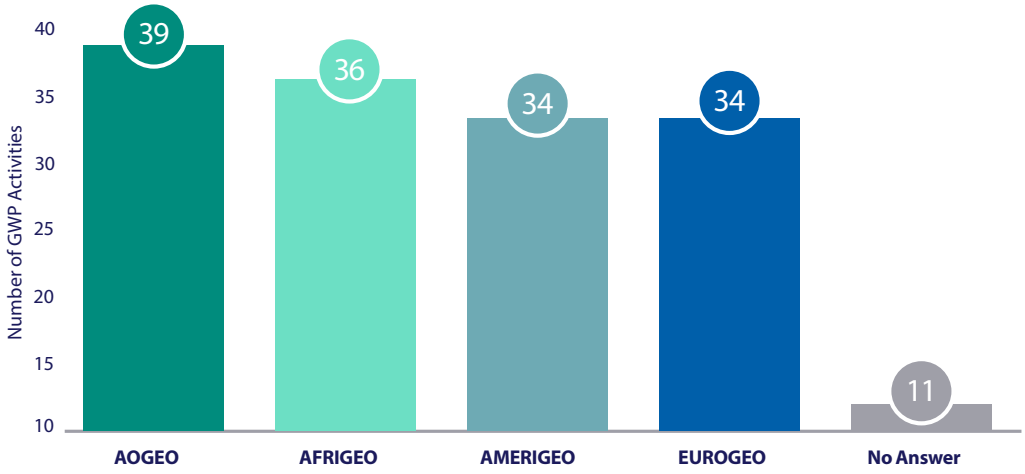
Fig.6 - GWP activities impact across geographies per type of activity



Furthermore, 54 GWP activities indicated that they work on a regional level (over 84%), and the geographical regions most focused on are those that correspond to AOGEO (39), AFRIGEO (36), AMERIGEO (34) and EUROGEO (34).

It should be noted that about half of the respondents selected all four regions, indicating a good extent of cross-regional work taking place.

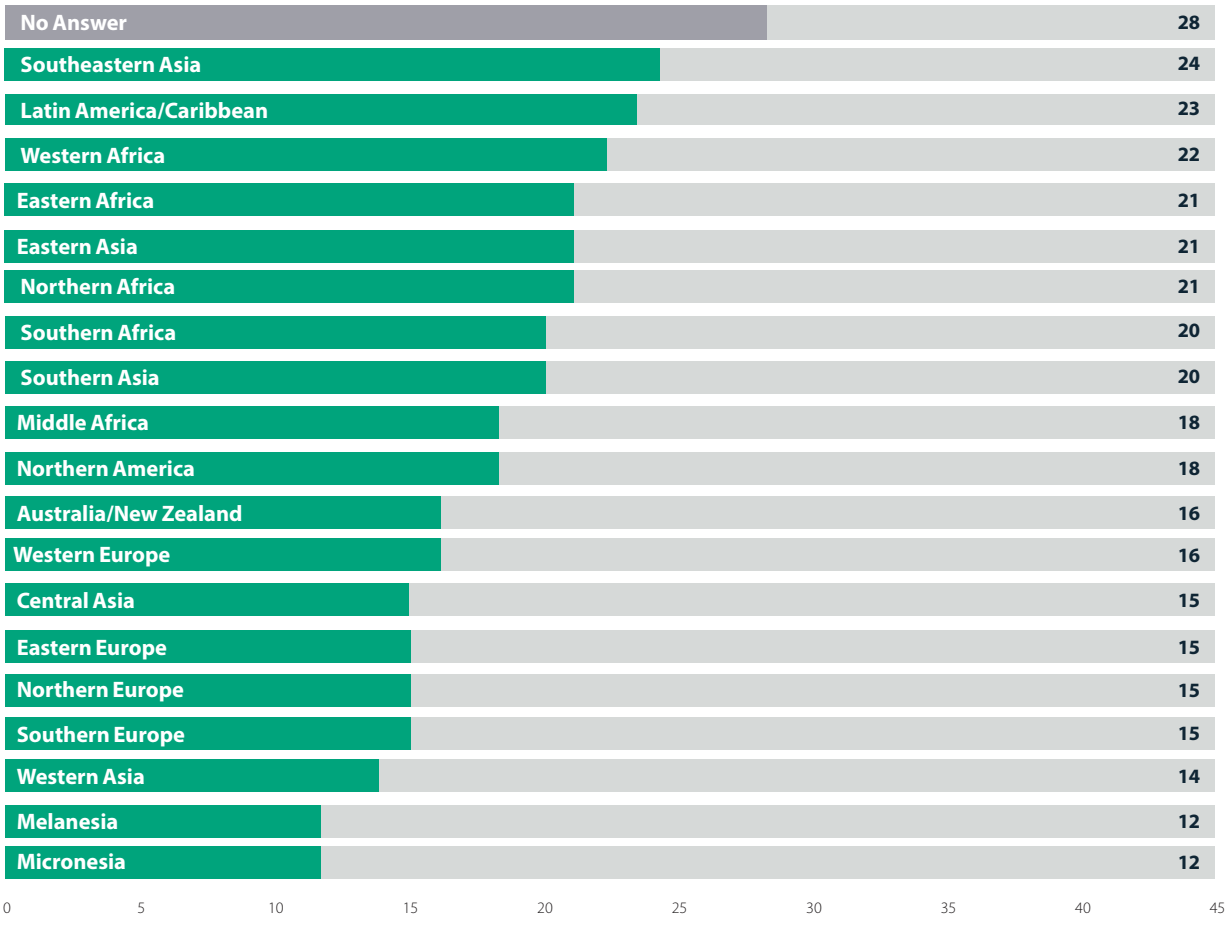
Fig.7 - GWP activities' impact by region



36 GWP activities (56%) indicated that they engage and have impact at the sub-regional level, with the top 3 sub-regions identified being Southeastern Asia (24), Latin America/Caribbean[5] (23), and Western Africa (22), and the sub-regions least addressed being Western Asia (14), Melanesia (12) and Micronesia (12).

It should be noted that the involvement of Pacific Island Countries and Territories and SIDS is being encouraged in GEO given the currently low engagement.

Fig.8 - GWP activities' impact by sub-region



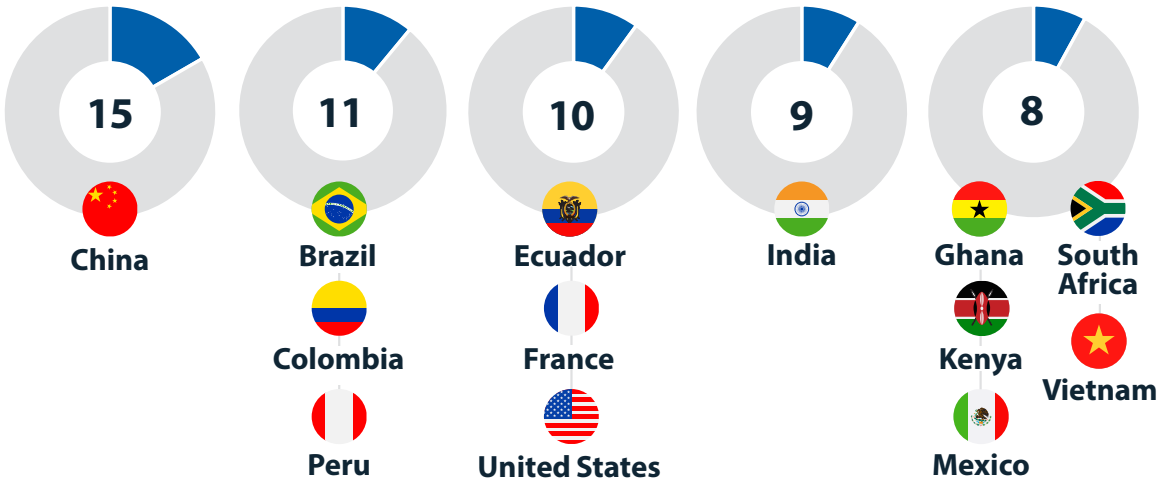
[5] The sub-regions grouping, whereby Caribbean countries are associated with Latin America, may be misleading in showing high representation of the Caribbean region.

While GEO has almost 115 members, examples of ongoing cooperation with national governments that implement EO data and products for decision making can only be identified for some GWP activities. This can be explained since many GWP activities are working to support EO data and information needs at the regional or global level rather than national.

On a national level, less than half of the GWP activities indicated that they engage or have established cooperation with individual governments for the uptake of EO data and products. The countries most represented across the 30 GWP activities that responded are: China (15); Peru, Brazil, Colombia (11); Ecuador, France, United States (10); India (9); Ghana, Kenya, Mexico, South Africa, Vietnam (8).

However, more than half of the activities (34) did not indicate whether they are working with specific countries.

Fig.9 - Most cited countries for national engagement by GWP activities



The mapping results on GWP activities engagement with countries have provided the basis to examine connections between existing GWP activities and international policy frameworks for climate action and DRR.

With a view to upcoming engagements in international climate policy processes, it can be noted that GWP activities that have indicated that they have a collaboration with Egypt, the host country of the 27th Conference of the Parties to the UNFCCC (COP27) in 2022. These include GEOGLAM, GOS4POPS, GEO-LDN, GEO-CRADLE and CSDR. Only EO4SDG is collaborating with the UAE, the host country of UNFCCC COP28 in 2023. It should be noted that this is not an exhaustive list but a starting point to build a GEO value proposition for climate action to engage with the countries.

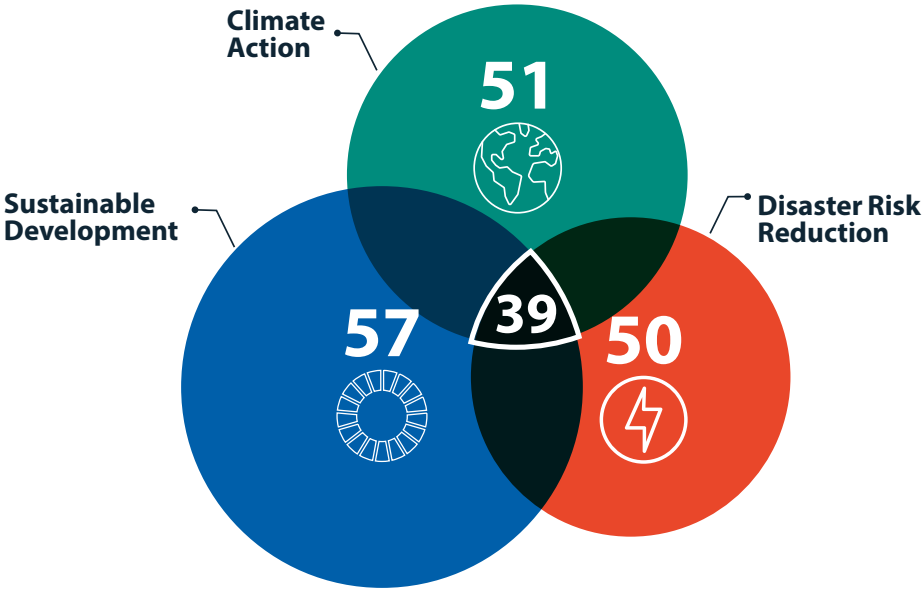
In light of the ongoing collaboration between GEO and UNDRR, 15 GWP activities in support of the Sendai Framework for DRR have connections to countries working closely with UNDRR (including 17 GRAF Pilot countries: Angola, Bangladesh, Cambodia, Chad, Costa Rica, eSwatini, Fiji, Haiti, Madagascar, Maldives, Mozambique, Pakistan, Philippines, Somalia, South Sudan, Sudan, and Tajikistan).

All GWP activities are engaged at least in one of the global policy drivers and GEO engagement priorities across Sustainable Development, Climate Action and DRR. While almost all GWP activities support Sustainable Development, there is large overlap across the three global agendas that have resilience building, Adaptation and Loss and Damage as intrinsic cross-cutting elements.

All GWP activities address at least one global policy driver, with 57 activities (about 89%) contributing to Sustainable Development (UN 2030 Agenda); 51 activities (about 80%) contributing to Climate Action (Paris Agreement); 50 activities (about 78%) contributing to DRR (Sendai Framework). While 38 activities (about 59%) contribute to all three policy drivers.

As it will appear more clearly later in the analysis, the areas of Adaptation and Loss and Damage particularly are addressed by GWP activities under both Climate Action and DRR. Therefore, resilience building appears to be one cross-cutting element that supports climate adaptation, preparedness to weather-related disasters, and overall sustainable development.

Fig.10 - GWP activities supporting the GEO engagement priorities and related global policy drivers



GWP ACTIVITIES:

ACIS	CROP-PEST-MONITORING	EO4WEF	GEO-VENER	GWIS	
AFRICULTURES	CSDR	EUROGEO	GEO-WETLANDS	HUMAN-PLANET	
AFRIGEO	DE-AFRICA	GDIS	GEOARC	IN-SITU-ESC	
AGRI-DROUGHT	DE-PACIFIC	GEO BON	GEODESY4SENDAI	LAND-COVER	
AMERIGEO	DELTA-ESTUARY	GEO-CITSCI	GEOGLAM	MUSYQ	
AOGEO	DIAS	GEO-CRADLE	GEOGLOWS	NEXT-EOS	
AQUAWATCH	EO-IIP	GEO-DARMA	GFOI	NIGHT-LIGHT	
ARCTIC-GEOSS	EO4DRM	GEO-ECO	GFRM	OEA	
ATLANTIC-EO	EO4EA	GEO-EV	GLOFAS	SCO	
BLUE-PLANET	EO4HEALTH	GEO-LDN	GOS4M	SPACE-SECURITY	
C3S	EO4MIN	GEO-MOUNTAINS	GOS4POPS	TIGGE	
CAMS*	EO4SDG	GEO-TREES	GSNL	UHCO	
CLIMATE-OBS	EO4SENDAI-MONITORING	GEO-VALUE	GUOI		

Climate Action

Climate change is one of the top engagement priorities across the GWP. While most activities are focused on climate change and climate action in general, the link between the GWP and the policy process appears to be indirect or lacking.

As noted in the previous question, 51 activities (almost 80%) appear to focus on climate action across the GWP. However, only 12 GWP activities (18%) state that they provide input to the UNFCCC and Paris Agreement processes, whereas the vast majority, 48 activities (76%), does not engage with these processes.

Most of these activities specified the type of engagement, which often qualifies as indirect input to the process. Few provide a direct input, with provision of observational data in support of Nationally Determined Contributions (NDCs) (C3S); reporting on GHG emissions for REDD+ (AMERIGEO); developing supplemental guidance on EO-based agricultural monitoring for National Adaptation Plans (NAPs) (GEOGLAM); and supporting the development of National Forest Monitoring Systems (NFMSs) and associated Measurement, Reporting and Verification (MRV) procedures to enable reporting on forest emissions to the UNFCCC in various forms and inform development of interventions to reduce national emissions and achieve NDCs. In one case (DE-AFRICA) the activity is not providing input yet, but they state that they can support national reporting under the UNFCCC.

Participating in the international climate policy process does not always equate to direct collaboration with governments. In fact, only a very small share, 6 GWP activities (about 10%), state that they collaborate with the UNFCCC National Focal Points in the countries of GEO activity operations, whereas 54 activities do not appear to engage.

Two of them (GDIS and DE-AFRICA) provided a description of their engagement, which indicates respectively a direct connection with the US delegation to the UNFCCC, and provision of technical support to countries on national GHG inventory reporting, as well as mitigation and adaptation planning. Notably, 2 GWP activities that have a regional focus (DE-PACIFIC and AOGEO) stated that while they do not provide input to the international climate policy process, they are collaborating with UNFCCC focal points in the countries.

United Nations
Framework Convention on Climate Change

Fig.11 - GWP activities providing input to UNFCCC and Paris Agreement

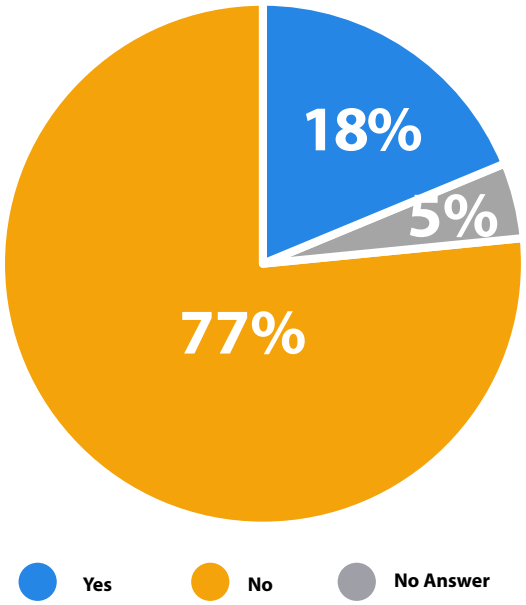
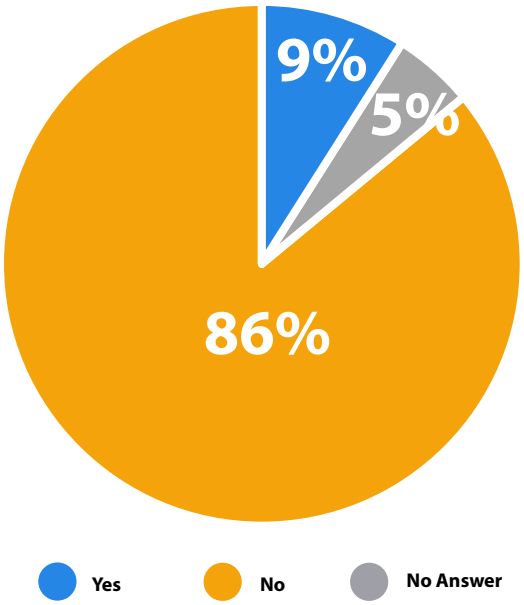


Fig.12 - GWP activities collaborating with UNFCCC National Focal Points



Few GWP activities (about 16%) currently engage in the Intergovernmental Panel on Climate Change (IPCC) process and assessments, mostly to support IPCC WGI reports on the Physical Science Basis and Special Reports.

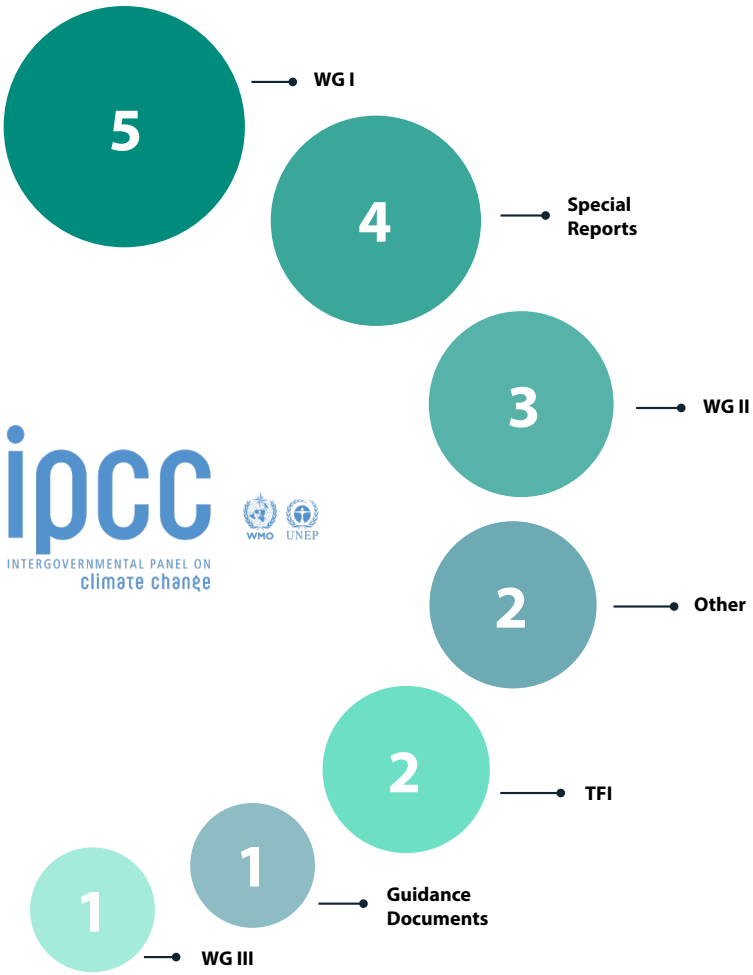
Of the engaged 11 GWP activities (about 16%), 5 activities support the preparation of IPCC Assessment Reports notably WGI on the Physical Science Basis, followed by 4 GWP activities supporting IPCC Special Reports, and 3 supporting WGII on Impacts, Adaptation and Vulnerability.

Overall, many GEO experts have been involved in IPCC assessments and special reports. Datasets and literature generated by GWP activities have been used to inform IPCC findings over time. These include numerous scientists from AMERIGEO, who have contributed to the Physical Science Basis report by WGI over multiple IPCC assessment cycles. C3S experts have also contributed to WGI reports, including the ERA5 dataset, a global atmospheric reanalysis of hourly meteorological conditions produced by the European Centre for Medium-Range Weather Forecasts (ECMWF) and C3S.

Other examples include:

- GEO-MOUNTAINS informed both the WGI and WGII assessments and provided delineations of mountain regions and population densities for the Cross-Chapter Paper Mountains in WGII, as well as delineation of mountain regions for the 2019 Special Report on the Ocean and Cryosphere in a Changing Climate.
- GFOI contributed significantly to the 2019 Refinement of the 2006 IPCC Guidelines for the National Greenhouse Gas Inventories.
- GDIS provided input to the 2012 Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation.
- Other GEO activities (such as AOGEO, CAMS*, GUOI, CLIMATE-OBS, HUMAN-PLANET, DE-AFRICA) have also participated in the IPCC assessments and processes to various extents. However, it is sometimes unclear what the actual contribution has been, or whether it is just a potential contribution as no specific information was provided to support this claim.

Fig.13 - GWP activities' contribution to IPCC assessments and processes



GWP activities mostly collaborate with space agencies and UN agencies to undertake climate-related work through participation in joint working groups or technical projects.

When asked who the GWP activities collaborate with the most for climate-related work, Committee on Earth Observation Satellites (CEOS) (24) appears to be a key partner for GWP activities, followed by United Nations Environment Programme (UNEP) (16), World Meteorological Organization (WMO) (14), Global Climate Observing System (GCOS) (8), World Climate Research Programme (WCRP) (5), and Coordination Group for Meteorological Satellites (CGMS) (2).

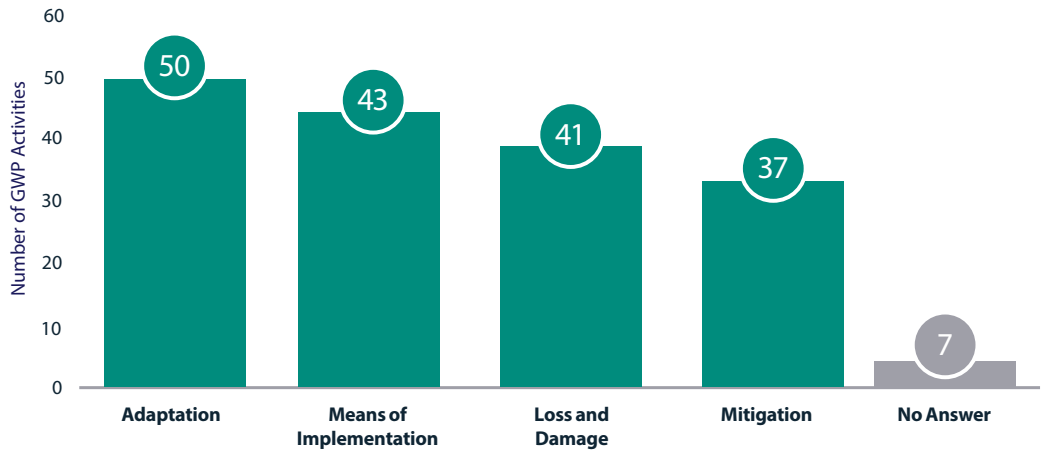
About half of the GWP activities (33) provided additional information on the type of engagement they have in place with key GEO partners. It is interesting to note that most collaborations are undertaken through the participation in dedicated joint working groups/task groups, or technical projects.

Upon further analysis, many WP activities relate to numerous workstreams under the UNFCCC and Paris Agreement, particularly climate change adaptation. However, the number of dedicated GWP activities does not necessarily reflect the actual delivery, with GWP activities showing mostly potential or partial contribution on Adaptation, Means of Implementation, and Loss and Damage. Mitigation-related activities across the GWP are fewer but appear to be providing more concrete contribution proportionally.

GWP activities support multiple areas simultaneously across the following specific workstreams of the Paris Agreement: Adaptation, Means of Implementation, Loss and Damage, and Mitigation using EO.

Looking at the numbers of activities only, the focus of the current GWP appears to be mainly on Adaptation (50), that is climate change impacts, vulnerability, and adaptation measures to increase resilience. A significant number of GWP activities also address Means of Implementation (43), that is access to capacity building, technology, and finance for developing countries to implement climate mitigation and adaptation actions. Numerous GWP activities also contribute to the area of Loss and Damage (41), that is approaches to averting, minimizing, and addressing loss and damage associated with the adverse effects of climate change including slow-onset and extreme events. Another area of interest for many GWP activities, although significantly fewer compared to adaptation, is Mitigation (37), that is GHG emission reduction.

Fig.14 - Climate action workstreams supported by GWP activities



In terms of delivery of GWP activities to support these broad workstreams under the Paris Agreement, generally it can be noted that it is mostly "partial" or "potential" contribution. However, Mitigation-related activities appear to perform slightly better proportionally, with about 67% of the respondents claiming that they provide "partial" and "considerable" contribution to this area of work, compared to lower delivery results of activities engaged in the areas of Adaptation and Means of Implementation (both about 60%), and Loss and Damage (about 58%) that therefore appear to be still latent, not yet operational, or just less mature.

Table 1 - GWP activities' contribution to climate action workstreams

Potential · Partial · Considerable contribution

GEO ACTIVITY	ADAPTATION	LOSS AND DAMAGE	MEANS OF IMPLEMENTATION	MITIGATION
ACIS			Partial	
AFRICULTURES	Considerable		Potential	
AFRIGEO	Potential	Potential	Potential	Potential
AGRI-DROUGHT		Considerable	Partial	
AMERIGEO	Considerable	Considerable	Partial	Partial
AOGEO	Partial	Partial	Potential	Potential
AQUAWATCH	Partial	Potential	Potential	
ARCTIC-GEOSS				
ATLANTIC-EO	Potential	Partial	Potential	Partial
BLUE-PLANET	Potential		Potential	
C3S	Considerable	Partial		
CAMS*	Considerable			Considerable
CLIMATE-OBS	Potential	Potential	Considerable	Potential
CROP-PEST-MONITORING	Potential	Potential	Considerable	Considerable
CSDR	Partial	Potential	Potential	
DE-AFRICA	Partial	Partial	Partial	Partial
DE-PACIFIC	Considerable	Partial	Partial	Potential
DELTA-ESTUARY	Potential	Potential	Potential	Partial
DIAS	Potential	Considerable	Partial	
EO-IIP			Considerable	
EO4DRM	Partial	Potential	Potential	
EO4EA	Potential	Potential		
EO4HEALTH	Partial	Considerable	Partial	
EO4MIN			Partial	Partial
EO4SDG	Considerable		Considerable	
EO4SENDAI-MONITORING	Potential	Potential		
EO4WEF	Partial	Considerable	Considerable	Partial
EUROGEO	Partial			Partial
GDIS	Potential			Partial
GEO BON	Potential	Potential	Considerable	
GEO-CITSCI				
GEO-CRADLE	Considerable	Partial	Considerable	Potential
GEO-DARMA	Potential	Potential	Potential	Potential
GEO-ECO	Partial	Partial	Potential	Partial
GEO-EV	Potential	Considerable	Potential	
GEO-LDN	Potential	Considerable	Partial	Partial
GEO-MOUNTAINS	Partial	Partial	Partial	Partial
GEO-TREES	Potential			Considerable
GEO-VALUE	Potential	Potential	Potential	Potential
GEO-VENER				Considerable
GEO-WETLANDS	Potential			Potential
GEOARC	Partial			Partial
GEODESY4SENDAI	Partial	Potential	Partial	Partial
GEOGLAM	Partial	Partial	Partial	Partial
GEOGLOWS	Considerable	Considerable	Considerable	Partial
GFOI			Considerable	Considerable
GFRM				
GLOFAS				
GOS4M				
GOS4POPS				
GSNL				
GUOI	Partial	Considerable		Partial
GWIS	Partial	Partial	Partial	Partial
HUMAN-PLANET	Considerable	Potential		Partial
IN-SITU-ESC	Potential		Potential	Potential
LAND-COVER	Partial	Partial	Potential	Potential
MUSYQ	Partial	Partial	Considerable	Partial
NEXT-EOS	Potential	Potential	Potential	Potential
NIGHT-LIGHT	Partial		Partial	Partial
OEA	Potential	Potential		
SCO	Considerable	Considerable	Considerable	
SPACE-SECURITY	Partial	Partial	Potential	Potential
TIGGE		Potential		
UHCO	Considerable	Considerable	Considerable	

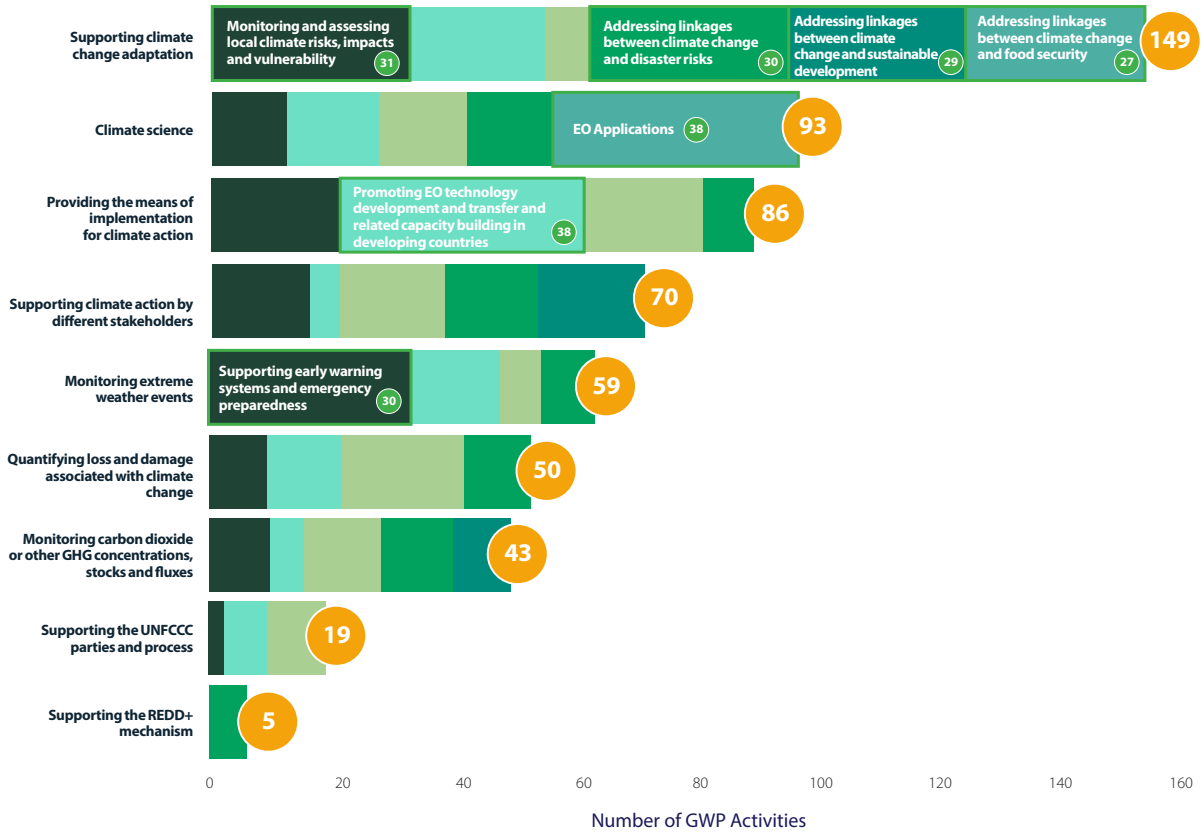
When digging deeper and looking at the content of the work of GWP activities, other sub-areas of work are revealed. The sub-areas that are mostly addressed across the GWP include developing EO applications (38) as well as promoting EO technology development and transfer and related capacity building in developing countries (38).

These are followed by monitoring and assessing local climate risks, impacts and vulnerability (31), supporting early warning systems and emergency preparedness (30), addressing linkages between climate change and disaster risks (30), climate and sustainable development (27), and climate and food security (27).

The more in-depth analysis of sub-areas of work revealed that:

- **GWP activities that are supporting climate change adaptation** are mostly focusing on monitoring and assessing local climate risks, impacts and vulnerability (48%) as well as addressing linkages between climate change and disaster risks (46%), sustainable development (45%), and food security (42%).
- **GWP activities that selected climate science** indicated that their work mostly focuses on EO applications (about 60%), while forecasting, climate predictions, reanalysis and model intercomparison are less prominent.
- **GWP activities that are providing the means of implementation** for climate action are primarily promoting EO technology development and transfer and related capacity building in developing countries (59%). Regarding climate finance, using EO to strengthen the evidence base in public funding proposals for climate action projects/programmes by developing countries (22%) appears to be a more common sub-area of work as opposed to using EO to support thorough climate risk assessments by businesses and financial institutions (8%).
- **GWP activities that are monitoring extreme weather events** are mostly supporting early warning systems and emergency preparedness (46%).
- **GWP activities that are supporting climate action by different stakeholders** are equally supporting education and youth in responding to climate change (26%), supporting climate action by non-state stakeholders (26%), local communities and Indigenous peoples (25%) and municipalities (23%). Little focus is on understanding and responding to the linkages between gender and climate change (7%).
- **GWP activities that are working to quantify loss and damage** associated with climate change are mostly doing so through comprehensive risk management approaches (29%).
- **GWP activities that are monitoring carbon dioxide or other GHG** concentrations, stocks and fluxes, are mostly focusing on assessing trends of GHG concentrations in the atmosphere (16%), supporting the development of GHG inventories (15%), and assessing past and present trends of GHG by countries (14%).
- **GWP activities that are supporting the UNFCCC Parties and process** are providing information to the Global Stocktake (14%) and supporting the development and/or monitoring of NDCs (10%).
- **GWP activities that are supporting the REDD+ mechanism under the Paris Agreement** provide methods and guidance materials on REDD+ MRV (about 8%).

Fig.15 - Sub-areas of work under climate action across GWP activities



	A	B	C	D	E	F
Supporting climate change adaptation	**Monitoring and assessing local climate risks, impacts and vulnerability (31)**	Monitoring and assessing global levels of climate risks, impacts, and vulnerability (21)	Developing and monitoring national adaptation plans (NAPs) (8)	**Addressing linkages between climate change and disaster risks (30)**	**Addressing linkages between climate change and sustainable development (29)**	**Addressing linkages between climate change and food security (27)**
Climate science	Model Intercomparison (12)	Climate Predictions (15)	Reanalysis (12)	Forecasting (16)	**EO Applications (38)**	
Providing the means of implementation for climate action	Assessing barriers and challenges faced by developing countries (21)	**Promoting EO technology development and transfer and related capacity building in developing countries (38)**	Using EO to strengthen the evidence base in public funding proposals for climate action projects/programmes by developing countries (19)	Using EO to support thorough climate risk assessments by businesses and financial institutions (8)		
Supporting climate action by different stakeholders	Supporting local communities and indigenous peoples in responding to climate change (16)	Understanding and responding to the linkages between gender and climate change (5)	Supporting education and youth in responding to climate change (17)	Supporting climate action by municipalities (15)	Supporting climate action by non-state stakeholders (17)	
Monitoring extreme weather even	**Supporting early warning systems and emergency preparedness (30)**	Supporting measures to enhance recovery, rehabilitation and build back / forward better (15)	Supporting social protection instruments, including social safety nets (6)	Supporting transformational approaches (8)		
Quantifying loss and damage associated with climate change	Losses related to human mobility / migration (9)	Non-economic losses (12)	Comprehensive risk management approaches (19)	Providing finance, technology and capacity building to address loss and damage (10)		
Monitoring carbon dioxide or other GHG concentrations, stocks and fluxes	Assessing past and present trends of GHG emissions by countries (9)	Assessing projected GHG emissions (5)	Assessing trends of GHG concentrations in the atmosphere (11)	Supporting the development of national GHG inventories (10)	Supporting the implementation of the IPCC guidelines for national GHG inventory (8)	
Supporting the UNFCCC Parties and process	Supporting the development of National Communications (NCs) or Biennial update reports (BURs) to the UNFCCC (3)	Supporting the development and/or monitoring of NDCs (7)	Providing information to the Global Stocktake (9)			
Supporting the REDD+ mechanism	Provision of methods and guidance materials on REDD+ MRV (5)					

Most GWP activities provided feedback on the relevance of the EO data, tools and products that are generated by their work to address climate change, which highlighted a variety of outputs and different levels of maturity across the GWP.

Most of the activities (26) that replied positively seem to be generating concrete outputs that support decision making to various extents, ranging from science basis and EO data, to tools and other operational products. Other GWP activities (8) have potential but are still too "young" to be providing operational support.

A few others (6) are not actively addressing or directly researching climate impacts on a tangible level since it is not the primary focus of the activity but could do so if prompted. For instance, GEO BON uses EO data and tools and builds additional tools to monitor and understand biodiversity change that is affected by climate change.

Generally, the results are consistent with a related question in the Capacity Development section indicating that GWP activities include capacity development in support of climate action for Adaptation (24), Means of Implementation (21), Loss and Damage (19), Mitigation (9), and other (5).

Consistently with the high number of activities working in the domain of climate adaptation, about half of the GWP activities state that their work and contributions are suitable to be the basis for supplementary technical guidance for developing countries to integrate EO into NAP processes.

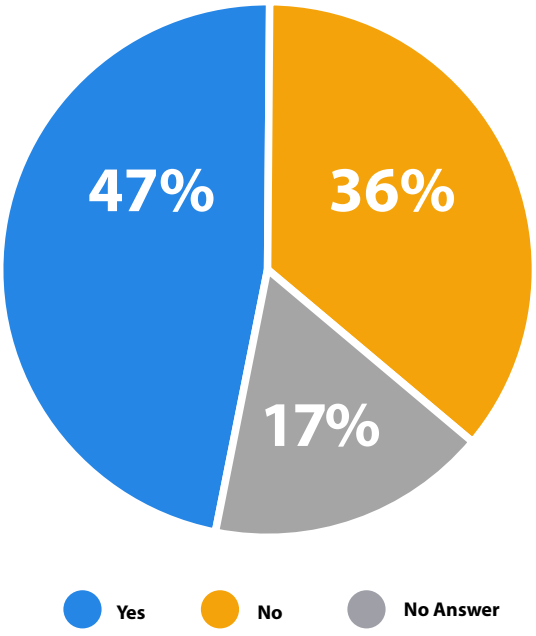
GWP activities that are willing to support the development and implementation of NAPs with supplementary technical guidance operate in different key sectors or thematic domains, such as agriculture, food security, land (6); marine, coastal and riverine hazards (4); urban areas (3); renewable energy (2); health (2); industrial applications (1); and mountains (1).

Other activities can leverage on their focus on data to address multiple sectors or topics (6) and on-the-ground implementation through local and regional partners (4). Others state that they are interested but will need to know more about the NAP process (1), do not specify their potential interest (1), or do not appear to be directly relevant (1).

Currently GEOGLAM is working to develop supplementary technical guidance for NAPs in the agriculture sector that will help LDCs and other developing countries integrate satellite-based observations and data into national planning for adaptation to climate change. GEOGLAM's NAP guidance (draft under development) will be a blueprint for other GEO activities in other key sectors, such as water, coastal areas, etc.

For instance, based on the analysis of the national investment for risk management and other factors within the 2018 National Plan for Adaptation to Climate Change in Colombia, presented at AMERIGEO Week 2021, there is potential for the application of EO-based climate services such as GEOGloWS to be mainstreamed into national planning.

Fig.16 - Suitability of GWP activities' contributions for EO guidance on NAP processes



Disaster Risk Reduction

DRR as one of GEO's engagement priorities is well represented in GWP activities. This was evident in multiple mapping results indicating a strong alignment with and support for the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR). Over half of the activities in support of SFDRR simultaneously support the Paris Agreement, especially in the areas of Adaptation and Loss and Damage.

The DRR engagement priority has been identified as the main area of work by 50 GWP activities (78%), showing an almost equal level of engagement to climate action (80%).

In addition, it should be noted that some of the activities which claimed no relevance for DRR initially, in fact appeared to be active in some elements of SFDRR:

- **Sendai Framework for Disaster Risk Reduction 2015-2030:** 37 GWP activities (58% of all GWP activities; 74% of DRR-related activities) state their work directly aligns with or supports the Sendai Framework.
- **Sendai Framework Priorities for Action:** 42 GWP activities (two thirds of the GWP activities; 84% of DRR-related activities) claimed to be aligned with or support one or more of the 4 Priorities for Actions. The most popular Priority was *Understanding Disaster Risks* (34).
- **Sendai Framework Global Targets:** 33 GWP activities (52% of all activities; 66% of DRR-related activities) claimed to directly support one or more of the 7 Global Targets. The most popular was *Target G: increasing availability of and access to Multi-Hazard Early Warning Systems (MHEWS) and DRR info assessments* (21).
- **Sendai Framework Indicators:** 24 GWP activities (38% of GWP activities; 48% of DRR-related activities) state that they directly support at least one of the 38 Indicators, with the most popular being *Indicator G5: number of countries that have accessible, understandable, usable and relevant disaster risk information and assessment available to the people at the national and local levels* (10).

Notably, 40 DRR-related activities also indicated their contributions to the Paris Agreement and climate action in general.

Focusing on national partners, although about half of DRR-related activities stated that they work with DRR partners in countries, further analysis revealed that activities do not necessarily have strong connections with users. In fact, not many activities have been engaging with relevant national government agencies, especially Sendai Framework National Focal Points.

This can be explained by the limited number of GWP activities with concrete DRR-related product or service offerings that are currently working with specific countries, such as global datasets that are down-scalable to the national levels well as tools, services and methodologies applicable at national level.

When the GWP activity leads were asked whether they work with DRR practitioners in any countries they are actively collaborating with, 27 GWP activities (42%) confirmed that they work with national DRR practitioners (public, private, or civil society), institutions or agencies, whereas 37 GWP activities (58%) either responded negatively or did not provide answers.

- **DRR partners including private, public, civil society, academic, international:** Out of 27 GWP activities who stated they work with country-level DRR partners, 24 activities provided qualitative answers, including information on the types of partners, such as international non-profit organisations (Open Geospatial Consortium), humanitarian agencies (International Committee of the Red Cross), United Nations agencies and other international organizations (UNDRR, World Food Programme (WFP), WMO, UN Human Settlement Programme (UN-Habitat), UN Economic and Social Commission for Asia and the Pacific (UNESCAP), World Bank Global Facility for Disaster Reduction and Recovery (GFDRR), Organisation for Economic Co-operation and Development (OECD), UN Office for Outer Space Affairs (UNOOSA) and its Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER)) and/or regional/national development agencies (United States Agency for International Development (USAID)).

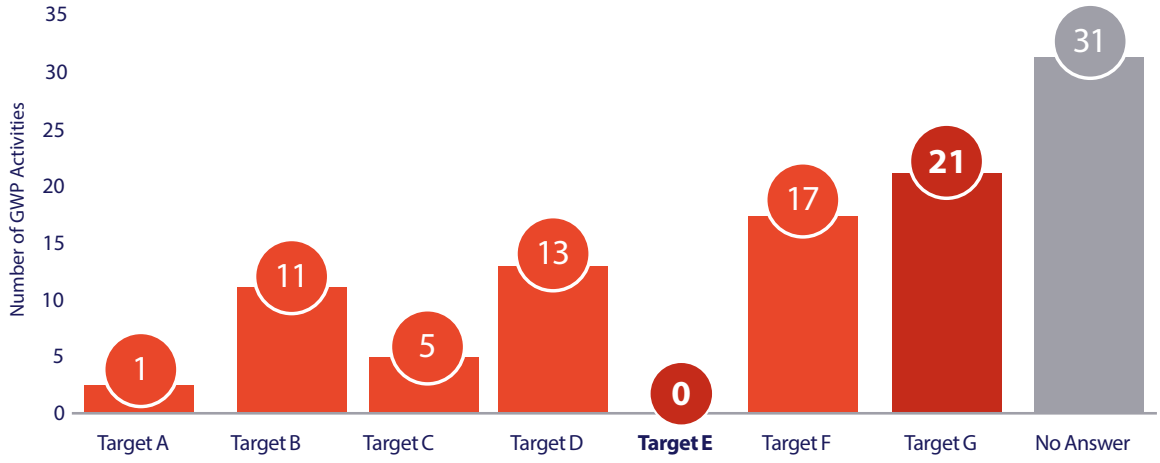
- **National DRR government agencies:** Looking closely into the qualitative answers, 14 GWP activities work with relevant national DRR agencies, such as civil protection/disaster management agencies, national hydrometeorological agencies and agricultural ministries.
- **Sendai Framework National Focal Points:** When GWP activities were asked whether they actively engage with National Focal Points, 8 of them confirmed and almost all provided qualitative information on entities and content. However, only 2 GWP activities were verified through follow-up that they do work with their respective SFDRR National Focal Points.[6]
- **Tools and services for specific countries:** 15 GWP activities (23%) specified the countries they work with while also providing information on their DRR-related tools and services offering. Only one of them (GEOGLAM) is a Flagship activity.

A critical gap identified in this mapping was the limited contribution to DRR policy. While EO data can greatly assist countries in assessing current risk trends with a view to determining the most pressing priorities for DRR, it appears that none of the GWP activities have provided input to national DRR strategies (SFDRR Target E). However, activities may have contributed indirectly through other relevant policies.

While GWP activities provide input to one or more of the SFDRR Global Targets to various extent, no GWP activity stated that they currently contribute to Target E and its 2 indicators: *Increasing number of countries adopted* and *Implemented national and local DRR strategies*.

Meanwhile 7 GWP activities stated that their GWP activities have been mentioned in national DRR strategy of the countries they work with but did not provide further information. It remains to further investigate how and to which level this work is carried out concretely.

Fig.17 - GEO activities directly supporting one or more of the seven Sendai Framework Global Targets



[6] Sendai Framework National Focal Points are designated individuals, normally in national disaster management agencies, who are responsible for leading the coordinated implementation of the Framework, following up and reporting on progress. See more details in Words into Action Guidelines: National Focal Points for DRR, National Platforms for DRR, Local Platforms for DRR) (UNISDR, 2017)

GWP activities may have been contributing to other policy documents that are relevant for DRR, as 9 activities said they deployed capacity development activities to support countries to produce their national DRR/climate policies. Only one GWP activity provided concrete information on how their partner country is leveraging the activity efforts to inform government for the official monitoring and reporting process of SFDRR. Qualitative answers seem to suggest that the majority of GWP activities are not at all familiar with the role of the National Focal Points to report back to the Sendai Framework Monitoring System.

About a third of all GWP activities claimed that they have supported the national monitoring and reporting process with the Sendai Framework Indicators, with the most prevalent indicators being on DRR information, capacity building, and exchange of science, technology and innovation. However, only a few GWP activities appear to support reporting on the common indicators with SDGs.

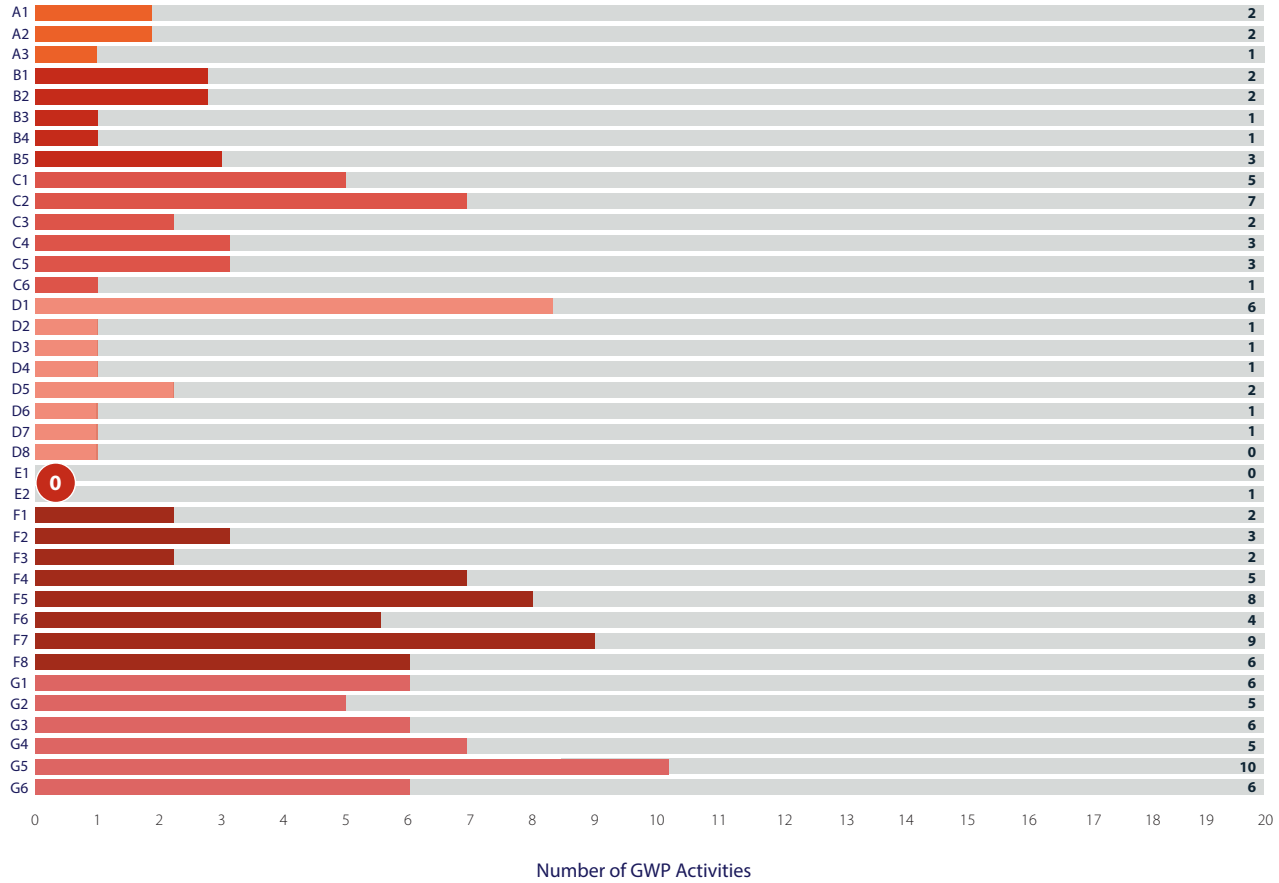
Generally, 24 GWP activities (about 37%) provided feedback on how they directly support the 38 Sendai Framework Indicators, congruent to the 7 Sendai Framework Global Targets A-G.

The indicators most supported by the GWP activities were:

- *G5: Number of countries that have accessible, understandable, usable and relevant disaster risk information and assessment available to the people at the national and local levels* (10 activities).
- *F7: Number of international, regional and bilateral programmes and initiatives for disaster risk reduction-related capacity-building in developing countries* (9 activities).
- *F5: Number of international, regional and bilateral programmes and initiatives for the transfer and exchange of science, technology and innovation in disaster risk reduction for developing countries* (8 activities).

Notably, none of the GWP activities directly support the two global indicators on DRR strategies: at national level (E1) and local level (E2). This result is consistent with the zero response on the Sendai Framework Global Target E, as described above.

Fig.18 - GWP activities directly supporting the 38 Sendai Framework Indicators

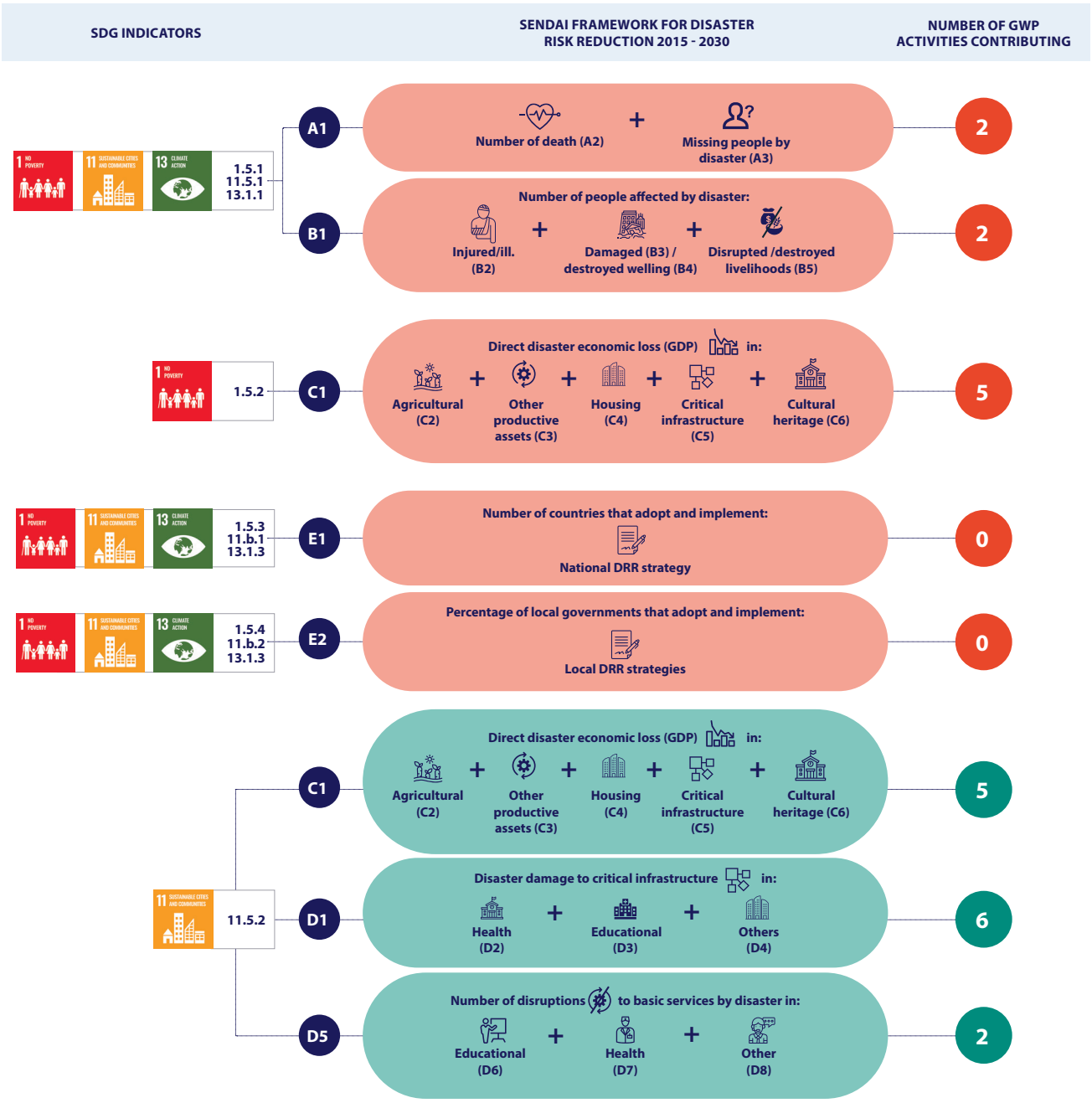


Even though 44 GWP activities (69% of all activities; 8% of DRR-related activities) state they contribute to both DRR/SFDRR and UN 2030 Agenda for Sustainable Development, only 15 activities (23% out of all activities) are working on Sendai Framework/SDG common indicators.[7]

For example, looking at SDG Indicator 11.5.2, which consists of three SFDRR indicators (highlighted in light green in table 4), only a handful of the GWP activities indicated their contributions to each of them:

- *C1: Direct economic loss attributed to disasters in relation to global gross domestic product* (5 activities)
- *D1: Damage to critical infrastructure attributed to disasters* (6 activities)
- *D5: Number of disruptions to basic services attributed to disasters* (2 activities)

Table 2 - Overlap of indicators between SDG Global Targets and Sendai Framework Global Targets, and the numbers of GWP activities contributing towards SFDRR



[7] SFDRR Targets: A (disaster mortality), B (affected people), C (economic loss), D (damage to critical infrastructure and basic service) and E (DRR strategies), which correspond to SDG indicators: 1.5.1 – 4; 11.5.1 – 2; 11.b.1 – 2; and 13.1.1 – 3.

In terms of strengths, the GWP seems to be well positioned to respond to two critical areas of DRR: climate change-induced hazards (i.e. floods, droughts, wildfires) and Early Warning Early Action (EWEA).

Additionally, the mapping results identified the area of opportunities for multiple GWP activities to join forces to address another key area in DRR: integrated risk assessment of systemic risk caused by multi-hazards (i.e. tsunamis, earthquakes and epidemics/ pandemics in combination).

- **Climate change-induced hazards:** Top 3 DRR thematic areas among the GWP activities were floods (35), droughts (34) and wildfires (28). This result is consistent with a related question in the Capacity Development section which identified the same three themes as the most popular choices of capacity development activities that support DRR.
- **EWEA:** 34 GWP activities (53%) cover "preparation/ early action" in pre-impact phase of disaster management risk (e.g. detecting hazardous events, such as a tropical cyclone, drought-induced famine, wildfire). This result is consistent with the previously mentioned questions on SFDRR Indicators and Targets; Target G and Indicator G5 are directly associated with EWEA and are the most popular choice of the GWP activities.

Fig.19 - Thematic areas within DRR addressed by GWP activities

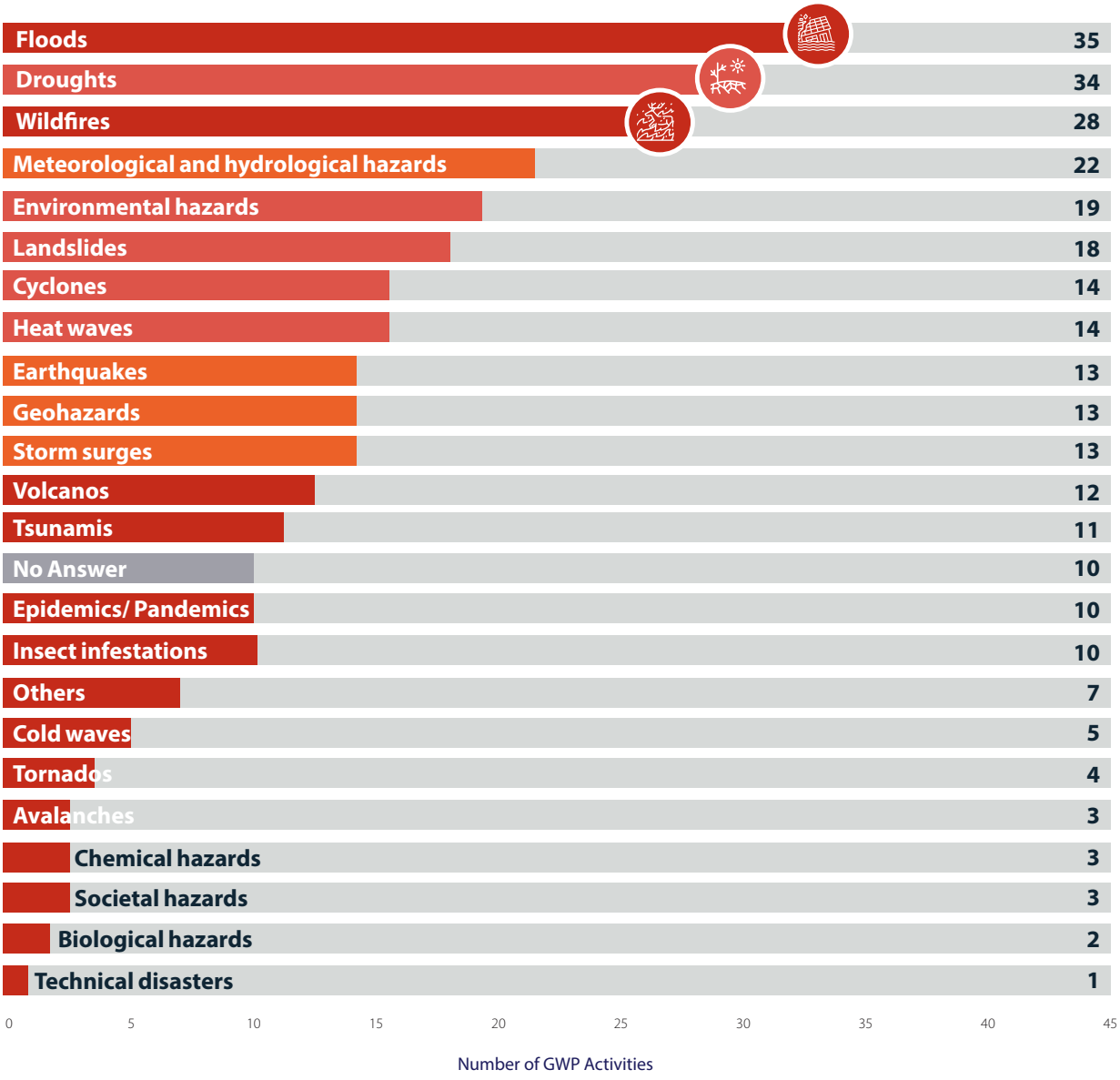
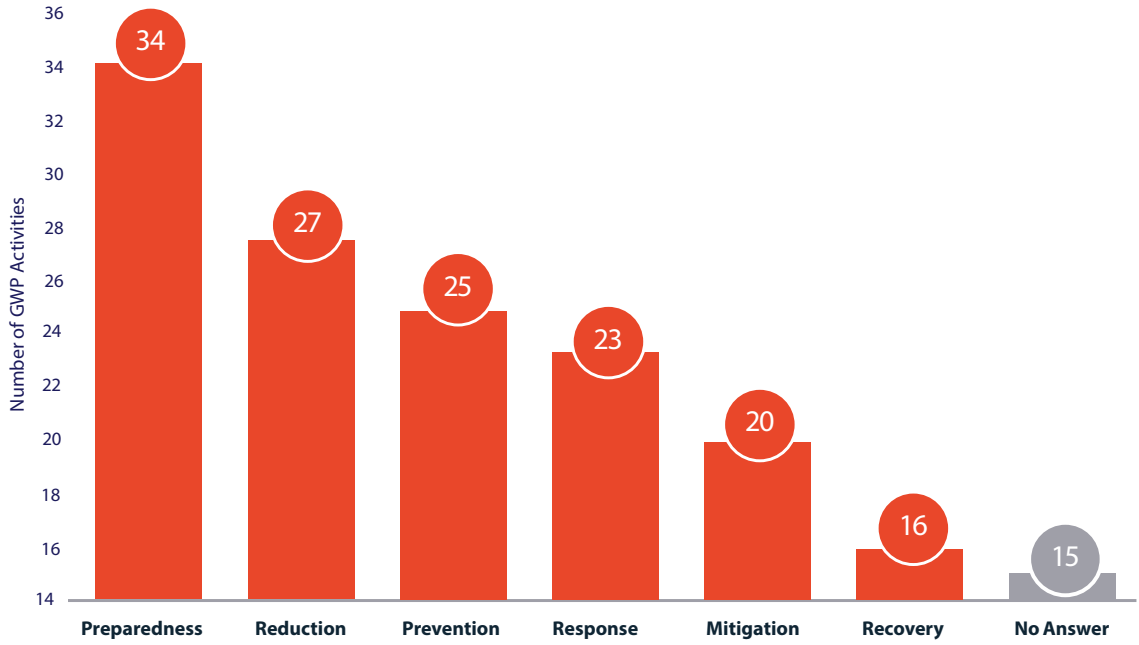


Fig.20 - GWP activities focus' on DRR phases



In terms of weakness and opportunities for improvement, the GWP mapping results identified a gap where UNDRR and countries have been increasingly concerned: systemic risk to address multiplier effects of multi-hazards through integrated risk assessment.

For example, tsunamis and earthquakes are two interlinked hazard types, which happen to be common in SIDS and LDCs. But only 5 activities look at both tsunami and earthquakes simultaneously, and one of them is a Regional GEO.

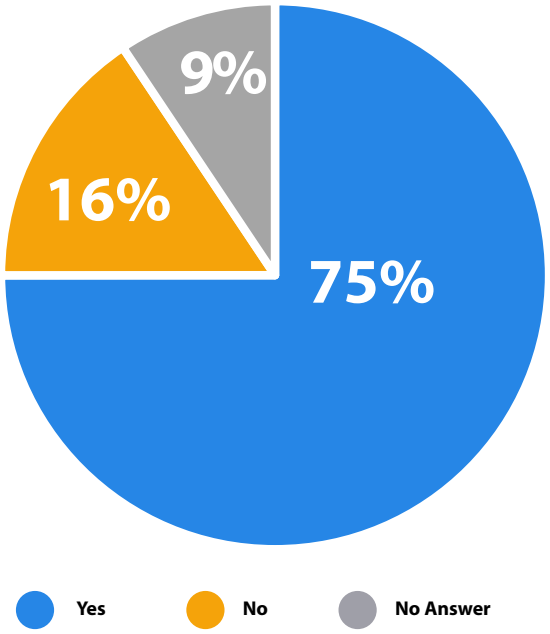
Similar results came out in relevant question in the capacity building section: only 4 GWP activities have capacity building components relevant to tsunamis and/or earthquakes while working with specific countries.

Additionally, UNDRR has been interested in integrated risk of COVID-19 and other epidemics and pandemics. Across the GWP, there are only two activities that look at all three hazards (tsunamis, earthquakes and epidemics/pandemics), and one of them is a Regional GEO. The mapping results indicate the need for collaboration across GWP activities to integrate risk data and the importance of Regional GEOs in facilitating joint efforts.

A large majority of the GWP activities is willing to work with the new EO Risk Toolkit as 48 GWP activities (75%) confirmed their interest.

EO-informed insights are needed to support evidence-based decision making to reduce disaster risk, such as early warning systems contributing to EWEA. GEO DRR-WG in collaboration with the UNDRR GRAF team intends to aggregate GEO activities related to DRR into the EO Risk Toolkit, highlighting existing tools/services and developing associated use cases. As mentioned above about GWP activities' engagement with countries, 15 DRR-related activities have connections to the GRAF Pilot countries. Together with the high level of interests in EO Risk Toolkit (as an integral part of RiX), the mapping results indicate an opportunity for GWP activities to contribute to countries where UNDRR have been engaging with risk data, tools and services.

Fig.21 - GWP activities' willingness to work with the new EO Risk Toolkit



Capacity Development

Research and academic institutions are the most common target users for capacity development resources across GWP activities, while many other stakeholders such as non-governmental organizations (NGOs), Private sector, Consortia and Indigenous groups are not a prime target user yet.

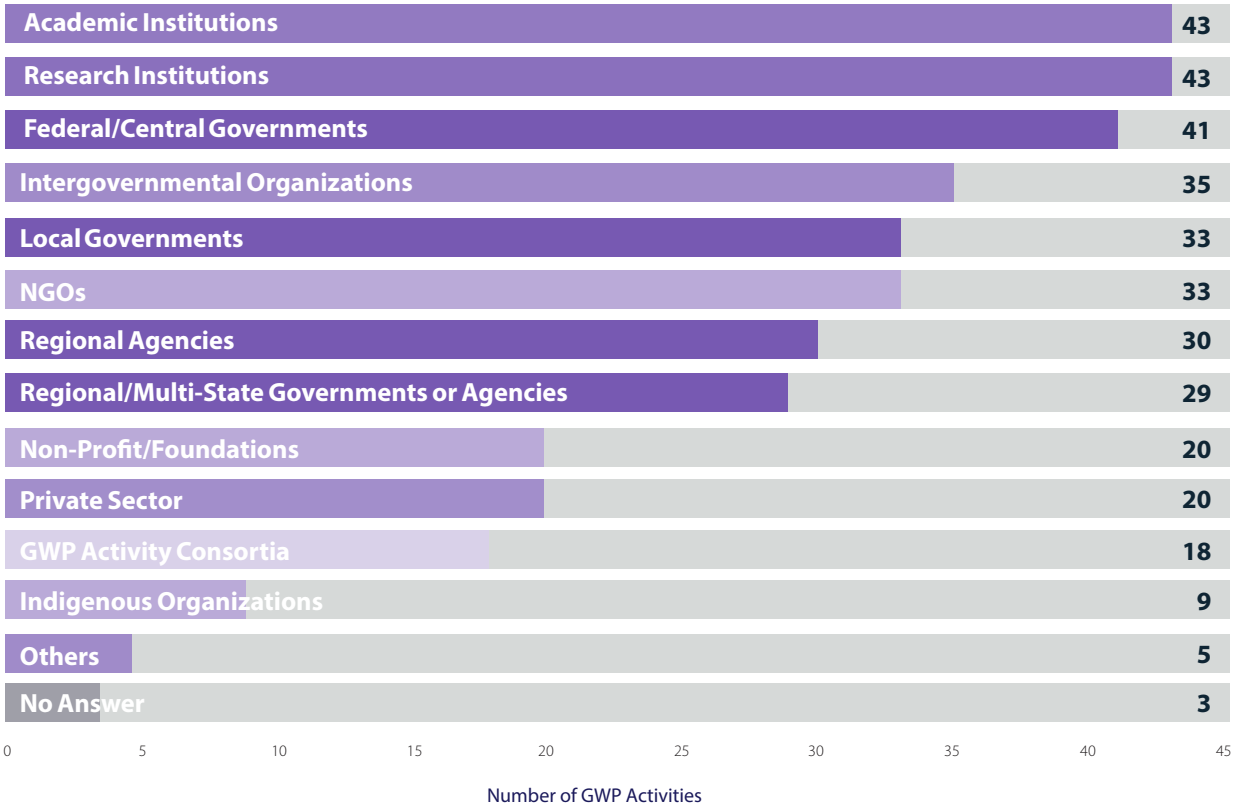
Given the choice of 12 different types of target users, GWP respondents indicated that capacity development activities are mainly focused on the user categories of: Academic Institutions (43), Research Institutions (43), and Federal/Central Governments (41). Currently, lesser targeted user categories are Indigenous organizations (9), GWP Activity Consortia (18), Private Sector (20), and Non-Profit organizations (20).

- The focus on the public administration may reflect the GWP orientation on measuring results and collecting feedback to adjust public policies, rather than directly engaging with entities, such as the private sector for commercial uptake.

One example would be EO4WEF: together with the help of National Aeronautics and Space Administration (NASA) scientists, this activity is developing a decision support system with a water-food-energy nexus approach for the irrigation sector in Sweden, based on a drought event in 2018. Currently the model relies mostly on mesoscale data and EO for data assimilation, with the potential to be scaled up in different countries.

- The activities' focus on academic institutions and research institutions may reflect a priority to increase the use of EO data results through academic channels. For example, GWP activities such as AFRICULTURES and AMERIGEO actively aim to integrate graduate students and the next-generation Earth systems science workforce.
- Notably, 20 GWP activities stated that they also engage or collaborate with private sector stakeholders.

Fig.22 - Current target users for capacity development resources across the GWP



GWP activities tend to rely on traditional channels of dissemination of data and information, such as websites, geospatial portals, and social media. Increasingly, the customization of content using national/local languages seems critical.

The results of the mapping helped identify primary methods of dissemination and build a preliminary inventory of existing GEO activity data and information dissemination resources. In general, GWP activities use traditional methods of dissemination, with websites, geospatial portals, and social media featuring most prominently.

- 29 GWP activities indicated that they utilize **websites** which offer greatly extended possibilities, though GWP activities may consider reflecting on the different dissemination objectives and audiences. Website analytics may be also used to articulate capacity assets and needs.
- In addition to websites, 21 GWP activities indicated that they use **geoportals**, and these provide essential capacity to analyze and synthesize data and information from the GWP activities.
- 6 GWP activities indicated that they currently use **social media** to motivate and mobilize stakeholders as well as to promote engagement of the civil society.

In addition to the channels of dissemination, some GWP activities also reported on which languages were used for developing and disseminating GWP resources. The respondents indicated that they provide resources in national and local languages and specifically identified English, Spanish, Chinese, and French as the most frequently used for communication and publication. There is no doubt that national/local languages play a vital role in the dissemination of knowledge and capitalizing on existing multilingual capacities, which may better reach different communities.

Use cases are considered the most effective method of delivering capacity development across GWP activities, in comparison to more elaborate content-specific tools and large Massive Open Online Courses (MOOCs) which may be more difficult to develop or maintain, as well as costly to put in place.

GWP leads were asked to indicate their opinion on effective capacity development methods of delivery. The objective of this question was to focus on recommendations rather than identifying currently available resources, to determine the methods of delivery for future capacity development outputs would be most responsive to community needs and preferences. Analysis reveals both the specific forms of capacity development that are effective methods of delivery and uptake, and the methods that seem survey participants indicate as less successful approaches. Fig.23 shows the types of capacity development delivery and learning that survey participants consider to be their best recommended form, whereas Fig.24 depicts the types of capacity development currently being carried out by GWP activities.

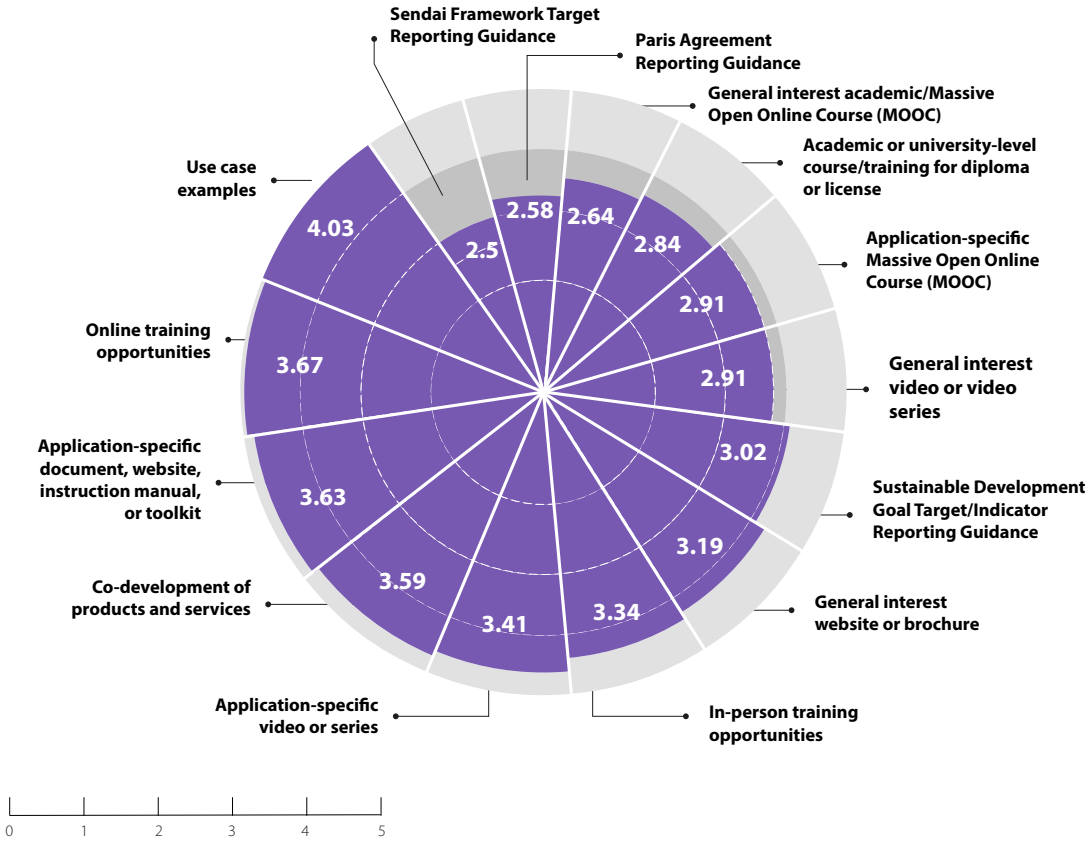
More traditional methods of delivery, such as use cases (ranked 4.03 out of 5) and documents and toolkits (3.63) still seem to be highly effective, as well as additional forms of training, in-person (3.34) and online (3.67), as well as application-specific videos (3.41). More general forms such as MOOCs (2.64) or general videos (2.91) seem to be either not used as much or add limited value in comparison to the former, however it should be noted that there is some question if some survey respondents were not clear on the difference between "online training opportunities" and "MOOC". Also, academic or university-level course/training for diploma or license were ranked low (2.84). In addition to preferred approaches, respondents provided rich examples of resources they recommend, including LinkedIn communities, application-based trainings and webinars.

It should be noted that guidance for reporting under the Paris Agreement and Sendai Framework ranked low, which can be explained by the fact that these resources may be too specific or may not be the primary focus of the related activity.

Many GWPs also provided examples of recommended resources. For example, AFRICULTURES has organized virtual workshops, offered a marketing toolkit on their website, and created a LinkedIn community of youth and African professionals that is growing. Although MOOCs were not identified among the top methods, several GWP activities mentioned their value and use, including EO4EA, EO4HEALTH, and EUROGEO.

A number of training approaches were described, including webinar series by GEO BON, trainings and workshops by CSDR, online training through DE-AFRICA's website, and university level courses and application-specific training linked to NASA ARSET series by EO4WEF.

Fig.23 - Recommended EO capacity development methods of delivery



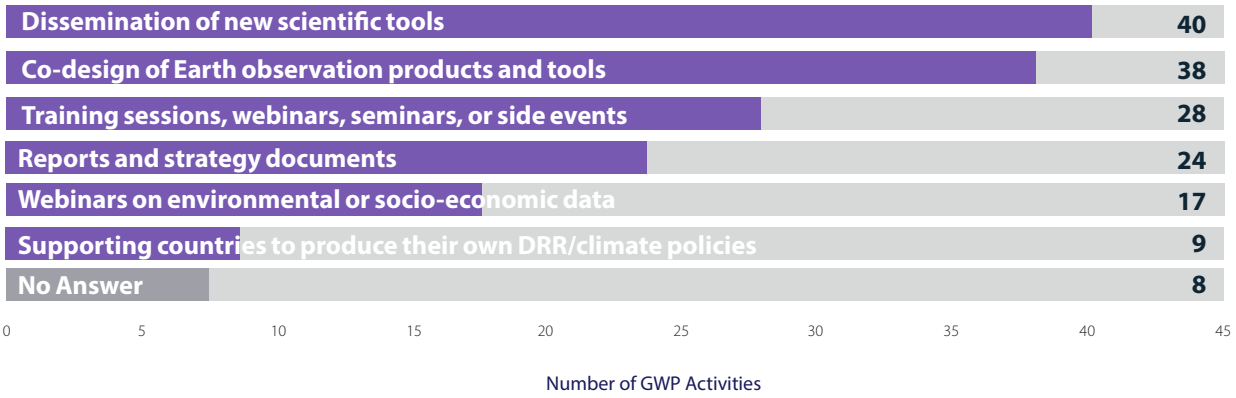
GWP capacity development activities currently include different typologies of delivery and dissemination methods, with the dissemination of new scientific tools, and co-design of EO products and tools being the most popular.

GWP leads were asked to indicate the typology of their current capacity development delivery methods and dissemination channels. The results indicate that GWP activities include capacity development activities in different typologies, as follows: Dissemination of new scientific tools (40), Co-design of EO products and tools (38), Training sessions, webinars, seminars or side events (28), Reports and strategy document (24), Webinars on environmental or socioeconomic data (17), and Supporting countries to produce national DRR/climate policies (9).

It is interesting to note that several GWP activities state they include capacity development activities to support countries produce their national DRR/climate policies: AFRICULTURES, AMERIGEO, C3S, EO4DRM, GEO-CRADLE, GEODARMA, GEO-LDN, GLOFAS, GWIS.

These results are complementary to the recommended forms of resource delivery and uptake.

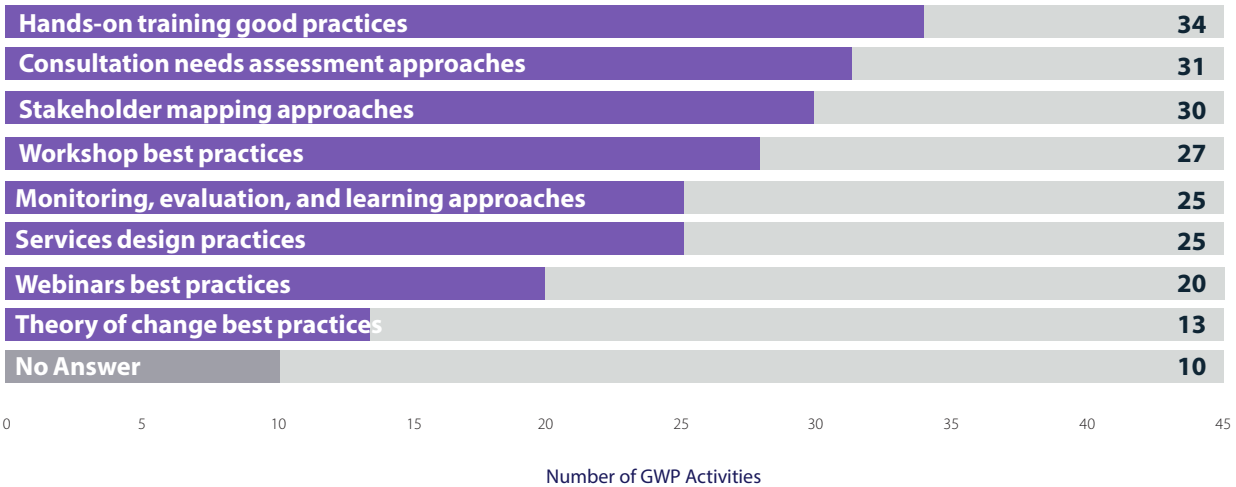
Fig.24 - Typologies of capacity development activities currently carried out by GWP activities



GWP activities would like to build their knowledge and capabilities around hands-on training good practices, consultation and needs assessment approaches, and stakeholder mapping approaches.

The results indicate that GWP participants have capacity development knowledge gaps, and their top 3 capability needs include: Hands-on training good practices (34), Consultation and needs assessment approaches (31), and Stakeholder mapping approaches (30). This summary can inform efforts of community of practices on capacity development and illustrates positive interest and opportunities across the board.

Fig.25 - GWP activities' needs for additional capacity development knowledge or capabilities to address current capacity development gaps



Almost half of the GWP activities collaborate with another GWP counterpart (Flagship, Initiative, or Community activity) primarily through capacity development work. However, there is also considerable engagement through specific Climate Action and DRR work.

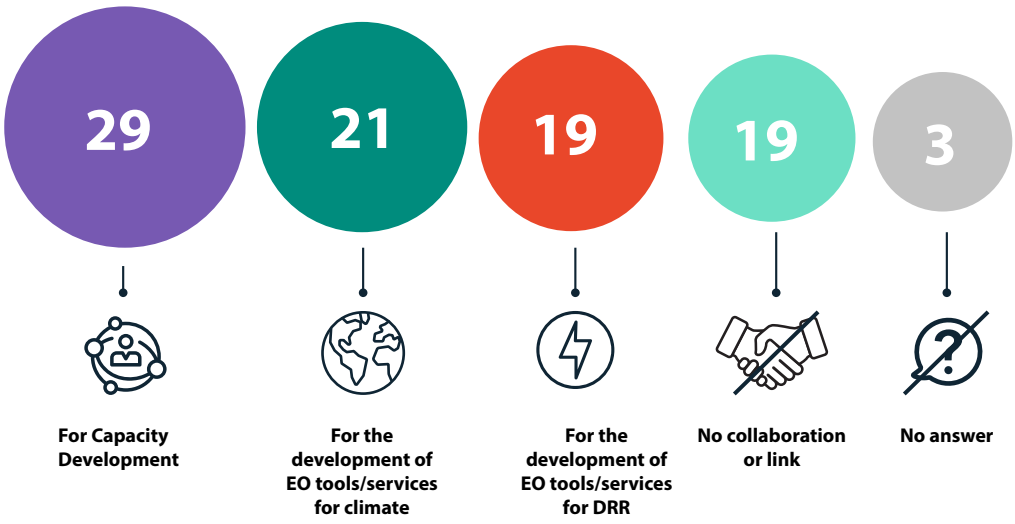
In general, capacity development provides the opportunity to function as an entry point or a way to increase collaboration across GWP activities to enable them to set and achieve their own development objectives over time. 29 GWP activities (45%) indicate that they collaborate with their GWP counterparts for capacity development. This is especially true for Community Activities, as one third of them (13 out of 35) noted that they build collaboration through capacity development work. Also, 10 GWP activities stated that they collaborate across all three areas of capacity development, DRR and Climate Action.

However, 19 GWP activities indicated that they have no collaboration in place or link at all. None of the four GEO Flagships claimed or specified that they had collaboration with other activities on capacity development.

Furthermore, GWP activities also strongly collaborate on a thematic level: Climate Action (21) and DRR (19) are almost equally relevant in this regard. Notably, 6 activities specifically collaborate on Climate Action (C3S, DE-PACIFIC, GE-EV, GEO-LDN, GEO-TREES and HUMAN-PLANET), while 2 activities especially collaborate on DRR (DELTA-ESTUARY and GLOFAS).

Based on the qualitative input, it is interesting to note that 7 out of 19 activities for DRR, 6 out of 21 activities for Climate Action, and 14 of all collaborating activities appear to be developing and leveraging their own online information portal with analytical functions as part of dissemination and capacity development.

Fig.26 - Existing collaboration or link with other GWP activities



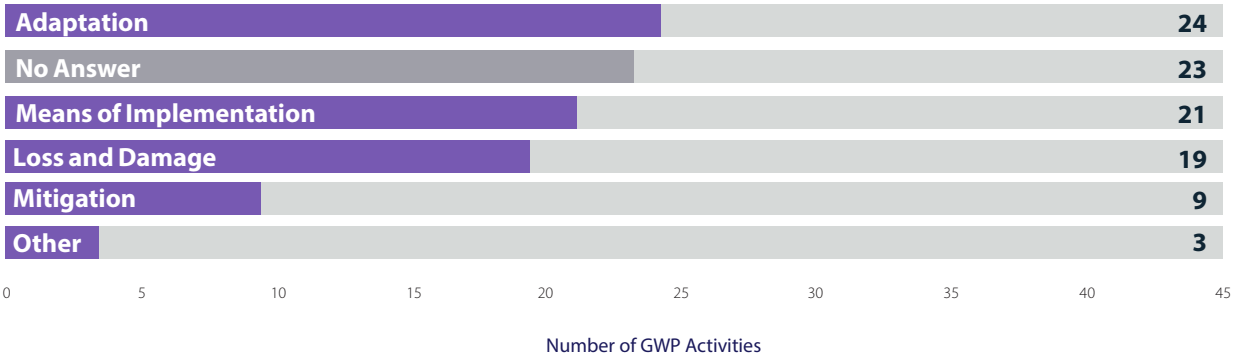
Capacity development is an essential element for supporting both Climate Action and DRR activities, which empowers the GEO community with the tools and knowledge it needs to maximize the impact and utility of EO.

For Climate Action, most GWP capacity development resources focus on Adaptation and fewer on Mitigation, which aligns with the level of engagement across workstreams in the GWP.

GWP activities indicated they are most engaged in capacity development work on Adaptation (24), followed by Means of Implementation (21), and Loss and Damage (19). Mitigation (9) was identified as the least prominent or established area of work for capacity development within the GWP, while one third of the GWP activities did not answer this question. These data points are consistent with the total number of activities engaged in the related Climate Action workstreams.

Capacity development activities may be seen as a critical dimension of adapting to climate change to prepare for and adjust to both the current effects of climate change as well as the predicted impacts in the future. Capacity development activities, such as reporting on good practices or lessons learnt, strongly support climate change adaptation processes and deliver a common basis for cooperative adaptation activities between different actors/stakeholders.

Fig.27 - GWP activities involving capacity development resources that support Climate Action in one or more workstreams

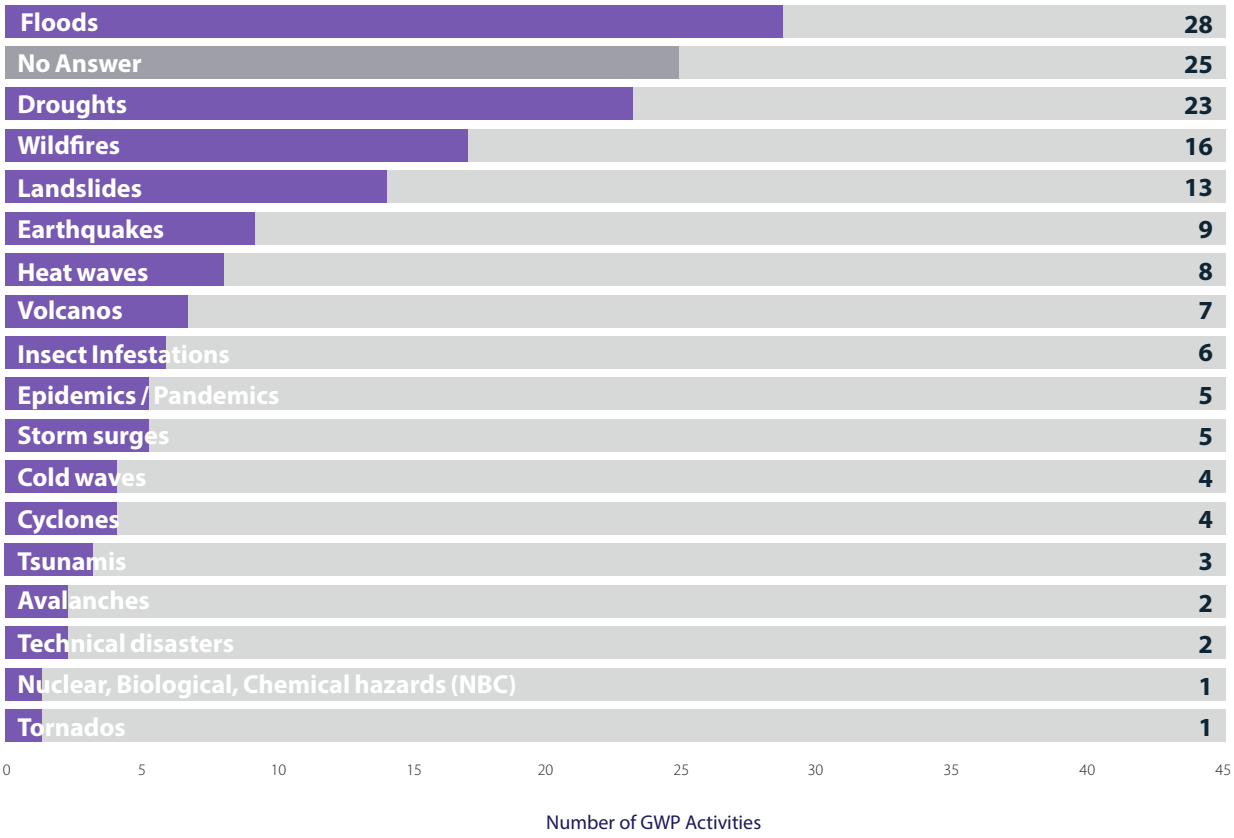


Most DRR capacity development resources focus on flood, drought, and wildfire, which aligns with DRR thematic areas most addressed across the GWP.

Across the GWP, floods (28), droughts (23) and wildfires (16) are the highest reporting themes involving capacity development resources. These climate change-induced hazards are also the most addressed thematic areas by GWP activities that are active on DRR.

The practice of reducing disaster risks through systematic but iterative capacity development efforts may help to analyze and manage the causal factors of disasters, especially with floods, drought and wildfire events where wise management of land and the environment, and improved preparedness for adverse events will reduce the exposure to hazards and lessened vulnerability of people and property.

Fig.28 - GWP activities involving capacity development resources that support DRR in one or more areas

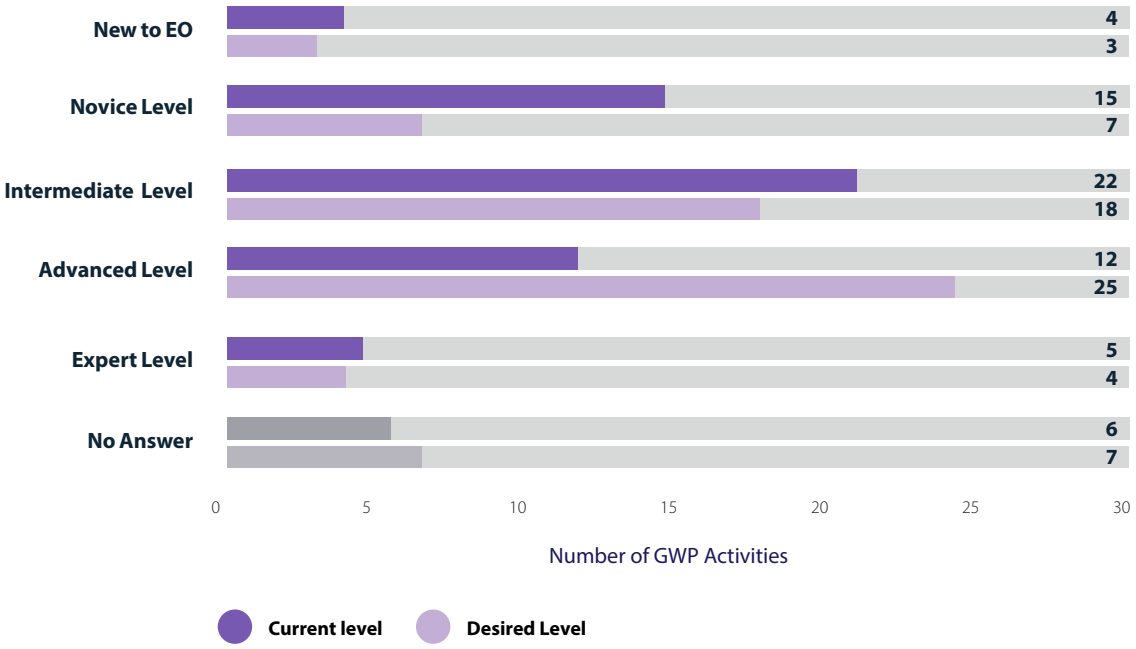


Current GWP capacity development activities mostly focus on users with intermediate level skills and aim to give users advanced level skills.

When asked about the current and desired capacity development level of target user in their GWP activities, respondents indicated that most of their users currently have an intermediate level of skill to engage in GWP activities, whereas there are only a few users that are considered "new to EO", as well as "experts".

The current capacity development activities across the GWP mostly aim to increase the overall users' skills to advanced level (25) in the future. Looking at the data in more detail, there are also some initiative-specific approaches. For instance, GEO BON is currently focused on advanced users, but desires to also expand towards novice users. These more detailed responses can help identify capacity development communities of practice around targeting different skill-level users.

Fig.29 - Current and desired capacity levels of target users within the GWP activities

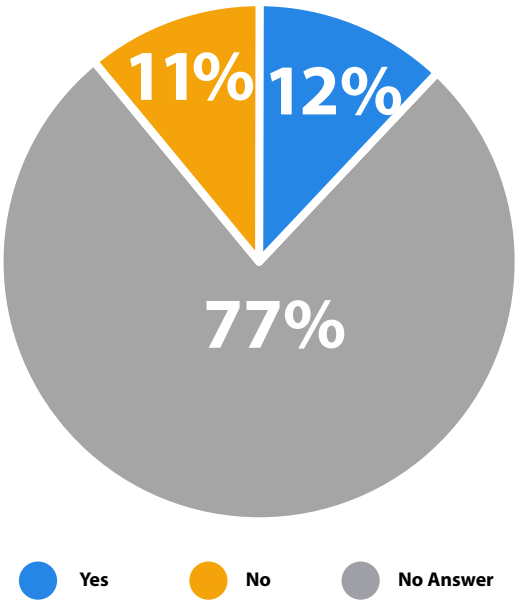


Some GWP activities indicate a specific need for improvement or update on EO capacity development resources within the GWP, whereas the majority remains unsure about concrete actions or needs.

The majority of GWP activities (43) were unsure whether there are EO capacity development resources within the GWP that need improvement or update, whereas a smaller number (8) confirmed the need, or, on the contrary, stated that there is no need for further improvements at this point (7).

The GWP activities were given the opportunity to provide more concrete feedback on the needs for improved capacity development resources. The qualitative inputs were informative and project-specific, comprising a range of resource interests, including more EO high spatial resolution products, capacity development tools for open data cube, need for regional capacity development centers, and a real-time cloud platform.

Fig.30 - Need for improvement or update on EO capacity development resources within the GWP



About half of the GWP activities responded with a ssuccess story or a case study.

There were various and wide-ranging climate action and DRR development success stories and case studies provided. Some examples include the following: AFRIGEO referenced an ongoing activity in Malawi for flood early warning systems; AMERIGEO organized Peru Mapathon 2021 as a catalyst to garner national organizations' interest in disaster preparedness and response; CLIMATE-OBS referenced the World Bank Climate Change Knowledge Portal and the UN Climate Action website; CROP-PEST-MONITORING research and monitoring results were used by the Food and Agriculture Organization of the United Nations (FAO) and the Global Biodiversity Information Facility (GBIF) to support crop pest management and training to support desert locust monitoring and management in Pakistan; GDIS extended global precipitation monitoring beyond seasonal drought to sub-seasonal time domain; GEO-VENER and GEO-CRADLE provided tools to guide renewable energy investments; SPACE-SECURITY provided training on the use of European Union Satellite Centre (SatCen) geospatial platform; and TIGGE supported the use of TIGGE/global ensembles in tropical cyclone research and operational forecasts.

Overview of perceived gaps and synergies for next GWP

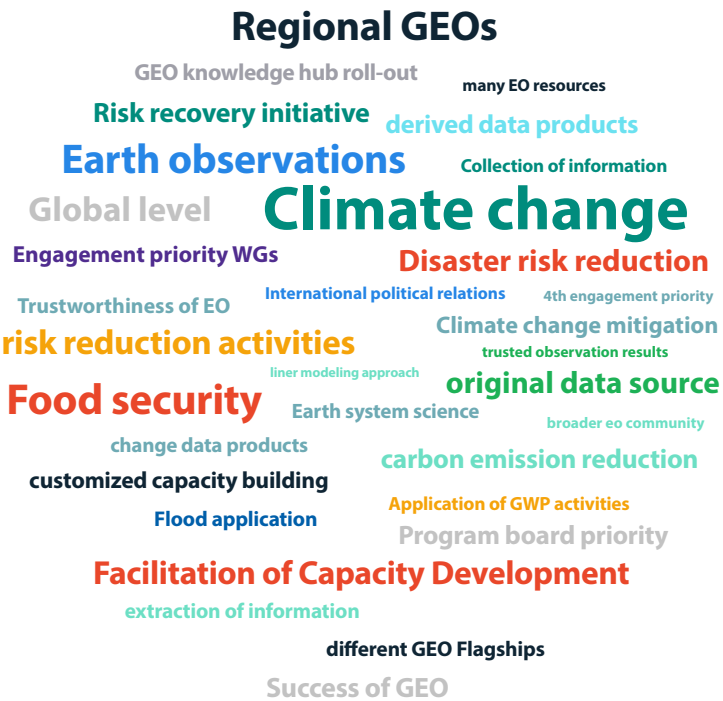
Despite the different levels of engagement and maturity of the current GWP activities, there is clear interest to continue improving and strengthening the work under GEO, and the bridging of thematic gaps, expanding aspects of regional collaboration and representation, enhancing access to funding, improving the trustworthiness of EO data and products, as well as developing user-customized capacity development.

When asked about perceived gaps or synergies to be addressed in the next GWP 2023-2025, 29 GWP activities (about 45%) responded positively, with almost all of them providing more detailed feedback.
The word cloud provides a non-exhaustive overview of some of the key topics and inputs provided about perceived gaps or synergies, which are summarized below.

- **Coordination and collaboration:** There is a perceived need to improve visibility and strengthen collaboration within the GWP, notably addressing thematic collaborations of existing activities and related EO products and applications, integrating nexus areas, addressing interlinkages across SDGs and across the four GEO engagement priorities, also by involving new stakeholders such as the private sector. Collecting information, use cases, good practices and success stories within the GWP is perceived as useful to take advantage of existing synergies.
- **Governance:** There is a request from several GWP activities to strengthen regional representation in the PB to include least developed countries, also through the participation of Regional GEOs, as well as to promote ministerial-level engagement during regional GEO Weeks.
- **Funding:** Finance is considered a big gap and there is a need for direct and indirect funding to be raised through dedicated funding strategies to sustain and boost GWP activities.
- **Private sector engagement:** Generally, around one third of GWP activities is currently collaborating with private sector entities. There might be opportunities to engage with businesses and financial institutions to promote EO-based risk assessments for assets and operations.
- **Data management and policies:** There is a perceived need to improve the awareness of the definition of EO in general, and the interoperability of data, syntax and semantics in particular. Further work on figuring out data quality issues and defining principles for proper use of the data products are considered essential to guarantee the trustworthiness of EO-derived products and applications for decision making. Also, GWP activities are seeking clarity around, development of, and better access to the GEOSS Platform.
- **Capacity development:** GWP activities are looking for assistance with user-customized capacity development, including online training and tools, development and/or integration of toolkits.

Addressing GWP activities' input on perceived gaps and synergies in the next GWP will require follow-ups with individual GWP leads.

Fig.31 - Word cloud of qualitative inputs on perceived gaps and synergies for the next GWP



Lessons learnt on survey design, tools and applications

The 2020-2022 GWP mapping was carried out for the first time in a digital format through Survey123. Overall, the exercise took about 12 months and can be seen as a critical component to establish a comprehensive baseline overview of the GWP and gather detailed information about the GWP activities and outlook for future needs and gaps. It also informs GEO's work on communicating GWP activities and the relevance of the GWP to address key environmental and socioeconomic challenges.

As part of this one-year process, the cross-WG task team has gathered the most relevant lessons learnt on the survey design, tools and applications, and technical recommendations:

- An online format is an effective and inclusive way to reach all GWP members for data collection (improvement to previous Excel survey), which can be expanded over time, including to cover other relevant GEO engagement priorities.
- It is important to support the GWP mapping participants in retrieving accurate responses, by providing more details and explicit descriptions of the specific questions and answer categories, to avoid any confusion by the respondents. It could be useful to share an overview brief about thematic areas and content covered before the survey launch with the respondents, in order to help clarify or identify potential gaps and ensure a comprehensive approach.
- There is need to streamline survey questions for coherence and avoid redundancy in questions causing inconsistencies in the data, especially for Section 2 (general information).
- There is need to ensure coverage of all relevant answer options. Notably, for the overview of thematic domains, it would be important to consider additional categories that are deemed relevant for current GWP activities, such as additional thematic domains (e.g. Air/Atmosphere) and socioeconomic sectors (e.g. Energy/Infrastructure, Health).
- Additionally, some GWP activities mentioned that they need better understanding of the overall ongoing processes within GEO to answer some of the questions fully, which can be addressed through iterative efforts to involve GWP leads more in relevant WGs and overall GWP interactions.
- There is need for a detailed review of the question structure and specific technical requirements such as length of qualitative answers, formatting of questions, and the overall sequencing of survey questions. In particular:
  - Character limit should be extended for open questions;
  - Responses should be made mandatory, including the category "other" and "if yes, provide detail";
  - A clear sequencing of questions, and if possible, the format of a "decision tree" should be implemented to make sure that participants are only asked to give more detailed information when they indicated the specific section or thematic areas is relevant, to avoid inconsistencies of data or duplication;
  - When asking for more detailed information, it is important to provide a similar structure and number of answer categories for better comparability of inputs.
- There were limitations on data processing and data visualization in current online tool. The technical team lead used Arcade code to visualize multiple-choice responses, as these are not able to be visualized otherwise through the Survey123 dashboard. A more extensive coding is needed to make these charts even more dynamic (e.g. stacked serial charts for multiple-choice responses). Single-choice response-type questions are easier and more straightforward to visualize without code.
- Overall, the data visualizations in Survey123 dashboard and large-scale dataset have great potential for future assessments. Notably, the large-scale dataset and respective data visualization in dashboards survey hold great potential to be used as an additional resource that is complementary to the report as they are interactive and allow the user to explore the data that is of most interest to them.

More detailed feedback on survey design, tools and applications was collected by the cross-WG task team for each section, which will be used for internal purposes.

The next GWP mapping exercise should build on lessons learnt and feed into the GWP 2023-2025 online information collection process. As such, the GWP mapping could become a standing component of the biannual call for IPs, whereby baseline data is collected on an automated basis.

Recommendations

Recommendations are based on the findings of the mapping. These are meant to inform the effective development of the 2023-2025 GWP, through inclusion of considerations and relevant targets in IP submissions by GWP leads, as well as through potential improvements to the GWP structure and processes by GEO governing bodies and the GEO Secretariat.

General recommendations

Future GWP activities should align with nomenclatures and taxonomies describing EO services to avoid issues of mixing sectors, thematic perspectives and topics.

Future GWP activities should consider prioritizing thematic domains such as **Arctic/ Cryosphere** and **Small Islands** that entail cross-cutting EO activities between land and water, as well as leverage the **strengths of existing water-related activities**, to bring relevant initiatives together and capitalize on knowledge and products.

Future GWP proposals should focus on these areas to develop a new activity targeting support to SIDS and build on ongoing work around the Arctic Council mandate.

More mature GWP activities, and ideally all GWP activities, should have concrete targets for **on-the-ground implementation and collaboration with user communities** for user uptake, particularly national governments as well as value chains and business sectors.

As the GWP strengthens its focus towards outcomes and implementation, it should be supported by a dedicated GEO resource mobilization plan to ensure reliable funding to enable GWP activities to grow and deliver.

The GEO Secretariat should facilitate the connection between GWP activities and GEO focal points in the countries in which they are active.

In order to facilitate the sharing of collaboration experiences, GEO Members could be invited to prepare their own country profiles covering GWP activities operating at the national and local level (e.g. on the model of Australia, Colombia, and the UK).

More effort is needed to support the participation of developing country members from under-represented regions in GEO governing bodies, notably the PB.

Regional GEOs should strengthen their coordination role among GWP activities that aim to be active in the region. Additionally, it is recommended that cross-communication is established between Regional GEOs, GWP activities, and relevant WGs, to ensure that there is exchange and collaboration on priority engagement areas.

Existing and future GWP activities should consider addressing needs of sub-regions underrepresented in terms of impact across the GWP, including Western Asia, and Pacific Island Countries and Territories (e.g. Melanesia and Micronesia).

Future GWP activities should be **delivering EO data, knowledge and products** that directly **support global policy agendas** for Climate Action, DRR and Sustainable Development, as well as Sustainable Urban Development. This could be promoted through the revision of **selection criteria of GWP activities** to align more closely with global policy agendas and GEO engagement priorities.

The GWP mapping, including regular collection of information, use cases, good practices and success stories across the GWP activities, should become a regular element embedded in future GWP cycles, to also cover other engagement priorities and cross-cutting elements. The GEO Secretariat is already working on the inclusion of the GWP mapping into the IP online template.

Recommendations for Climate Action

Existing and future GWP activities should aim at identifying and establishing collaboration with relevant **UNFCCC and IPCC national focal points**, especially through national and local GWP activity partners, to provide input to international climate policy and science processes.

In addition to connecting with national focal points, more variety in the selection of collaborating partners to develop and implement climate-related EO activities should be encouraged across the GWP.

The GWP can build on its strength in the area of **resilience building** which cuts across global Climate Action, DRR, and Sustainable Development agendas. Future GWP activities should develop or improve **tools, services and methodologies** that contribute to **Adaptation** and **Loss and Damage**, notably include knowledge products targeting **support to developing countries for NAPs**, while continuing to provide EO needed for climate science.

Targeted support for existing and future GWP activities related to Adaptation and Loss and Damage should be provided to improve the delivery of tangible output that can support decision making in line with national climate plans, and for scaling-up of activities.

Priority sectors and related GWP activities for GEO supplementary technical NAP guidance include agriculture, food security and land, marine, coastal and riverine hazards, urban areas, renewable energy, health, industrial applications, and mountains.

Future GWP activities that address the use of EO in climate finance to implement the Paris Agreement should focus on supporting businesses and financial institutions in running **climate risk assessments**, as well as supporting LDCs and SIDS in improving the **climate rationale of project proposals for adaptation and mitigation** with EO data.

Future GWP activities that address the use of EO to quantify Loss and Damage should encompass impacts and losses related to human mobility and migration.

Future GWP activities that address climate science should continue focusing on EO applications and include EO in forecasting, climate predictions, reanalysis and model intercomparison.

Future GWP activities that focus on monitoring climate-related extreme events should include consideration of the role of EO in supporting social protection instruments, including social safety nets, as well as supporting transformational approaches that imply changes in fundamental attributes of a socioecological system in anticipation of climate change and its impacts.

Future GWP activities that focus on Mitigation with the use of EO, including assessing GHG emissions and supporting the REDD+ mechanism, should do so by leveraging on existing relevant GWP activities that are already operational.

Future GWP activities should strengthen the focus on the role of EO in supporting UNFCCC Parties and process, including for the development and monitoring of National Communications, BURs, and NDCs, and providing information to the Global Stocktake of the Paris Agreement.

Future GWP activities that address climate action by different stakeholders should consider how EO can enhance understanding of linkages between equity and climate change.

Existing and future GWP activities should seek opportunities for collaboration with other GWP activities, Regional GEOs and the CC-WG in **nexus areas** where they can develop an integrated approach to address **climate change impacts across key sectors**, such as climate-health-cities, climate-energy-infrastructure, climate-ocean-biodiversity.

Recommendations for Disaster Risk Reduction

The GEO Secretariat and the DRR-WG should continue supporting existing and future GWP activities to improve the basic understanding of the mechanism of national Sendai Framework monitoring and reporting via the Sendai Monitor, including the roles of Sendai Framework national focal point agencies.

Existing and future GWP activities should aim at establishing collaboration with at least one specific **national stakeholder for DRR**, such as Sendai Framework national focal points and civil protection agencies.

In terms of countries, the activities ideally work with SIDS and/or LDCs as well as the low and middle-income countries that are vulnerable to repeated loss and damage.

Types of national DRR users they can consider in addition to civil protection, disaster management agencies are, for example, national hydrometeorological agencies, fire department, agricultural ministry and other national and local government agencies; also should be considered are international and regional organizations and NGOs working operationally on disasters in the country of interest.

The activities that aim to contribute to SFDRR should try to identify the Sendai Framework national focal point of the countries where they are operating (usually the civil protection disaster management agency or foreign ministry) and establish collaboration, including through national and local GWP activity partners.

Existing and future GWP activities should develop or improve tools, **services and methodologies** that contribute to **specific Sendai Framework Targets and Indicators**, notably on Early Warning (Target G) and SFDRR/SDG common indicators.

In doing so, it is essential for all GWP activities to clearly define and be ready to explain what services/products offering they have or are developing.

Then, they activities should examine which Sendai Framework Global Targets and indicators they can support with their offerings, especially the common indicators of the Sendai Framework and SDGs, which includes contributions to national and local.

Future GWP activities that have elements of EWEA should consider how to contribute to Sendai Framework Target G and to respond to the UN Secretary General's call for equipping all countries with early warning systems by 2027.

All GWP activities should consider providing the activity's open knowledge to the GEO Knowledge Hub while also working with DRR-WG to provide contents for the EO Risk Toolkit to highlight what products offering they have.

If the GWP activities are already working in one of the GRAF pilot countries, they should also plan how to provide risk data to RiX in coordination with the EO Risk Toolkit, that is to help countries reduce existing risks and to prevent future risks with risk data, tools and services.

Existing and future GWP activities should seek opportunities for collaboration with other GWP activities, Regional GEOs, and the DRR-WG in **nexus areas** where they can develop an integrated approach to address increasingly systemic nature of disaster risk where events overlap and interplay with **multiple risk drivers**.

The activities should join forces to simultaneously address related multi-hazards i.e. earthquakes, tsunami, cyclones, landslides under COVID-19 pandemic.

Whatever combination of hazards they address, it is also critical to take into consideration of exposure data, for example, in terms of critical infrastructures and human movements.

Recommendations for Capacity Development

The **concept of "capacity sharing"** and other more inclusive and culturally sensitive terminology and practices should be considered in recognition of the diversity of the GEO community. The CD-WG should support events and other initiatives for sharing of current resources and good practices, as well as fostering diverse and inclusive engagement with under-represented user groups, such as Indigenous communities.

Existing and future GWP activities should tailor tools and resources to their current target users and consider strategies for including and engaging with less targeted user groups, alongside strategies for strengthening **effective dissemination and delivery**. This includes clarifying and systematizing the resources' purpose and the users, with plans, templates, and good practice examples, and making use of existing GEO dissemination channels and targeted community sharing opportunities.

Different typologies of capacity development resources should be considered to share good practices to make them more discoverable. Consideration should be given to develop consistent terminology and definitions (e.g. "what is a use case") that are aligned with relevant international frameworks and terminology.

Each capacity development method of delivery has advantages and disadvantages, so designing and using a combination of methods is recommended.

Making work accessible in more than one language should be considered.

Making better use of existing dissemination channels in GEO should be considered, as well as additional channels.

Inclusion of strategic communications plans that link general capacity development resources and good practice to specific GWP activities should be considered.

The GEO Secretariat should work with the CD-WG to make available an **inventory of capacity development resources**, potentially as a function of the GEO Knowledge Hub, whereby existing resources can either be modified or repurposed, or serve as an example of good practices.

Existing and future GWP activities and the CD-WG should consider ways to strengthen linkages among GWP elements in order to efficiently collaborate on the development and design of use cases, documents and toolkits, in-person and online training, and application specific videos.

Current and future GWP activities and the CD-WG should consider emerging effective low-cost opportunities for both service co-development and capacity development innovations and synergies, including big EO data, cloud computing, open science, and open knowledge.

GROUP ON EARTH OBSERVATIONS