GGOS External Relations Update

October 2021-May 2022

IUGG

Global Geodetic Observing System

GGOS Coordinating Board

16 May 2022

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Global Geodetic Observing System

Jet Propulsion Laboratory
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GGOS Outreach and External Relations (mid-2022)

Working toward proactive engagement with the broader Earth observations community, identifying tangible geodetic contributions to UN SDG and Sendai Framework targets and indicators, as well as working with external partners in capacity building and development initiatives.

GGOS externally advocates for interoperable, discoverable, and openly available geospatial data, promotes infrastructure development, and contributes to developing effective capacity building initiatives -- to ensure geodesy is a visible, valued, and sustainable worldwide asset.

Advocacy

- GGOS participation in diverse stakeholder organizations works to **identify synergies, making connections across organizations** in the name of geodesy and mutual benefit.

Collaboration

- GGOS participation in diverse capacity development efforts serves as the **"human reference frame"** to link between organizations for otherwise overlooked opportunities.

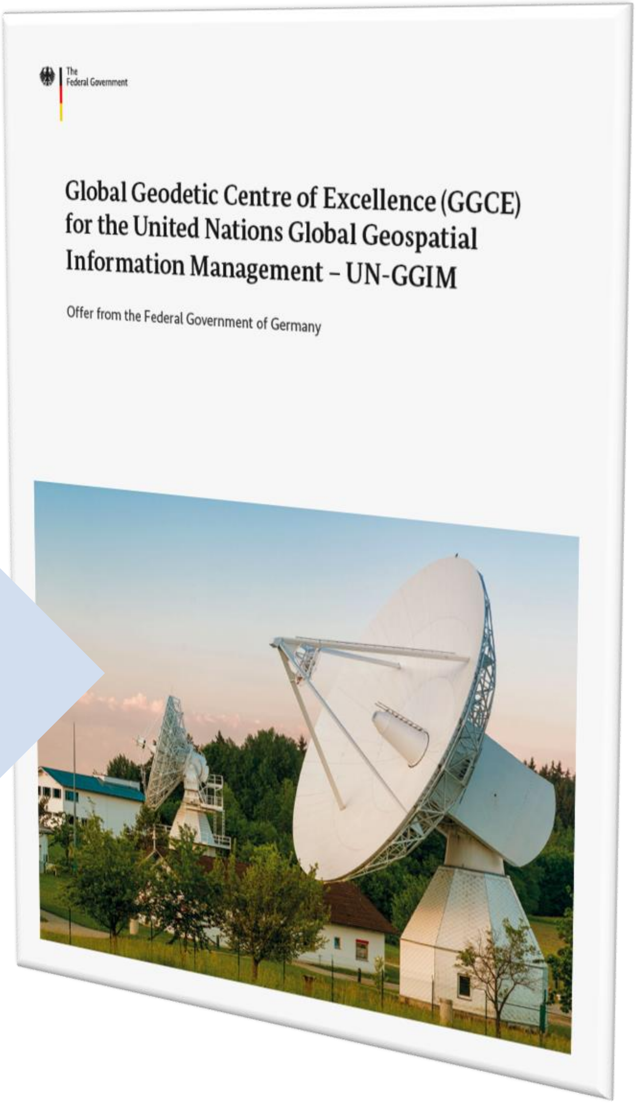
Sustainability

- **We don't know who the next generation of geodesists are…** and we will need people to operate, maintain, utilize infrastructure in order for these efforts to be sustainable.

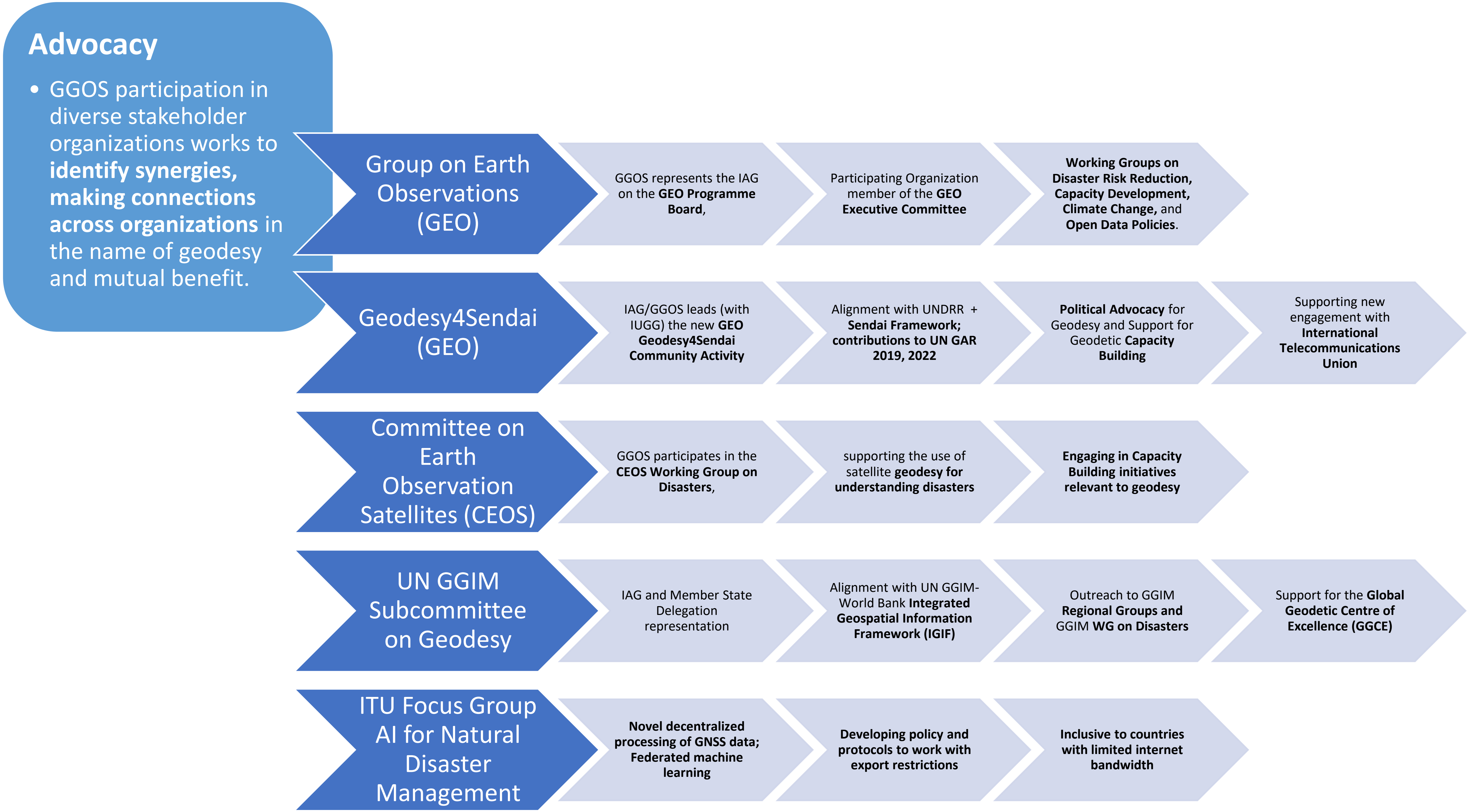
Visibility

- GGOS participation and leadership – often on behalf of the IAG -- **reminds Earth observation organizations that geodetic infrastructure is important** for things like climate change and disaster risk reduction.

The Committee on Earth Observation Satellites

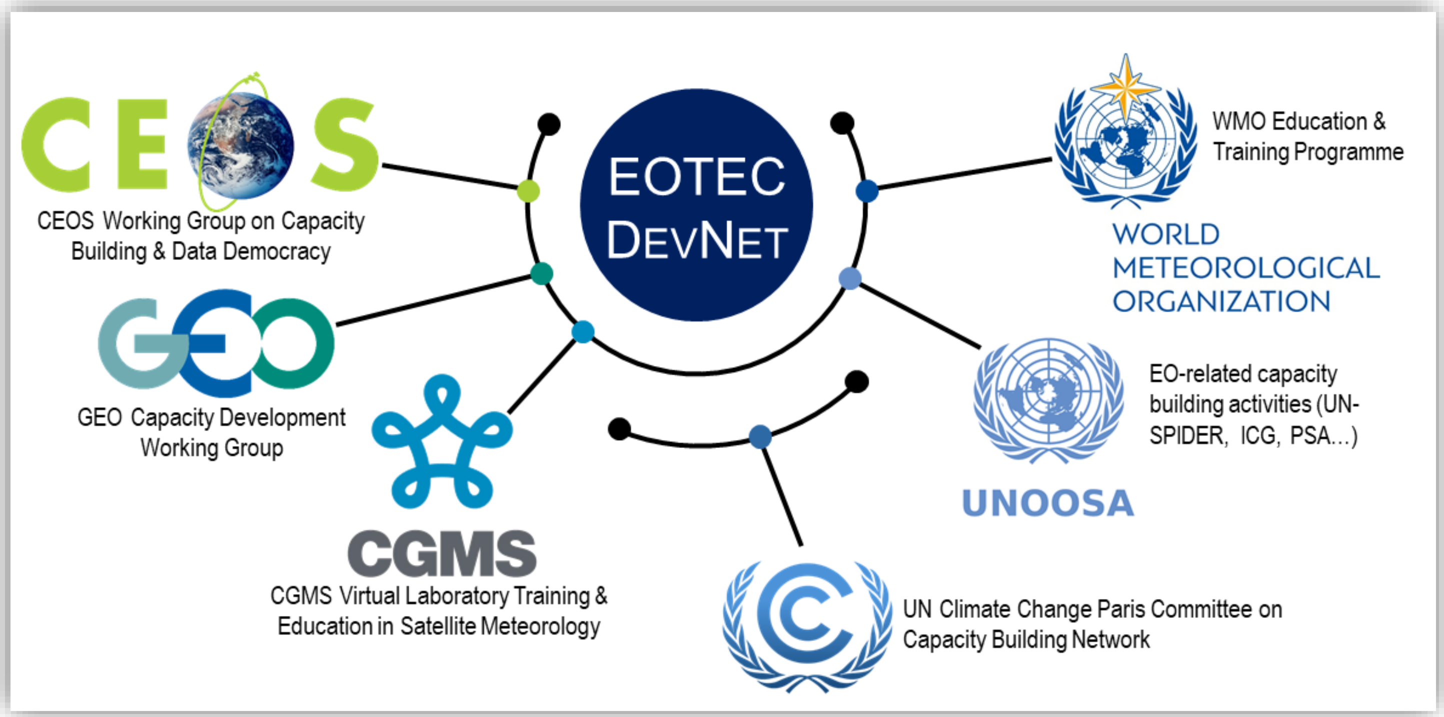


Global Assessment Report on Disaster Risk Reduction


Advocacy
GGOS participation in diverse stakeholder organizations works to identify synergies, making connections across organizations in the name of geodesy and mutual benefit.
Group on Earth Observations (GEO)
GGOS represents the IAG on the GEO Programme Board,
Participating Organization member of the GEO Executive Committee
Working Groups on Disaster Risk Reduction, Capacity Development, Climate Change, and Open Data Policies.
Geodesy4Sendai (GEO)
IAG/GGOS leads (with IUGG) the new GEO Geodesy4Sendai Community Activity
Alignment with UNDRR + Sendai Framework; contributions to UN GAR 2019, 2022
Political Advocacy for Geodesy and Support for Geodetic Capacity Building
Supporting new engagement with International Telecommunications Union
Committee on Earth Observation Satellites (CEOS)
GGOS participates in the CEOS Working Group on Disasters,
supporting the use of satellite geodesy for understanding disasters
Engaging in Capacity Building initiatives relevant to geodesy
UN GGIM Subcommittee on Geodesy
IAG and Member State Delegation representation
Alignment with UN GGIM-World Bank Integrated Geospatial Information Framework (IGIF)
Outreach to GGIM Regional Groups and GGIM WG on Disasters
Support for the Global Geodetic Centre of Excellence (GGCE)
ITU Focus Group AI for Natural Disaster Management
Novel decentralized processing of GNSS data; Federated machine learning
Developing policy and protocols to work with export restrictions
Inclusive to countries with limited internet bandwidth

Collaboration

- GGOS participation in diverse capacity development efforts serves as the **"human reference frame"** to link between organizations for otherwise unlikely overlooked opportunities.



GEO GROUP ON EARTH OBSERVATIONS

UN-GGIM UNITED NATIONS COMMITTEE OF EXPERTS ON GLOBAL GEOSPATIAL INFORMATION MANAGEMENT

WORLD METEOROLOGICAL ORGANIZATION

UN environment programme

ITU

AI: AI for Natural Disaster Management ITU Focus Group

CEOS The Committee on Earth Observation Satellites

UNDRR UN Office for Disaster Risk Reduction

Sustainability

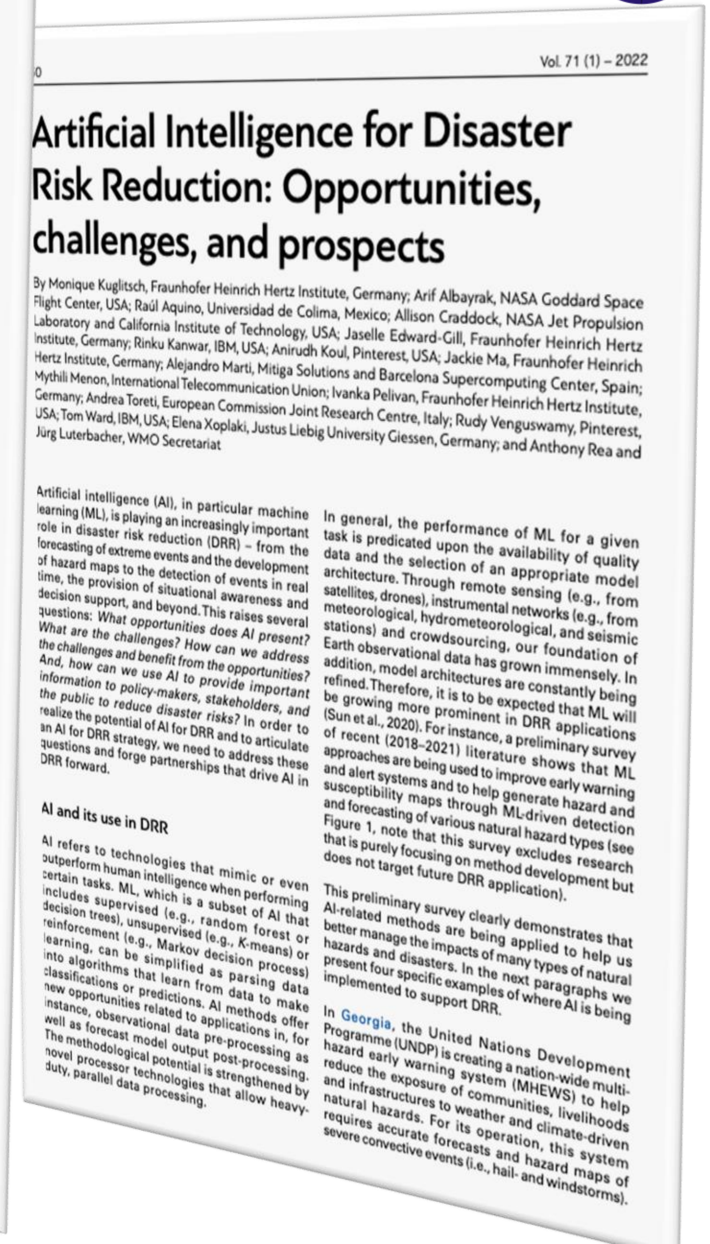
- **We don't know who the next generation of geodesists are…** and we will need people to operate, maintain, utilize infrastructure in order for these efforts to be sustainable.

- Acting on behalf of IAG, GGOS participates in numerous activities in the Group on Earth Observations, and was a co-author of the GEO Statement on Equality, Diversity, and Inclusion (EDI).
- The GEO five-pillar EDI framework outlines a vision that equality, diversity, and inclusion are considered in every aspect of GEO, answering the mandate of the GEO mission to *"**unlock the power of Earth observations** by facilitating their accessibility and application to global decision making within and across many different domains."*

Visibility

- GGOS participation and leadership – often on behalf of the IAG -- **reminds Earth observation organizations that geodetic infrastructure is important** for things like climate change and disaster risk reduction.

quickly in the aftermath to save lives during recovery operations (Martire et al., 2021). Geodesy4Sendai, a Group on Earth Observations (GEO) Community Activity led by the International Association of Geodesy (IAG) and the International Union of Geodesy and Geophysics (IUGG), is participating in a new tsunami early warning collaboration with the International Telecommunication Union (ITU), WMO, and United Nations Environment Programme (UNEP) Focus Group on Artificial Intelligence for Natural Disaster Management (FG-AI4NDM). Within the *Topic Group on AI for Geodetic Enhancements to Tsunami Monitoring and Detection*, experts have started to look at relevant best practices in use of Global Navigation Satellite Systems (GNSS) data (Astafyeva, 2019; Brissaud and Astafyeva, 2021). Specifically, the experts are exploring the feasibility of using AI to process GNSS data in countries where exporting real-time data is prohibited by law, and to establish protocols for development and sharing of export-permitted products derived



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Artificial Intelligence for Disaster Risk Reduction: Opportunities, challenges, and prospects

By Monique Kuglitsch, Fraunhofer Heinrich Hertz Institute, Germany; Arif Albayrak, NASA Goddard Space Flight Center, USA; Raúl Aquino, Universidad de Colima, Mexico; Allison Craddock, NASA Jet Propulsion Laboratory and California Institute of Technology, USA; Jaselle Edward-Gill, Fraunhofer Heinrich Hertz Institute, Germany; Rinku Kanwar, IBM, USA; Anirudh Koul, Pinterest, USA; Jackie Ma, Fraunhofer Heinrich Hertz Institute, Germany; Alejandro Marti, Mitiga Solutions and Barcelona Supercomputing Center, Spain; Mythili Menon, International Telecommunication Union; Ivanka Pelivan, Fraunhofer Heinrich Hertz Institute, Germany; Andrea Toreti, European Commission Joint Research Centre, Italy; Rudy Venguswamy, Pinterest, USA; Tom Ward, IBM, USA; Elena Xoplaki, Justus Liebig University Giessen, Germany; and Anthony Rea and Jürg Luterbacher, WMO Secretariat

Artificial intelligence (AI), in particular machine learning (ML), is playing an increasingly important role in disaster risk reduction (DRR) – from the forecasting of extreme events and the development of hazard maps to the detection of events in real time, the provision of situational awareness and decision support, and beyond. This raises several questions: *What opportunities does AI present? What are the challenges? How can we address the challenges and benefit from the opportunities? And, how can we use AI to provide important information to policy-makers, stakeholders, and the public to reduce disaster risks?* In order to realize the potential of AI for DRR and to articulate an AI for DRR strategy, we need to address these questions and forge partnerships that drive AI in DRR forward.

AI and its use in DRR

AI refers to technologies that mimic or even outperform human intelligence when performing certain tasks. ML, which is a subset of AI that includes supervised (e.g., random forest or decision trees), unsupervised (e.g., *K*-means) or reinforcement (e.g., Markov decision process) learning, can be simplified as parsing data into algorithms that learn from data to make classifications or predictions. AI methods offer new opportunities related to applications in, for instance, observational data pre-processing as well as forecast model output post-processing. The methodological potential is strengthened by novel processor technologies that allow heavy-duty, parallel data processing.

In general, the performance of ML for a given task is predicated upon the availability of quality data and the selection of an appropriate model architecture. Through remote sensing (e.g., from satellites, drones), instrumental networks (e.g., from meteorological, hydrometeorological, and seismic stations) and crowdsourcing, our foundation of Earth observational data has grown immensely. In addition, model architectures are constantly being refined. Therefore, it is to be expected that ML will be growing more prominent in DRR applications (Sun et al., 2020). For instance, a preliminary survey of recent (2018–2021) literature shows that ML approaches are being used to improve early warning and alert systems and to help generate hazard and susceptibility maps through ML-driven detection and forecasting of various natural hazard types (see Figure 1, note that this survey excludes research that is purely focusing on method development but does not target future DRR application).

This preliminary survey clearly demonstrates that AI-related methods are being applied to help us better manage the impacts of many types of natural hazards and disasters. In the next paragraphs we present four specific examples of where AI is being implemented to support DRR.

In Georgia, the United Nations Development Programme (UNDP) is creating a nation-wide multi-hazard early warning system (MHEWS) to help reduce the exposure of communities, livelihoods and infrastructures to weather and climate-driven natural hazards. For its operation, this system requires accurate forecasts and hazard maps of severe convective events (i.e., hail- and windstorms).

Global Geodetic Observing System

Visibility

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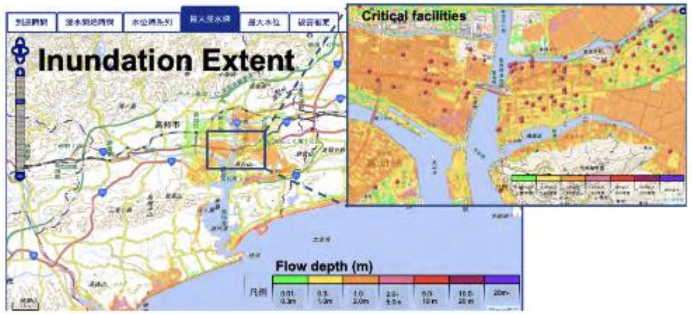
Global Satellite Navigation Data for Real-Time Tsunami Forecasting

Ten years ago, when Japan's northern coastal areas were hit by the Tohoku tsunami, it took several days to grasp the entirety of the vast damage. Now, Earth observations, combined with artificial intelligence (AI) and machine learning (ML), can be used to assess threats and prepare ahead of time, to evaluate impacts as they unfold (as little as 20 minutes after earthquake occurrence), and to respond more quickly in the aftermath to save lives during recovery operations.

Geodesy4Sendai, a GEO Community Activity led by GEO Participating Organizations the International Association of Geodesy (IAG) and the International Union of Geodesy and Geophsics (IUGG), is participating in a new tsunami early warning collaboration with the recently established ITU Focus Group on Artificial Intelligence for Natural Disaster Management, organized jointly with WMO and UNEP.

A Topic Group "AI for Geodetic Enhancements to Tsunami Monitoring and Detection" has begun to look at relevant best practices in use of Global Navigation Satellite Systems (GNSS) data. The group is exploring the feasibility of using AI to process GNSS data in countries where exporting real-time data is prohibited by law, and to establish protocols for development and sharing of export-permitted products derived from AI and related methods. The group is also considering innovative communications technologies for transmitting real-time GNSS data to countries or regions with limited bandwidth capacity, where using AI for decentralized, data-derived product sharing could enable the transmission of life-saving information over limited communications infrastructure.

Such an effort would lay the groundwork for expanding the use of these methods in developing countries which suffer from increasing tsunami threats in addition to other climate change impacts such as sea level rise.



Simulation of an anticipated mega quake (M9) in Kochi City, Japan, produced by supercomputer and AI/ML

International Association of Geodesy

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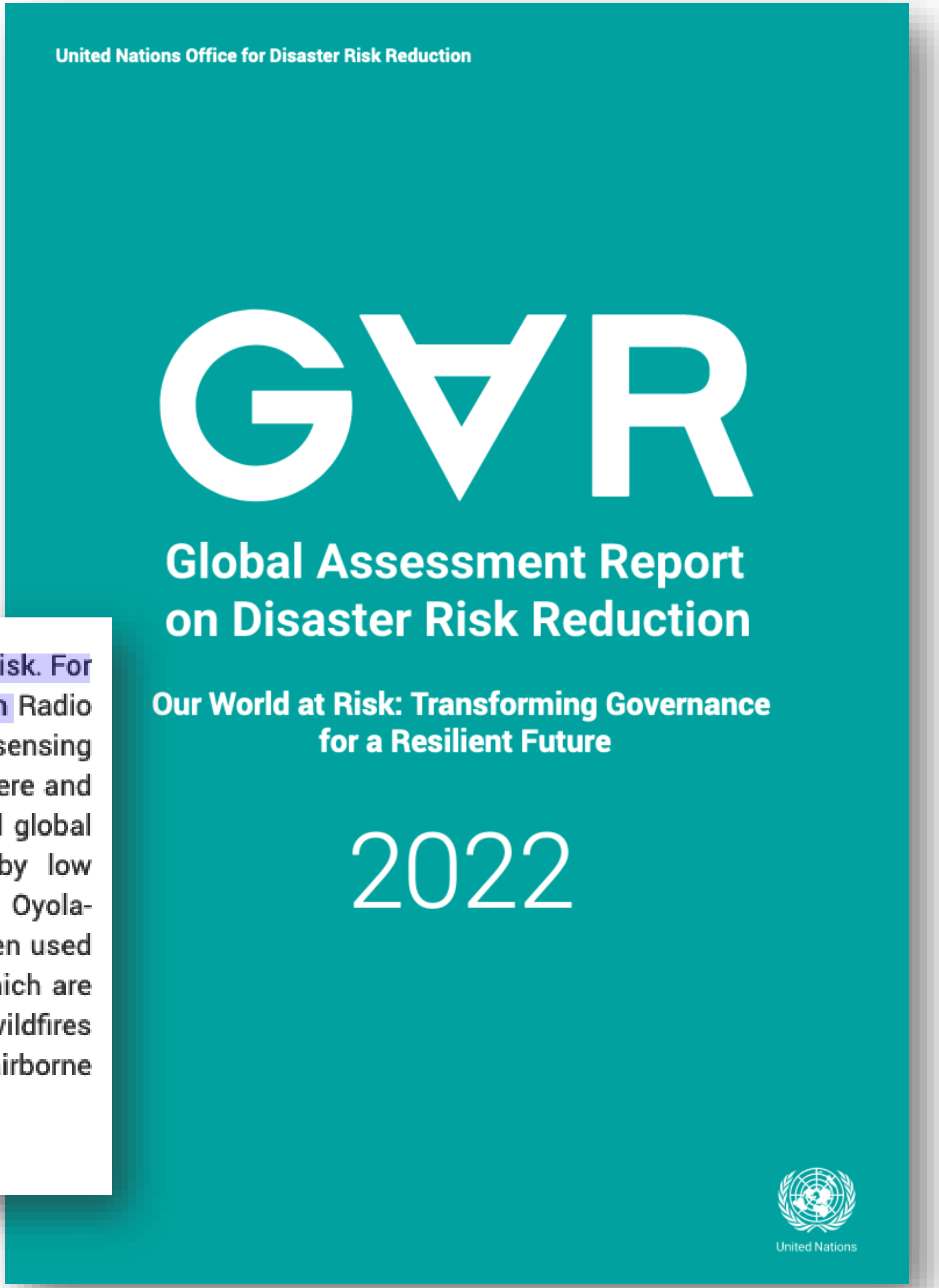
Earth observation techniques are increasingly being developed that can help fill gaps, by monitoring impacts such as the deterioration of air quality due to wildfires or other air pollution. For example, in North America, an Earth observation analysis technique is being used to study environmental triggers to air quality deterioration at regional and global scales. It is coupled with existing and emerging aerosol concentration information from Earth observation satellites, weather models and air quality indices. Such approaches are building on previously unused or underutilized technologies and are applying them with new data to contribute to an improved transdisciplinary understanding of disaster risk. For example, Global Navigation Satellite System Radio Occultation analysis is a satellite remote-sensing technique that profiles the Earth's atmosphere and ionosphere with high vertical resolution and global coverage using measurements received by low Earth-orbiting satellites (Chen et al., 2021; Oyola-Merced et al., 2022). This technique has been used to monitor black carbon concentrations, which are a major factor in pollution produced by wildfires and a major threat to public health when airborne (Figure 11.1).



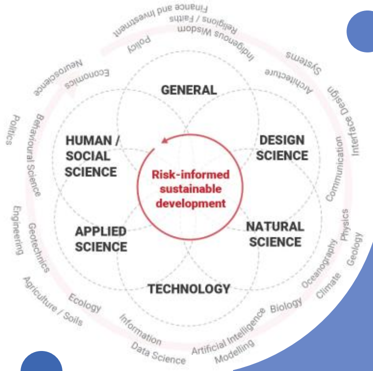
Moving Forward…

IUGG

Global Geodetic Observing System

Supporting establishment of the UN Global Geodetic Centre of Excellence

GAR Global Assessment Report on Disaster Risk Reduction



Engaging in new opportunities to enable and diversify geodesy's contributions to natural hazards and disaster risk reduction

Tracking Geodetic Indicators to UN Sustainable Development Goals

11 SUSTAINABLE CITIES AND COMMUNITIES

3 GOOD HEALTH AND WELL-BEING

17 PARTNERSHIPS FOR THE GOALS

Thank you!

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Contribution to the 2022 UNDRR Global Assessment Report (GAR): Transdisciplinary application of Global Navigation Satellite System Radio Occultation (GNSS-RO) to characterize atmospheric hazards and model systemic risk.

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GGOS Global Geodetic Observing System

SUSTAINABLE DEVELOPMENT GOALS

11 SUSTAINABLE CITIES AND COMMUNITIES

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UN World Conference on Disaster Risk Reduction
2015 Sendai Japan

- **Sustainable Development Goal 11: (Make cities and human settlements inclusive, safe, resilient, and sustainable)**
    - **Indicator 11.6.2 specifically seeks to measure the annual mean levels of fine particulate matter (such as PM 2.5 and PM 10) in cities**
- *Sustainable Development Goal 3: (Ensure healthy lives and promote well-being for all at all ages)*
    - *Target 3.9 (By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and **air**, water and soil pollution and contamination),*
    - *Indicator 3.9.1 (Mortality rate attributed to household and **ambient air pollution**).*
- *Sustainable Development Goal 17: (Strengthen the means of implementation and revitalize the global partnership for sustainable development)*
    - *Indicator 17.7.1 (Total amount of approved funding for developing countries to promote the development, transfer, dissemination and diffusion of environmentally sound technologies)*
    - *Indicator 17.6.1 (Number of **science and/or technology cooperation agreements** and programmes between countries, by type of cooperation).*
- **Sendai Global Targets:**
    - **G (Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030)**
    - **F (Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030)**

AI for Natural Disaster Management
ITU Focus Group

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Global Geodetic Observing System

Use Case: Enabling Natural Hazards Risk Information Sharing Using Derived Products of Export-Restricted Real-Time GNSS Data for Detection of Ionospheric Total Electron Disturbances

- This project seeks to explore the feasibility of using AI for novel decentralized domestic processing of GNSS data in countries where
  - Exporting of real-time GNSS data is either prohibited by law, or
  - Participation/data sharing is restricted by limited internet bandwidth capacity.
- The project will establish protocols for development and sharing of export-permitted data-derived products through artificial intelligence, federated machine learning, or a combination thereof.
- This would ultimately enable sharing of life-saving geodetic real-time tsunami risk information within the parameters of data export restrictions

AI for Natural Disaster Management

ITU Focus Group

- The ITU/WMO/UNEP Focus Group on AI for Natural Disaster Management (FG-AI4NDM) invites proposals for representative use cases (i.e., natural disaster case studies), which can include available datasets, applicable AI methods, and existing AI algorithms.
- The use cases will form the basis of our activities, which are to explore the potential of AI for natural disaster management (on various time and space scales) and to lay the groundwork for best practices.

AI for Natural Disaster Management
ITU Focus Group

IUGG

GGOS Global Geodetic Observing System

- Real-time GNSS-derived total electron content (TEC) is applied to derive products indicative of impending natural disasters including propagating tsunamis.
- An important part of the project will be the development of software and algorithms for the timely evaluation of hazard and risk through nowcasting and forecasting methods.
- Algorithms for the estimation of current risk will be developed that will allow the timely anticipation of major earthquakes and tsunamis.
- Models will be trained using both supervised and unsupervised learning methods, including principal component analysis.
- The initial proposal will use ionospheric observations in real time based on JPL's GNSS-based Upper Atmospheric Realtime Disaster Information and Alert Network (GUARDIAN). Additional GNSS data and infrastructure will be provided by the International GNSS Service, a technical service of the International Association of Geodesy.

https://www.itu.int/en/ITU-T/focusgroups/ai4ndm

Participation is open to all interested in contributing to this work!