

**Title:** Geodesy for the Sendai Framework

**Short Title:** Geodesy4Sendai

**Category:** Community Activity (2020-2022 GEO Work Programme Candidate)

**Planned Activities:**

Implementation of Global Navigation Satellite System Enhancement for Tsunami Early Warning Systems (GTEWS 2017 Recommendations); Organization of a GNSS “Tsunami Shield Consortium;” additional activities pertaining to geodesy support of disaster risk reduction (TBD).

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## 1. Executive Summary

This activity will establish the Geodesy4Sendai Community Activity with its first project: organizing the GNSS Tsunami Shield Consortium of international organizations to enhance tsunami early warning systems with the unique powerful capabilities of GNSS real time positioning and ionospheric imaging for the GNSS enhancement for Tsunami Early Warning Systems (GTEWS). Through the Geodesy4Sendai activity, the Consortium will implement the recommendations of the GTEWS 2017 workshop as presented within the 2019 Global Assessment Report on Disaster Risk Reduction (GAR19) of the United Nations Office for Disaster Risk Reduction (UNDRR).

The GTEWS 2017 workshop was supported by the eleven nation GATEW working group of the Global Geodetic Observing System, the Association of Pacific Rim Universities (APRU),

the International Research Institute of Disaster Science of Tohoku University (IRIDeS), and NASA. The GTEWS 2017 report provides the rationale and strategy to implement Resolution #4 of the 2015 International Union of Geodesy and Geophysics (IUGG) General Assembly. As its first task, Geodesy4Sendai will bring together these supporting organizations, the GEO community and several national real time GNSS networks within the Indo-Pacific and Caribbean basins to establish a prototype GTEWS network to demonstrate the implementation of IUGG 2015 Resolution #4.

This activity was influenced by the objectives and approaches of the Earth Observations for Disaster Risk Management component of the GEO 2017-2019 Work Programme. The application of advanced GNSS real time processing for positioning and ionospheric imaging provides very significant improvements to Tsunami Disaster Early Warning. Furthermore, the GTEWS initiative is in significant alignment with the goals of the Sendai Framework as outlined in the GTEWS supporting paper of the GAR19 report.

## 2. Purpose

### Rationale:

The GAR19 paper entitled [Global Navigation Satellite System Enhancement for Tsunami Early Warning Systems \(GTEWS\)](#) describes how GNSS real time networks and geodetic analysis techniques can significantly improve the life-saving accuracy and timeliness of tsunami early warning for communities nearest to the epicenter of mega-thrust earthquakes while also providing a tsunami tracking capability to warn communities in the far field of impending inundation by propagating tsunamis. The GTEWS report was accepted and submitted for publication of the UNDRR Assessment Report on Disaster Risk Reduction for 2019 (GAR19). The GNSS Tsunami Shield Consortium is the executive body that will identify and promote partnerships for the development of a GTEWS capability within the Indo-Pacific and Caribbean Basins.

### Planned Outputs:

This activity defines the structure of Geodesy4Sendai and assembles the GNSS Tsunami Shield Consortium of international and national organizations to include **the IAG-GGOS/IUGG, APRU, the UN-GGIM a GNSS Tsunami Shield Consortium and the many prototype GTEWS networks identified in the GTEWS 2017 report.** These organizations will bring the resources and strengths of their respective programs in support of the GTEWS network for the Indo-Pacific and Caribbean basins. Geodesy4Sendai will work to influence the development of international ministerial level support and financial support for the GTEWS program for the Asia-Pacific and Caribbean economies while also accelerating the development of the GTEWS products to enhance existing and planned tsunami warning systems. These efforts will provide GNSS information to regional tsunami warning systems and national emergency services in formats that are readily assimilated.

These development activities will include:

- **The encouragement of software, data exchange, and continued improvement of GTEW network design and performance.** Geodesy4Sendai will develop protocols for the exchange of real-time GNSS tsunami warning data, the sharing of research results, and the development of support agreements.
- **Strengthen broadband communication to underserved regions of the GNSS Tsunami Shield.** Portions of the prototype GTEWS networks are not connected through real-time communications between receiver and analysis centers. Real-time GTEWS communications requirements can be met with current Fourth Generation wireless technology.
- **Encourage national organizations including those mandated for natural hazards mitigation to develop agreements for inclusion of their GNSS receivers within the GNSS Tsunami Shield.** National or agency level restrictions for access to real-time GNSS data is the greatest challenge to the integration of an effective GTEW system.
- **Design an optimal GNSS Tsunami Shield network for both crustal displacement and high-resolution Total Electron Content (TEC) monitoring.** The GTEWS 2017 workshop recommended a numerical analysis that includes local geology, seismicity and communications infrastructure. Use existing GNSS sites wherever possible.
- **Understand the operational requirements of existing tsunami warning systems and determine the steps required to interface these tsunami warning systems.** GTEWS is an observational and analysis capability that must be integrated with public advisory and warning capability. The rapid and successful implementation of GTEWS will rely upon fluid interactions amongst national agencies.

### Expected Users and Informed Decisions:

National and regional tsunami warning systems, seismic monitoring systems, atmospheric modeling systems as well as meteorological services are expected to be the major/primary users and beneficiaries of Geodesy4Sendai. Effective execution of the GTEWS through Geodesy4Sendai will better inform decisions regarding evacuation and determination of disaster emergency preparation levels.

Secondary users will include Earth observation systems and satellites that rely upon precise geodetic infrastructure to underpin their intrinsic value of providing a high-quality observation at a precise location, on a repeated, reliable, and sustainable basis.

## 3. Background

The effort emerged from recommendations and resolutions of numerous Academic Organizations including the IAG/IGS, APSG, IOC, GGOS, IUGG. The community activity was significantly influenced by the objectives of the Earth Observations for Disaster Risk Management component of the GEO 2017-2019 Work Programme and the UNDRR Sendai Framework for Disaster Risk Reduction 2015-2030.

## 4. Key Activities

The first activity of Geodesy4Sendai will be to establish the GNSS Tsunami Shield Consortium membership, its terms of reference and its bylaws by which it will carry out the following goals:

- ⇒ Encourage broader cooperation within the Indo-Pacific and Caribbean communities for the development of GNSS enhancement to Tsunami Early Warning Systems (GTEWS);
- ⇒ Establish a program to advance the technical, scientific, and policy developments needed to advance the GTEWS advancement;
- ⇒ Involve the critical agencies of the Indo-Pacific and Caribbean regions to identify and overcome the challenges to a successful international GTEWS development.
- ⇒ Encourage software, data exchange, and continued improvement of network design and performance.
- ⇒ Strengthen broadband communication to underserved regions of the GNSS Tsunami Shield.
- ⇒ Work with national organizations including those mandated for natural hazards mitigation to develop agreements for inclusion of their GNSS receivers within the GNSS Tsunami Shield. Design an optimal GNSS Tsunami Shield network for both crustal displacement and high-resolution TEC monitoring.
- ⇒ Develop products suited to the operational requirements of existing tsunami warning systems and determine the steps required to interface these tsunami warning systems.

## 5. Relationship to GEO Engagement Priorities and to other Work Programme Activities

In close collaboration with GEO Blue Planet and other GEO components, as well as in concurrence with the proposed EO4Sendai Community Activity, Geodesy4Sendai's GTEWS will support the implementation of the Sendai Framework for Disaster Risk Reduction, having a contribution to targets A, B, C, and D in efforts to substantially reduce loss of life, economic impact, and critical infrastructure and services disruption. Geodesy4Sendai also strongly aligns with and contributes to Targets F and G, growing international cooperation – especially in small island developing states – by supporting access to early warning systems and other DRR information.

Determination and benchmarking of progress against both SDG and Sendai indicators with precise GNSS data and analysis strongly supports the monitoring processes outlined by both, and works toward ensuring the best possible interoperability, discoverability, and accessibility.

The Community Activity will also inform the achievement and measurement of the SDG targets. As identified by the organizers of EO4Sendai, “enabling countries to strengthen their disaster resilience through better and more consistent data on disaster risk and damage, the activity will contribute to the achievement and measurement of SDGs 1.5, 11.5, 11.b and 13.1. The derivation of information from earth observation data for Sendai indicators can contribute to a comprehensive risk assessment and management and enhance a countries capacity to develop

national adaptation plans or disaster risk management strategies.” Additional SDG targets and indicators will be added as identified by activity leadership, and in consultation with EO4SDG.

Furthermore, the work of Geodesy4Sendai shall be in strong interoperable alignment with the UN-GGIM World Bank Integrated Geospatial Information Framework as well as the UNDRR Global Risk Assessment Framework (GRAF).

Linkages to initiatives and activities from GEO Work Programme 2017-2019:

Initiatives:

- Data Access for Risk Management (GEO-DARMA);
- Blue Planet;
- AOGEO;
- EO4SDG

Community Activity:

- Earth Observations for Disaster Risk Management

## 5. Governance

This Community Activity is led by the IAG Global Geodetic Observing System. All efforts, projects and activities within Geodesy4Sendai will be led by GGOS in close cooperation with the International GNSS Service and IUGG GeoRisk Commission. The IGS Central Bureau shall serve as the secretariat for this activity, in consultation with the GGOS Coordinating Office and IUGG Secretariat.

Where appropriate, cooperation and alignment with the UN Global Geospatial Information Management Committee of Experts (UN-GGIM) and its Subcommittee on Geodesy (SCoG), as well as the UN International Committee on GNSS and UN-SPIDER, will be planned.

## 6. Data Policy

Geodesy4Sendai espouses an open data policy, in compliance with GEOSS Data Sharing Principles and the GEOSS Data Management Principles, as well as the open data policies and/or philosophies of the International Association of Geodesy, Global Geodetic Observing System, and International GNSS Service.

## Annex A: Resources

Geodesy4Sendai will be supported by in-kind contributions.

## Annex B: Acronyms

AOGEO: Asia Oceania regional GEO

GGOS: Global Geodetic Observing System

GGIM: (UN) Global Geospatial Information Management (UN Committee of Experts)

GEO: Group on Earth Observations

GNSS: Global Navigation Satellite System

IAG: International Association of Geodesy

ICG: (UN) International Committee on GNSS

IGS: International GNSS Service

SDG: (UN) Sustainable Development Goal

SPIDER: (UN) Platform for Space-based Information for Disaster Management and Emergency Response

## Annex C: Project Coordinator/Leader CV

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