WG-D and WG-B’s Task Force on Applications of GNSS for Disaster Risk Reduction

Report to ICG-17

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**Scope Reminder - Context within ICG**

This Task Force was created at ICG-16 in October 2022, following **WG-D’s Recommendation #26** and in tandem with **WG-B**.

**Rationale:** Apparent lack of international coordination on topics at the intersection of **GNSS applications** and **disaster risk reduction**.

**Focus:** GNSS-based **monitoring** and **remote sensing**, **not** transmission of alerts, **not** replacement of existing EWS.

**Task Force Co-Chairs:**
- **IGS** (Léo Martire, WG-D),
- **China** (Jun Shen, WG-B),
- **Japan** (Naofumi Takamatsu).
## Scope Reminder - GNSS Techniques vs. Hazards

**GNSS-based techniques** enable the (remote) sensing of the whole surface-atmosphere system. **Objective:** use GNSS to augment early warning systems for natural hazards.

<table>
<thead>
<tr>
<th>Technique</th>
<th>Probing Region</th>
<th>Relevant to</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNSS Precise Point Positioning (GNSS-PPP)</td>
<td>ground displacements (3D position of the receiver)</td>
<td>earthquakes</td>
</tr>
<tr>
<td>GNSS Reflectometry (GNSS-R)</td>
<td>surface conditions (e.g., soil moisture, ice thickness)</td>
<td>storms</td>
</tr>
<tr>
<td>GNSS Radio Occultation (GNSS-RO)</td>
<td>surface to mid-stratosphere (40 km) (temperature + moisture)</td>
<td>floods</td>
</tr>
<tr>
<td>GNSS Polarimetric RO (GNSS-PRO)</td>
<td>surface to mid-stratosphere (40 km) (temperature + moisture + heavy precipitation)</td>
<td>tsunamis</td>
</tr>
<tr>
<td>GNSS Ground-Based Ionospheric TEC (GNSS-TEC)</td>
<td>ionosphere (100-1500 km) (Total Electron Content - TEC)</td>
<td>wildfires, volcanic eruptions, solar storms, CMEs</td>
</tr>
</tbody>
</table>
Goals: Reminder and Completion

1. Assemble a *diverse group of members* representative of the GNSS community.
   - Diversity: 19 countries represented by at least 1 member (12 USA, 8 China, 5 Japan, 4 Fiji).
   - Natural hazards: at least 2 experts on each type.
   - GNSS expertise: PPP, TEC, administration, and source determination are well-represented; other fields of expertise are still slightly lacking.

2. Discuss *recommendations* for the next steps in using GNSS for natural hazards; present those at the yearly meeting of the International Committee on GNSS (ICG).
   ⇒ Today’s discussion.

3. Develop science connections to the strategic plans of the relevant agencies.
   - No significant progress.

4. Develop *operational tools* that would benefit natural hazards early warning systems.
   - 12 expert presentations given and 10 tools catalogued and over the course of the FY.
Attendance and Membership during FY23

- **Attendees per Meeting**
  - Graph shows a fluctuating trend with peaks and troughs throughout the fiscal year.
  - Notable increases during ICG-16 and ICG-17.

- **Registered Members**
  - Graph illustrates a steady upward trend from November 2023 to November 2023.
Joining the DRR Task Force

Please fill the following form: https://forms.gle/vJ Rt1TwaT6eRD oB39.

Please forward it to any and all colleagues who might be interested in contributing.

If there are any issues with Google Forms, please contact us directly (leo.martire@igs.org).
# GNSS-Based Tools for Disaster Risk Reduction

<table>
<thead>
<tr>
<th>Name</th>
<th>Point(s) of Contact</th>
<th>Technique</th>
<th>Natural Hazards (main focus, secondary focus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ShakeAlert¹</td>
<td>USGS, USA</td>
<td>PPP</td>
<td>earthquakes</td>
</tr>
<tr>
<td>REGARD²</td>
<td>GSI, Japan</td>
<td>PPP</td>
<td>tsunamis, earthquakes</td>
</tr>
<tr>
<td>G-FAST³</td>
<td>Crowell (UW, USA), Melgar Moctezuma (UO, USA)</td>
<td>PPP</td>
<td>tsunamis, earthquakes</td>
</tr>
<tr>
<td>R-CET GNSS⁴</td>
<td>d'Anastasio (GNS Science, New Zealand) Geng (WU, China), McClusky (GA, Australia)</td>
<td>PPP</td>
<td>earthquakes, tsunamis</td>
</tr>
<tr>
<td>VARION⁵</td>
<td>Ravanelli (IPGP, France)</td>
<td>PPP + TEC</td>
<td>tsunamis, volcanic eruptions, space weather</td>
</tr>
<tr>
<td>GUARDIAN⁶</td>
<td>Martire, Krishnamoorthy, Komjáthy (JPL, USA)</td>
<td>TEC</td>
<td>tsunamis, volcanic eruptions, space weather</td>
</tr>
<tr>
<td>IPS⁷</td>
<td>Sgammini (JRC, Italy)</td>
<td>TEC</td>
<td>space weather</td>
</tr>
<tr>
<td>VARION⁵</td>
<td>Han (University of Newcastle, Australia)</td>
<td>RO</td>
<td>tsunamis, volcanic eruptions</td>
</tr>
<tr>
<td>gnssrefl⁸</td>
<td>Larson (University of Bonn, Germany)</td>
<td>R</td>
<td>sea level, drought, floods</td>
</tr>
</tbody>
</table>

1. [https://www.shakealert.org/](https://www.shakealert.org/). Focus is the USA.
3. Is currently in trial use by tsunami warning centres both in the US and other Pacific countries.
4. R-CET is a 5 year project looking into a variety of tools for rapid modelling of earthquakes and tsunamis; a specific GNSS branch exists.
5. Was used in the exploratory stages of the GUARDIAN development.
7. Requirement is to provide space weather warnings 24 hours in advance. Uses machine learning. Is funded by the European Commission.
Suggested Recommendation

DRAFT Recommendation, hosted in WG-D:

• Demonstrate the deployment for a multi-technique GNSS station in an area of sparse coverage. A single ground station is sufficient for PPP, TEC, and interferometric R. Define and answer the important questions, provide a guide for future installations. Location? Land authorisations? Equipment? Connectivity? Operations? Etc..

• Foster open+free+accessible software+data. In particular:
  • Encourage open-source, free, readily- and easily-usable software.
  • Encourage open-access, real-time, high-rate, precise GNSS products.

• Pursue the development of data assimilation, data fusion for various types of datasets, and crowd-sourcing GNSS data. E.g.:
  • USGS’ ShakeMap,
  • ESA’s Camaliot project.