Tour de l'IGS Stop 5:
GNSS for Natural Hazards in the South Pacific
Abstracts

GNSS Tsunami Early Warning for the South Pacific

John LaBrecque, GGOS Geohazards Focus Area

GNSS has long been an important tool in advancing our understanding of risks posed by natural hazards whether they are seismic, volcanic, hydrologic or climatic in nature. During the past decade significant advances have reduced the latency and increased the accuracy of GNSS positioning. Near real time positioning and the resolution of associated environmental parameters are now available with sub-centimeter positioning accuracy. This GNSS real time capability is accurate enough to inform predictive finite fault models of possible mega-thrust displacement and provide very accurate tsunami predictions well within 5 minutes of initial displacement- well before coastal inundation. Most importantly GTEWS is an efficient and cost effective system that will provide coastal security.

In 2015, the IUGG General Assembly recognized the value of GNSS tsunami early warning. The 2015 General Assembly's Resolution #4 called upon IUGG membership to work toward the implementation of a Pacific GNSS Tsunami Early Warning System (GTEWS) to augment existing systems. Significant advancements include real time analysis packages and at least two online monitoring networks operating as GTEWS proof of concept systems. However the operational GTEWS implementation remains elusive.

The IUGG Commission on Geophysical Risk and Sustainability, the Global Geodetic Observing System and the Group on Earth Observation are working to explore the possibility of developing a GTEWS subnetwork for the Southern Pacific. While Australia and New Zealand are operating advanced GNSS networks, there is little networking of GNSS measurements within the Southern Pacific region at a density required for an operational GTEWS.

We will examine the state of GTEWS technology, its motivation, and the planning underway to explore the development of GTEWS for the South Pacific Region. I hope to be joined by members of the Geohazards Working Group (GATEW) in support of the South Pacific GTEWS Initiative.

A nation-wide tsunami inundation and damage forecast system in Japan

Shunichi Koshimura, International Research Institute of Disaster Science, Tōhoku University

Coming Soon.

GNSS Infrastructure and Technologies to Support Tsunami Early Warning System

Viliami Folau, Ministry of Lands & Natural Resources, Tonga

The January Hunga Tonga Hunga Ha'apai eruption and tsunami highlighted and amplified the level of unpreparedness of all for such a disaster of this magnitude. Being one of the most vulnerable countries in the world coupled with the lack of relevant technologies to support an early warning system increases our susceptible and prone to natural disasters, and most recently, tsunami. It has been discussed and agreed upon that GNSS can enhance tsunami early warning systems. Tonga, like the rest of the islands in the pacific, needs to employ GNSS technologies and infrastructures to support its early warning system.

Australian perspectives on the use of GNSS for Tsunami Warning

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There is evidence that several significant tsunamis have impacted Australia's northwest coast during the past few thousand years. This evidence is revealed through anomalous sedimentary deposits (such as those containing shell or coral) or other geomorphic features. The largest instrumentally recorded tsunami run-up was 7.9 m above the Australian Height Datum at Steep Point in Western Australia resulting from the July 2006 Java earthquake event. Following the devastating 2004 Sumatra earthquake and Indian Ocean tsunami, to address the problem of timely tsunami hazard detection and warning, the Joint Australian Tsunami Warning Centre (JATWC) operated by the Bureau of Meteorology and Geoscience Australia was established and officially launched in 2008. Based in Melbourne and Canberra, the JATWC's purpose is to detect,

monitor, verify and warn the community of the existence of tsunamis in our region and possible threats to Australian coastal locations and offshore territories. In this presentation we will give an of overview JATWC's current tsunami warning capabilities and then discuss future opportunities for possible augmentation of the JATWC with observations of ionospheric disturbance derived from both ground based GNSS infrastructure as well as GNSS receivers in Low Earth Orbit (LEO). We will present results of a recent analysis of LEO based GNSS observations of ionospheric disturbance following the January 2022 eruption of the Hunga Tonga–Hunga Ha'apai (HTHH) volcano as an example.

Pacific Sea Level and Geodetic Stations for Natural Hazards

Andrick Lal, SPC (Pacific Community)

The 30-year Pacific Sea Level and Geodetic Monitoring Project is iconic in the region and globally for the infrastructure (Global Navigation Satellite System Continuously Operating Reference Station (GNSS CORS) and the Tide Gauge Stations) in the following pacific Island countries: Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu.

This project is supported by the Australian Aid and is managed and implemented by the Bureau of Meteorology Australia with project partners such as Geoscience Australia, the Pacific Community and Secretariat of the Pacific Regional Environment Programme. The following organisations are responsible for the following:

- Sea Level data and information http://www.bom.gov.au/pacific/projects/pslm/.
- GNSS CORS information on https://www.ga.gov.au/scientific-topics/positioning-navigation/geodesy/pacificsealevel with datasets on GNSS Network Portal (https://ga.gov.au).
- Oceanography data and information on the Pacific Ocean Portal (https://spc.int).

The GNSS CORS and the Tide Gauge Station in the region are monitored every 18 months through the Total station differential levelling technique.

The project infrastructure plays an integral role in determining the long-term variation in sea level and animating as references to natural disasters, coastal inundation, risks, and hazards for the small island developing states in the pacific.

GNSS for Natural Hazards in Aotearoa New Zealand

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Aotearoa New Zealand is positioned along the collision zone of the Pacific and the Australian plates and is extremely prone to natural hazards, including volcanoes, earthquakes, tsunami, and landslides. GNSS data, with its ability to measure ground deformation with an accuracy of a few millimetres, revolutionised the understanding of plate boundary deformation processes. When combined with other data (such as seismic), real time GNSS has become a fundamental tool for rapid assessment of natural hazards. This is particularly true for large earthquakes that deform the surface of the earth within about 100 km from the nearest GNSS stations.

The GeoNet programme at GNS Science Te Pū Ao operates a multi-domain geophysical network, including ~200 continuous GNSS stations, used to monitor geohazards and further our understanding of the Aotearoa plate boundary. This network enabled the discovery of slow slip events at the Hikurangi subduction zone, detects displacements caused by major earthquakes, and helps researchers to monitor landslides, volcanoes, and a range of deformation processes throughout New Zealand's plate boundary zone.

25% of the GNSS network provides data in real time, thanks to the partnership with Toitū Te Whenua Land Information New Zealand and an open data policy championed by governmental policies, and which is a core tenet of the GeoNet programme. As part of a GNS-led multi-year programme (Rapid Characterisation of Earthquakes and Tsunami, R-CET), which began in 2021, these real time GNSS data will be used to implement a system that will use GNSS data to improve and accelerate the analysis of large earthquakes and tsunami sources for the purpose of delivering tsunami early warning and rapid impact information to underpin emergency response and decision making.