SAR INTERFEROMETRY FOR MONITORING GROUND DEFORMATION IN NEW ZEALAND

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Volcanic eruptions and earthquakes caused by the subduction of the Pacific tectonic plate beneath the Australian tectonic plate are two types of natural hazards events that threaten New Zealand most, but the threat of consequent tsunami, landslide, flooding or lahar is also very high. The largest M8.2 earthquake ever recorded in New Zealand occurred in 1855 in Wairarapa region. Only a few people died during that event mainly because of the sparse density of population living at that time. If a similar event were to occur now it would cause much more casualties and damages, particularly in the capital city of Wellington, one of the largest cities in New Zealand located near by.

The possibility of a large volcanic eruption is particularly high for the city of Auckland and the townships of Taupo and Rotorua. Auckland, the largest city in New Zealand with a population over 1.4 million (including its suburbs) is situated on a volcanic field that has been active for the past 150-200 K years. The last eruption at the Auckland Volcanic Field occurred about six hundred years ago at the Mt. Rangitoto, a volcanic island located only a few kilometers away from the downtown of present Auckland. It was observed that the magnitude of past eruption in the region has been increasing with time (e.g. recent eruptions are larger) suggesting that the next eruption will be even larger.

Townships of Taupo and Rotorua are located in the center of very tectonically active region known as Taupo Volcanic Zone. This area with dimensions of 50 (NW-SE) by 350 (SW-NE) km is located in the central North Island of New Zealand and currently experience active continental spreading related to the subduction of the Pacific plate beneath the Australian plate. The main volcanic threat in this region comes from Mt Ruapehu, the largest active stratotovolcano in New Zealand that has been and stays presently active. A few other volcanoes are also situated in the TVZ region along with intensive seismic activity of various origin cause potential risk to the inhabitants of this region.

In order to mitigate risk of eminent volcanic eruptions and earthquakes New Zealand government represented by the GNS Science, a leading geophysical and geological organization in New Zealand, installed and maintains state of the art seismic and geodetic networks. The more recently remote sensing observation techniques have been used for monitoring various tectonic events. In this work we utilize Synthetic Aperture Radar as a complimentary tool for studying ground deformation of various nature related to seismic and volcanic activities, as well as anthropogenic deformation caused by extraction of groundwater for power generation and irrigation.

First experiments with SAR interferometry using C-band ERS-1/2 and ENVISAT data starting from early 1990s showed that dense vegetation in New Zealand prevents creating interferograms with sufficiently long temporal baseline due to significant decorrelation effect. Some promising results were obtained for urban parts of Auckland Volcanic Field (particularly city of Auckland) and Taupo Volcanic Zone (mostly township of Taupo) using advanced processing techniques such as stacking, small baseline subset (SBAS) and permanent scatterers (PS). The further advancement came with the launch of ALOS satellite with L-band PALSAR sensor. For this work we acquired and processed ALOS PALSAR data spanning from December 2006 until present for a few particularly active (or interesting otherwise) regions in New Zealand: (1) Taupo Volcanic Zone, in order to monitor tectonic deformation as well as subsidence related to the extraction of the geothermal groundwater; (2) Wellington region, in order to monitor slow slip events on the western coast of New Zealand and possible slip on Wellington fault; (3) Auckland Volcanic Field, in order to monitor deformation related to volcanic activities; (4) Fiordland and Gisborne regions, in order to study seismic and aseismic deformation presently occurring in those regions.

Processing of SAR data was performed using GAMMA software and good results were achieved for most regions in spite of a large amount of atmospheric noise and large spatial baselines. The interpretation and modeling of results observed on these interferograms as well as a discussion about the requirements to the ideal SAR system used for monitoring of ground deformation in New Zealand will be provided.