GSNL - Geohazard Supersites and Natural Laboratories

Biennial report for Candidate/Permanent Supersite

New Zealand Volcano Supersite

Status	*Candidate or Permanent Supersite*
Proposal documents	*http://www.earthobservations.org/documents/gsnl/proposals/NewZealandVolcanoes_proposal.pdf*
Acceptance letter(s)	*http://www.earthobservations.org/documents/gsnl/proposals/NewZealandVolcanoes_acceptance_letter.pdf*
Previous reviews	*N.A*
Point of Contact	*Ian Hamling (I.Hamling@gns.cri.nz)* *1 Fairway Drive* *Avalon* *Lower Hutt 5040* *New Zealand*

Science teams

<In this section please list all science teams who used/received data in the table below>

Team 1	*Ian Hamling, GNS Science, New Zealand (Team includes multiple scientists from across GNS including: Sigrun Hreinsdottir, Nico Fournier, Charles Williams, Ted Bertrand, Laura Wallace, Tony Hurst, Geoff Kilgour.*

Science team issues

Although there are many people working on the Taupo Volcanic Zone, the PoC is not aware of external groups working on the supersite specifically. While to date there has been limited coordination/contact between external groups, within GNS Science the satellite data has been utilized within multiple internal groups working on various volcanic hazard related studies.

Although we have disseminated results in journal articles and conference presentations over the last two years from the supersites data, I am unaware of external teams utilizing the data (specifically radar data). However, studies have been conducted based on some of the ground based data which were previously available through New Zealand's Geonet project but have not been directly attributed to the supersites initiative. Given New Zealand's small size and limited resources the PoC is currently

the primary user of the radar data. Unlike some of the other supersites that are supported by large well-funded research projects there has been limited opportunities to expand users and build teams in New Zealand.

In situ data

Type of data	Data provider	How to access	Type of access
GPS	*GeoNet*	*http://info.geonet.org.nz/display/appdata/Applications+and+Data*	*Public*
Seismic	*GeoNet*	*As above*	*Public*
Gas	*GeoNet*	*http://fits.geonet.org.nz*	*Public*
Camera	*GeoNet*	*http://info.geonet.org.nz/display/appdata/Volcano+Camera+Images*	*Public*

All of the data described above can be extracted from GeoNets FITS API (http://fits.geonet.org.nz/)

In situ data issues

All of in situ datasets which are currently acquired as part of GeoNet are freely available to all members of the public. Although not really an issue, this makes it hard to track what data, if any, is being utilized with linkages to the supersite.

Satellite data

Type of data	Data provider	How to access	Type of access
TerraSAR-X	*DLR*	Available after proposal submission to and acceptance by DLR (https://supersites.eoc.dlr.de/)	GSNL scientists
Cosmo-SkyMed	*ASI*	POC requests access from ASI for individual user	GSNL scientists
RADARSAT-2	*CSA*	POC requests access from CSA for individual users	GSNL Scientists
Sentinel-1A/B	*ESA*	https://scihub.copernicus.eu/dhus/	Registered public
ALOS-2	*JAXA*	https://auig2.jaxa.jp/ips/home	Successful proposals

Satellite data issues

For the most part there have been no specific data issues relating to the access for the PoC. Ordering of data for some missions, specifically, RADARSAT-2 has been limited due to limited personnel time over the last 12 months. Furthermore, limited numbers of acquisitions of some sensors compared with, for example, the sentinel mission has reduced the usefulness of some datasets.

While I am unaware of requests for specific datasets from outside teams it is currently unclear how this would be facilitated with the different access policies for each of the space agencies. I am unclear how to gain access to data from JAXA as part of the supersite initiative although the PoC has access to some data through an existing proposal.

Research results

A major focus of the New Zealand supersite was to enhance monitoring the New Zealand volcanoes and help build on our understanding of the magmatic plumbing system beneath the TVZ.

Since the start of the New Zealand supersite the data have been well utilized in enhancing our monitoring capabilities. SAR data is providing new insights into deformation processes at White Island off of the North Islands coast as well as shown post-eruptive deformation at Tongariro which would not have been detectable without the availability of the InSAR data. In addition, the data which is made available through the New Zealand supersite has been an important component of many research proposals which are aiming to build on some of the early results which have been achieved thus far.

Below are some figures from ongoing activities as part of the New Zealand supersite.

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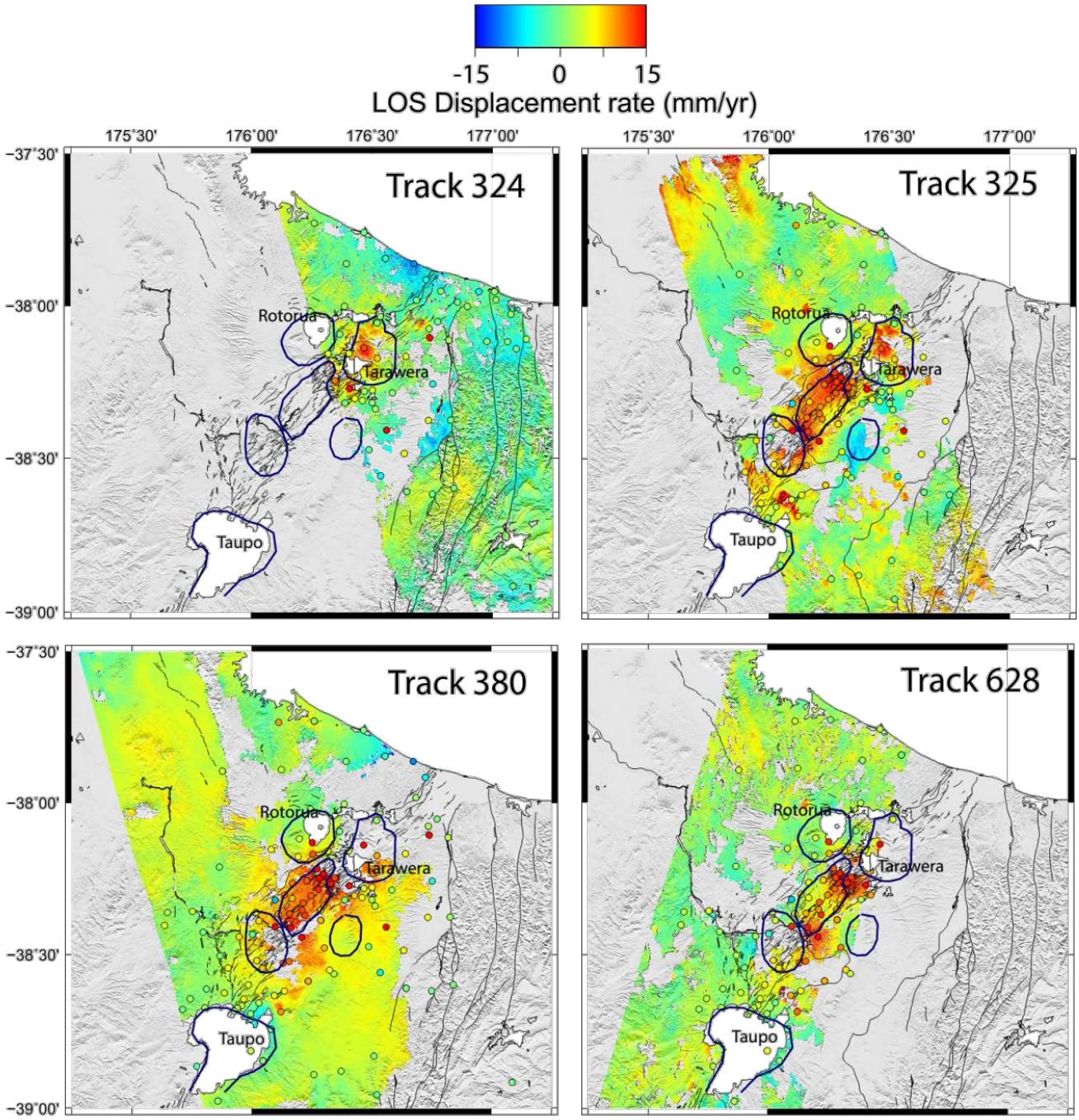

Figure 1) InSAR-derived rate maps for ALOS and Envisat data. Positive LOS displacements indicate motion away from the respective satellite. Colored circles show the GPS displacements at campaign and continuous sites converted into the satellites LOS. Heavy dark blue lines show the locations of the seven calderas. Lake Rotorua, Tarawera, and Taupo are also labelled. While not directly attributable to the supersite data, these results from envisat and ALOS-1 data show the large scale deformation occurring along the TVZ. These results were from an existing proposal prior to the supersites formation but highlights the potential improvements to monitoring that SAR data is providing.

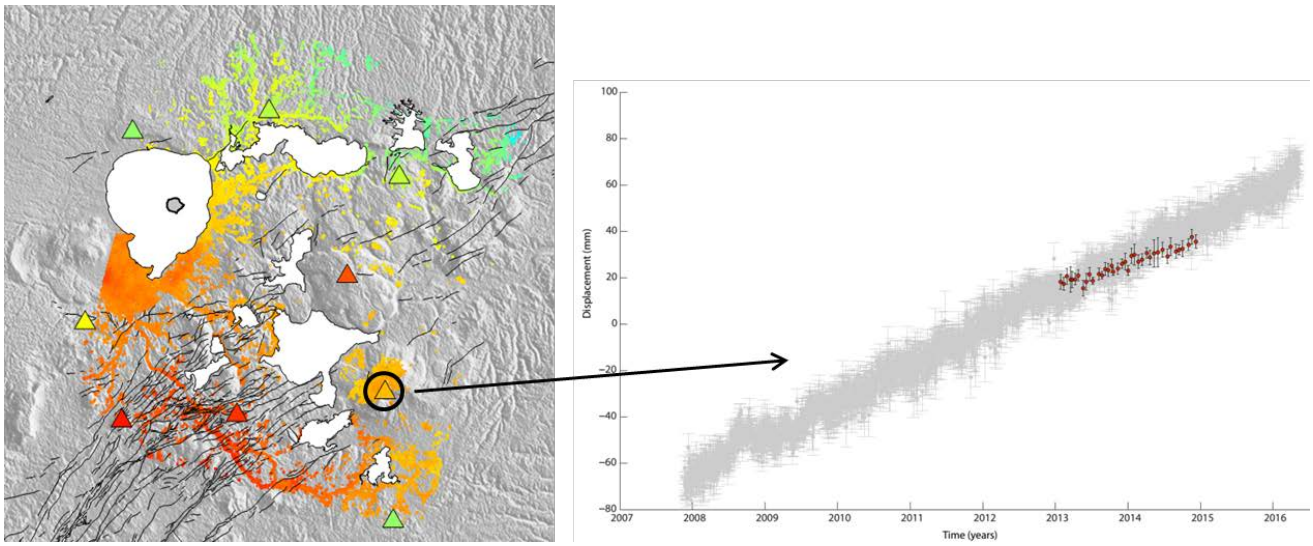

Figure 2) LOS displacements derived over the Okataina Caldera and city of Rotorua from Cosmo-Skymed data. The right hand panel shows the comparison between the InSAR and GPS. While there are limitations using the X-band satellites due to loss of coherence, these data are part of an ongoing project to better quantify the magmatic plumbing beneath the northern TVZ which is integrated the Magnetotelluric data and Finite element modelling.

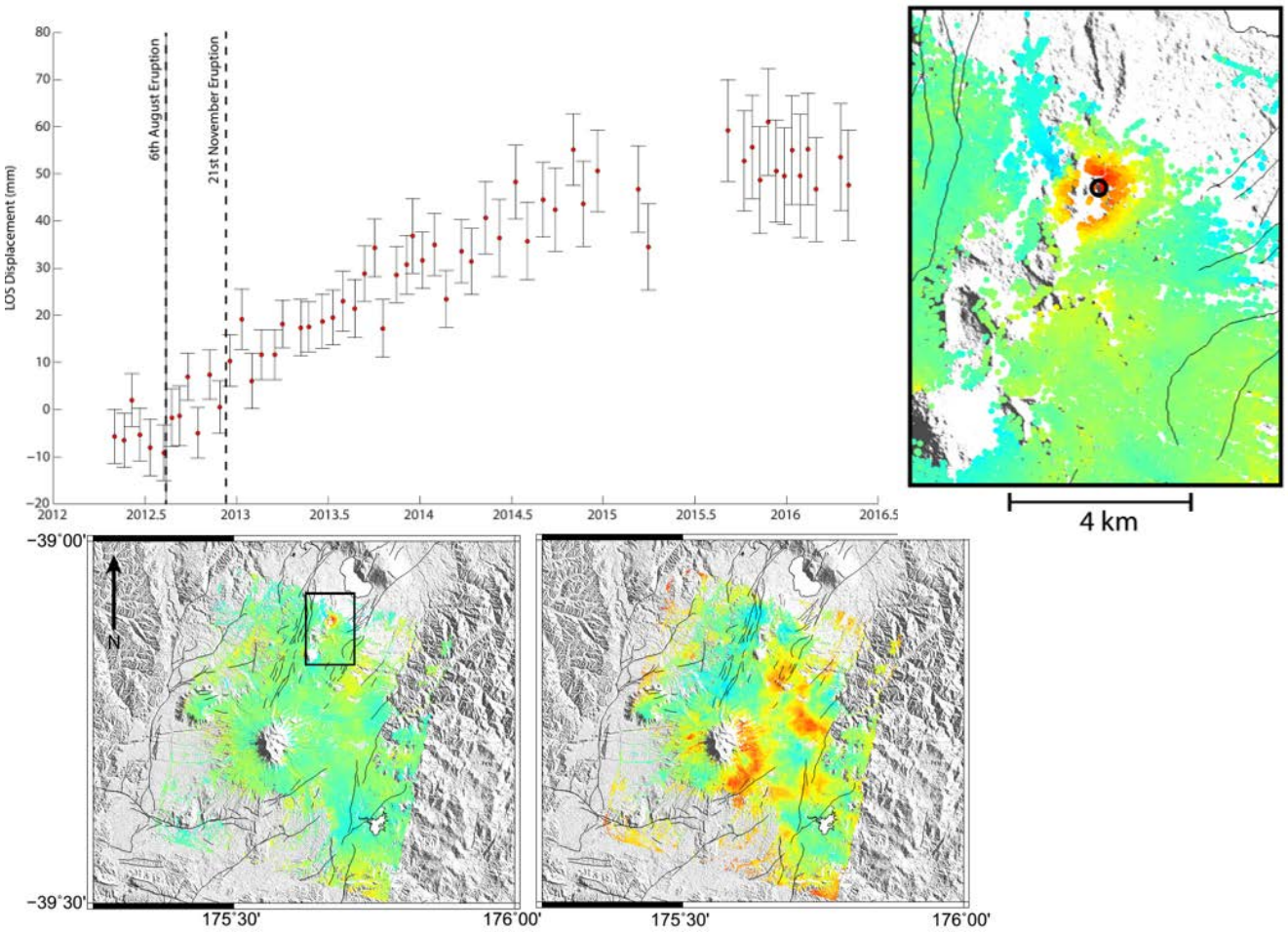

Figure 3) Post eruptive deformation over Tongariro from Cosmo-Skymed data. Using data acquired from 2012 – present we have shown significant subsidence over the Te Maari eruption site since the last eruption in November 2012. These results would not have been possible without the support of the supersites initiative.

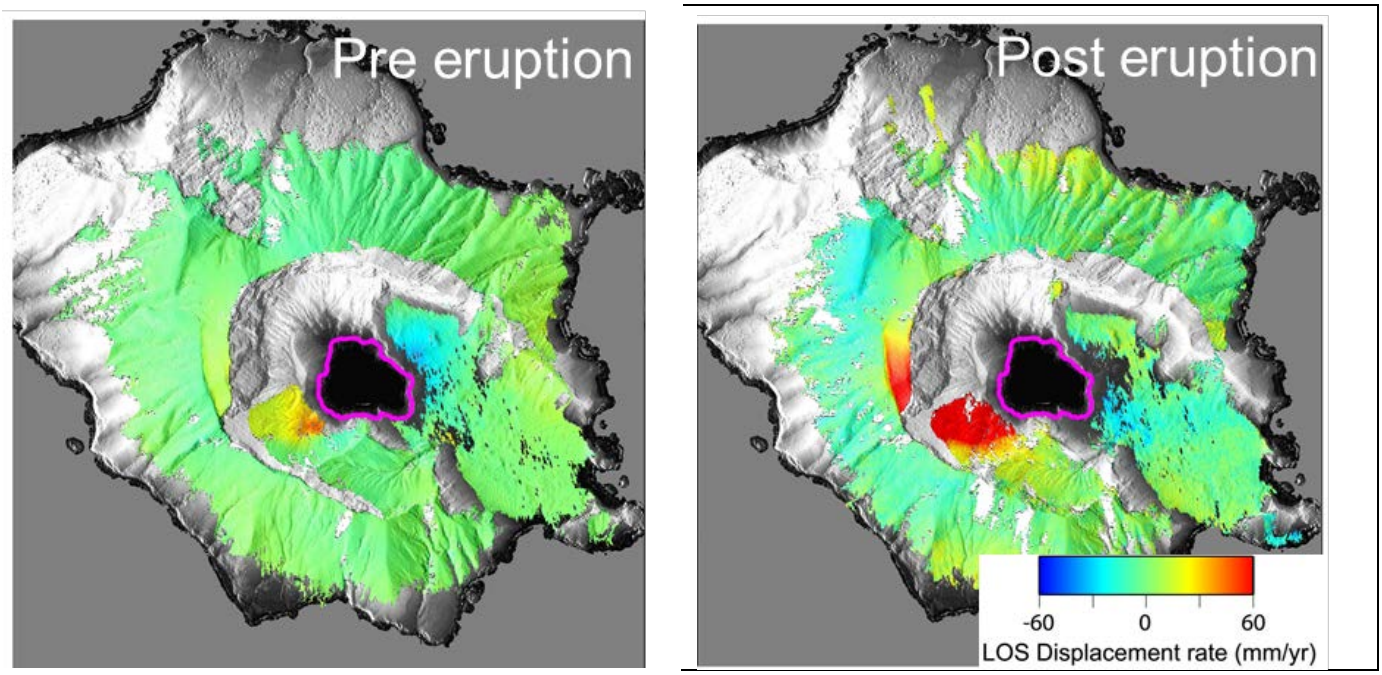

Figure 4) Example of LOS displacement maps over White Island derived from TerraSAR-X spotlight data. This data has revealed a number of previously unrecognized deforming areas. This includes a large region of subsidence along the south-western crater wall which has been moving at rates of 20 cm/yr since an eruption in 2016. As with the Tongariro case, this would not have been possible without the support of the supersite.

Publications

Peer reviewed journal articles

***Hamling, I.J.; Hreinsdottir, S.; Bannister, S.C.; Palmer, N.G. 2016 Off-axis magmatism along a subaerial back-arc rift : observations from the Taupo Volcanic Zone, New Zealand. Science Advances, 2(6): article e1600288**

***Hamling, I.J.; Williams, C.A.; Hreinsdottir, S. 2016 Depressurization of a hydrothermal system following the August and November 2012 Te Maari eruptions of Tongariro, New Zealand. Geophysical Research Letters, 43(1): 168-175; doi: 10.1002/2015GL067264**

***Hamling, I.J.; Hreinsdottir, S.; Fournier, N. 2015 The ups and downs of the TVZ : geodetic observations of deformation around the Taupo Volcanic Zone, New Zealand. Journal of Geophysical Research. Solid Earth, 120(6): 4667-4679; doi: 10.1002/2015JB012125**

Conference presentations/proceedings

***Hamling, I.J.; Hreinsdottir, S; Bannister, S.; Williams, C.. 2016 Eruptions and magmatic intrusions: Insights from the Taupo Volcanic Zone, New Zealand IN: Wegener 2016 : measuring and modelling our dynamic planet, Azores**

***Hamling, I.J.; Hreinsdottir, S.; Kilgour, G.N.; Bertrand, E.A. 2015 A multi-disciplinary investigation into the distribution of melt along the Taupo Volcanic Zone, New Zealand. abstract G41A-1010 IN: AGU Fall Meeting, San Francisco, 14-18 December 2015 : 2015 Fall Meeting program. USA: American Geophysical Union**

Hreinsdottir, S.; Hamling, I.J.; Palmer, N.G. 2015 Crustal deformation in the Taupo Volcanic Zone. p. 68 IN: Hannah, M.

(convener) Zealandia in space and time : Geosciences 2015, Geoscience Society of New Zealand, 25th-27th November 2015 : abstract volume. Wellington, N.Z.: Geoscience Society of New Zealand. Geoscience Society of New Zealand miscellaneous publication 143a.

Hamling, I.J.; Fournier, N.; Hreinsdottir, S. 2014 The ups and downs of the TVZ : geodetic observations of ground deformation along the Taupo Volcanic Zone. p. 120 IN: Wegener 2014 : measuring and modelling our dynamic planet : 1st - 4th September, 2014, University of Leeds, UK. University of Leeds

*** Although related to supersite activity the publication is not derived from supersite data.*

Research products

SEE BELOW

Research product issues

We do not currently have any formal research products beyond those made available from published works. Timeseries from GPS and other datasets generated through GeoNet are all available to the public but at present maps and other products derived from radar are not available. While this could be facilitated in the future, this would require additional support to achieve.

Dissemination and outreach

Results from the supersites have been presented to a number of regional council members to inform them of ongoing activities in monitoring of volcanic hazard. InSAR results, where applicable, are discussed in weekly volcanic hazard monitoring meetings to help inform. I have given a number of talks at New Zealand Universities highlighting the potential use for InSAR in volcano monitoring and the New Zealand supersite.

Funding

Much of the work described above has been funded through GNS via government core funding given to the organization. In addition, a number of proposals have been submitted to gain external funding of which supersite data will be utilized as part of ongoing research.

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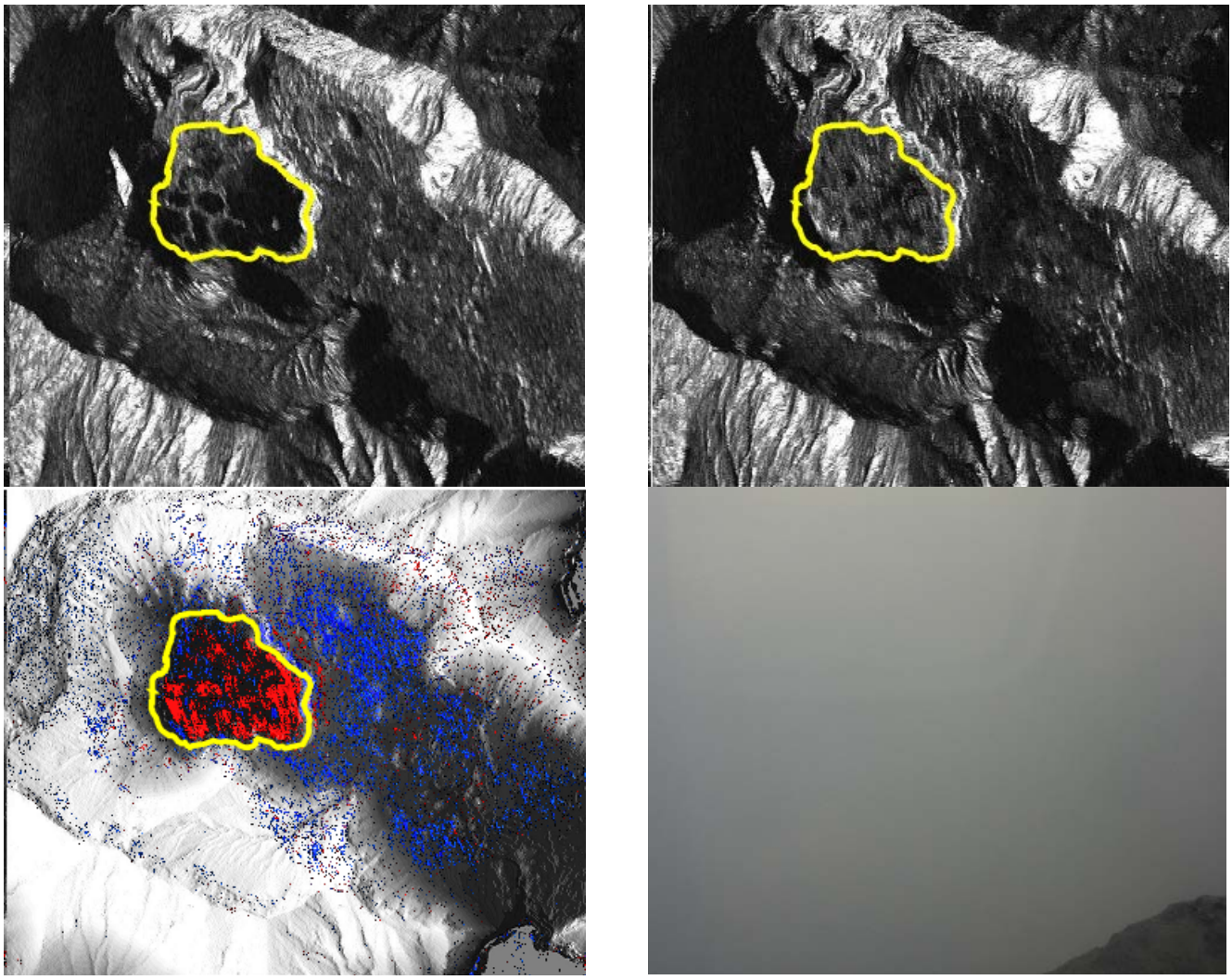
Societal benefits

Beyond the scientific community, the main stakeholders who benefit from the supersite has been GeoNet for enhancing the monitoring capabilities in time of crisis. In the event of a future eruption or increased activity this will have direct benefits to local authorities, regional councils and civil defence. To date, results from SAR observations have been utilized during hazard monitoring meetings to provide additional information not captured by our current ground based monitoring systems.



Examples of using TerraSAR-X data to monitor lake level on White Island. Top left image was captured two days before an eruption which emptied the crater lake (top left). The image in the bottom left shows the difference in amplitude before an image which shows the loss of water in the lake (red

colours). The blue areas correspond to ash which was deposited by during the eruption. The bottom right image shows a typical webcam picture from White Island which is often obscured by steam.

Conclusive remarks and suggestions for improvement

Although still in its infancy the New Zealand supersite is providing valuable information and insights into New Zealand's volcanic systems. Compared with some of the other supersites, which have had long term scientific activities such as the Hawai'i supersite, the New Zealand supersite has had limited outside interest beyond the PoC and collaborators. However, the data that has been made available is providing new and critical insights which would not have been possible without it.

Many of the issues that have arisen are related to limited resources and manpower to take full advantage of the all the data being supplied. Currently the PoC is the only active scientist working on InSAR in New Zealand and due to other time commitments, especially in the last 6 months, has resulted in long periods where data has not always been ordered due to other duties having to take priority. The automated nature of the initial ordering and delivery of Cosmo-Skymed data has been a huge benefit to the PoC negating the need to intermittently re-order scenes. If a similar procedure could somehow be arranged with the other data suppliers, then this would greatly increase overall efficiency.

Despite some of the issues described above, I believe the supersite initiative to be of huge benefit to New Zealand. In the coming years we are working to gain additional funding and possibility of hiring students to work on supersite data.

<Please address in the various sections of the report the situation of your Supersite with respect to the criteria listed in section 5 of the Supersites_Selection_Review_Procedures.pdf.>