GROUP ON EARTH OBSERVATIONS

Geohazard Supersites & Natural Laboratories

Status of the GEO-GSNL initiative

Stefano Salvi

Chair of the Supersites Advisory Committee

CEOS WG Disasters meeting #8, Buenos Aires, September 2017

Permanent Supersites

	Supersite	Status	Next Biennial report
1	Hawaiian volcanoes	Renewed at SIT 32	25-Oct-18 (3rd)
2	Icelandic volcanoes	Renewed at Plenary 29	5-Nov-17 (2nd)
3	Etna volcano	Renewed at Plenary 30	9-Apr-18 (2nd)
4	Campi Flegrei/Vesuvius volcano	Renewed at Plenary 30	9-Apr-18 (2nd)
5	Western North Anatolian Fault	Renewed at Plenary 30	9-Apr-18 (2nd)
6	Taupo Volcano	To be renewed at Plenary 31	29-Oct-18 (2nd)
7	Ecuador volcanoes	To be renewed at Plenary 31	29-Oct-18 (2nd)
8	Corinth Gulf/Ionian Islands	1st year of activity	8-Nov-18 (1st)
9	San Andreas Fault NL	Approved at SIT 32	27-Apr-19 (1st)

2017 Event Supersites

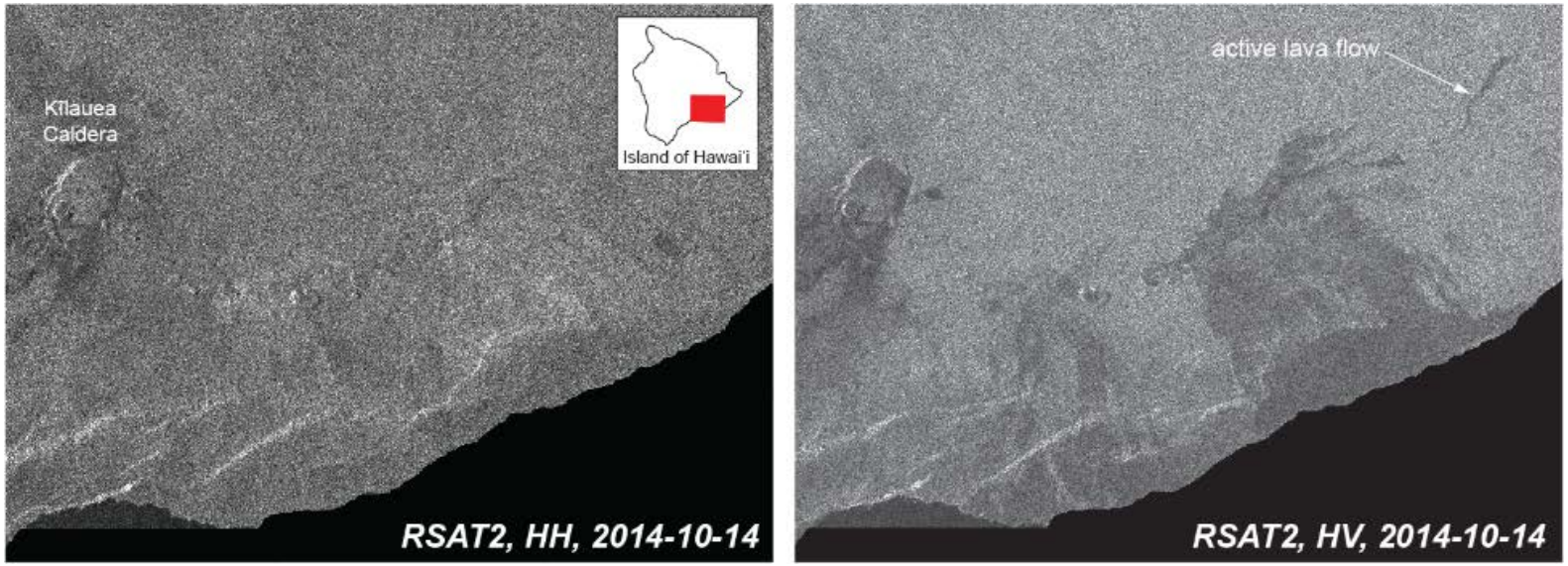
	Supersite	Supporting agencies	Date started
1	Sinabung volcano (Indonesia)	DLR (70 TSX), ASI (???)	??

Scientific results for the Supersites

- Hawai‘i (based on 2nd biennial report by Mike Poland)
- Taupo (based on 1st biennial report by Ian Hamling)
- Campi Flegrei (based on INGV work)
- Ecuador (based on F. Amelung presentation and 1st biennial report)

Hawai‘i Supersite

Radarsat 2 cross-pol data show new lava flows in forested areas

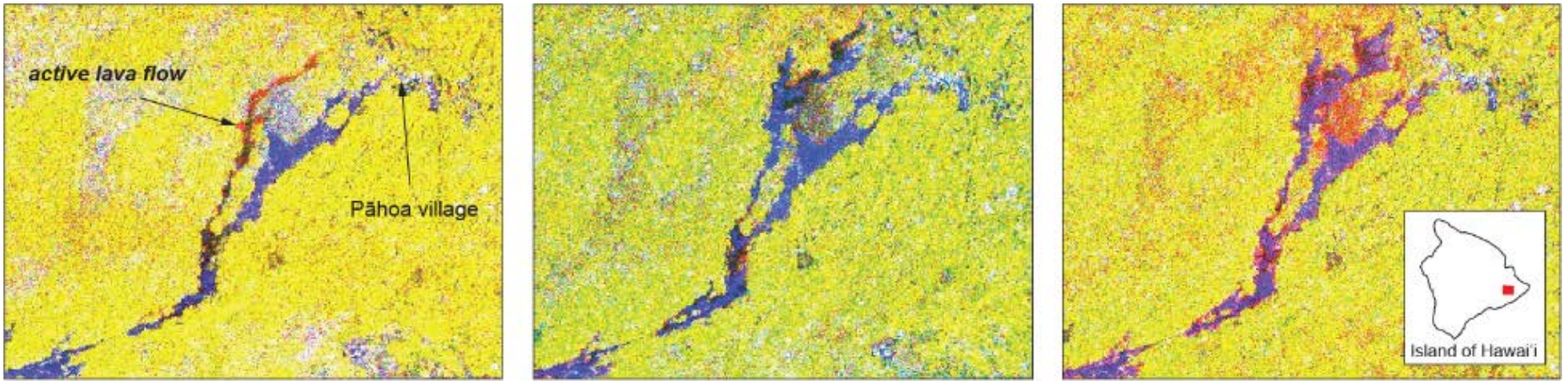


The backscatter differences between volcanic deposits and vegetation are large in cross-polarized SAR amplitude.

SAR data as those of RADARSAT-2 which are frequently acquired in high-res quad-pol modes, provide exceptional views of lava flow emplacement in forested areas

Hawai‘i Supersite

Sentinel 1 cross-pol data used to closely monitor new lava flows

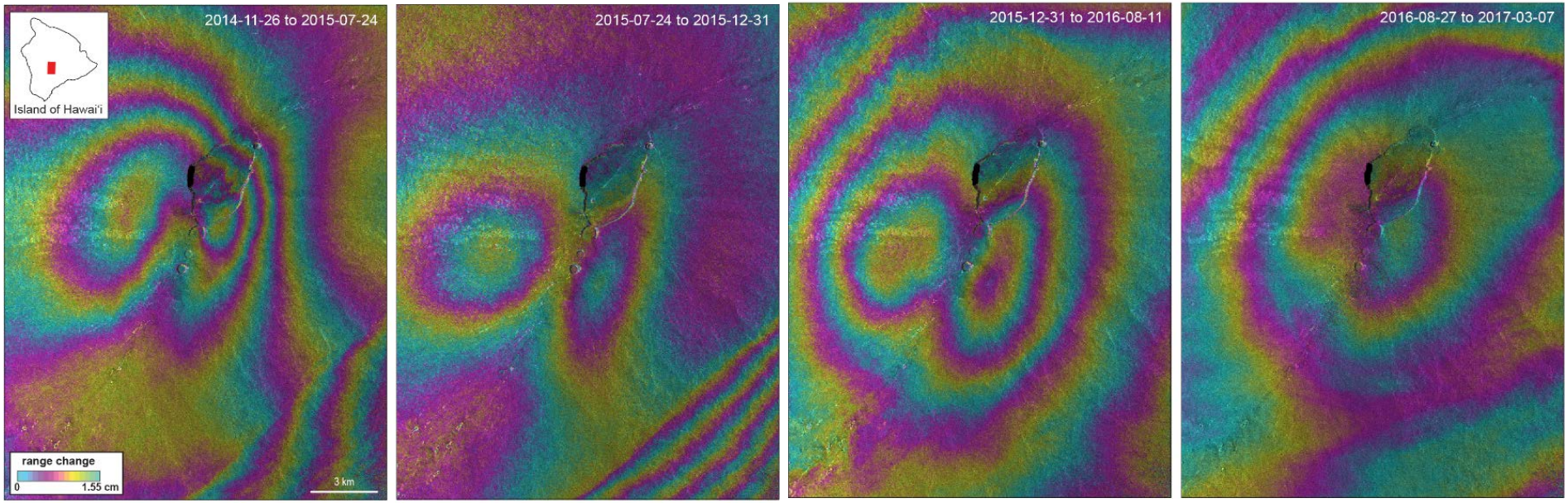


Sequential false-color images (RGB: R=earlier HV, G=later HV, B=coherence) from Sentinel-1 showing development of the Pāhoa lava flow at Kīlauea during late 2014 - early 2015.

Each image is approximately 10 km across. New lava flow activity appears reddish.

Hawai‘i Supersite

CSK data used to monitor Mauna Loa plumbing system complexities

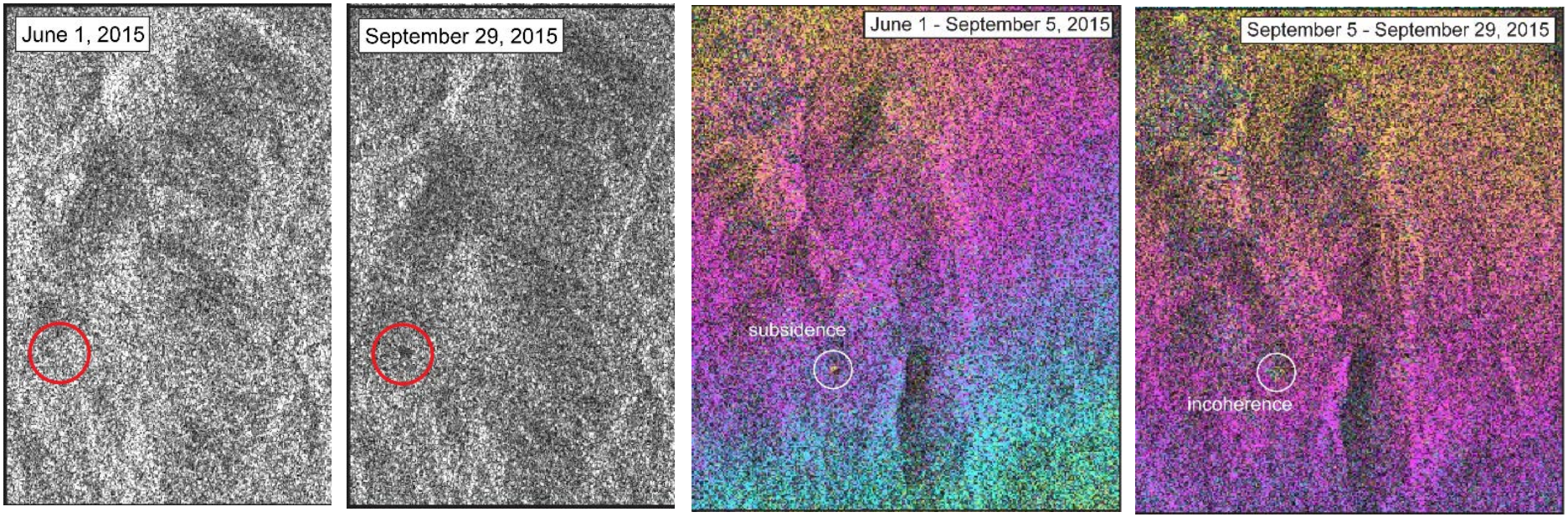


The summit inflation pattern initially resembles the one occurred in 2002-2009, then shifts to the SW, then again to the previous location, suggesting magma accumulation in compartments that in certain conditions may become isolated from one another.

Note that GPS station density is not sufficient to map this complex dynamics.

Hawai‘i Supersite

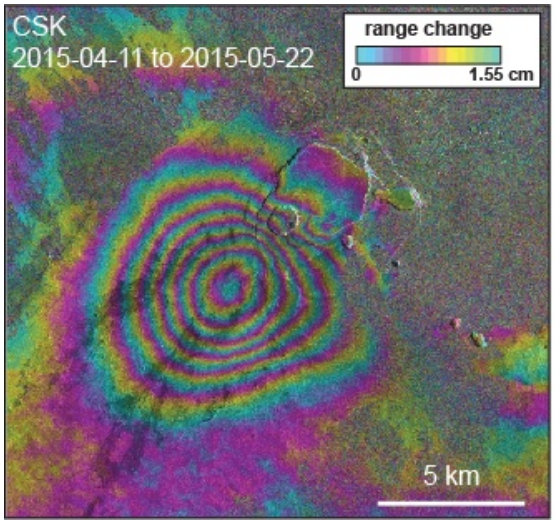
Radarsat 2 data used to study a new pit crater on Mauna Loa

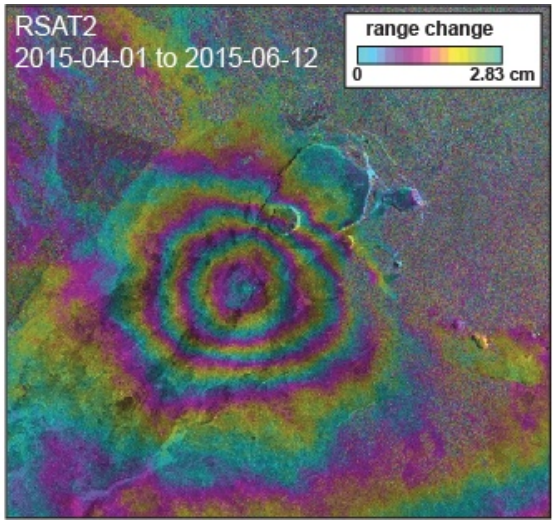


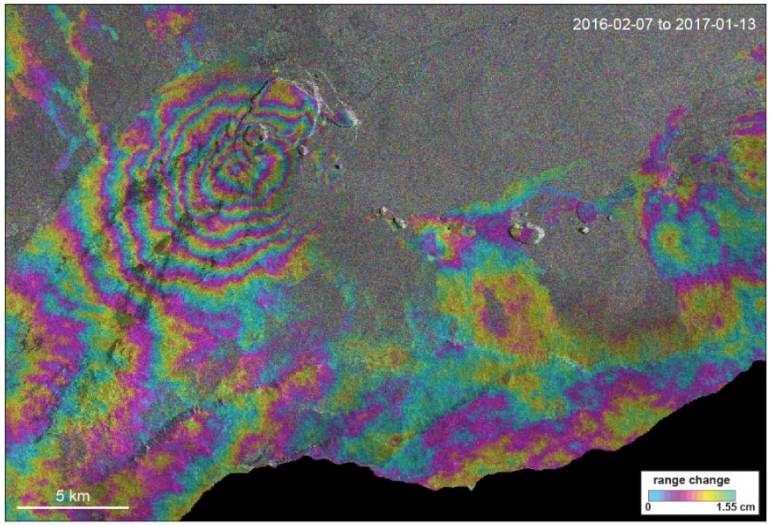
The crater formation was temporally framed using Rsat images, then it was found that the ground collapse was preceded by about 1 cm of subsidence relative to the surrounding area in the days to weeks before the crater formed.

Hawai‘i Supersite

CSK, Rsat 2 and TSX reveal change in eruptive activity at Kilauea



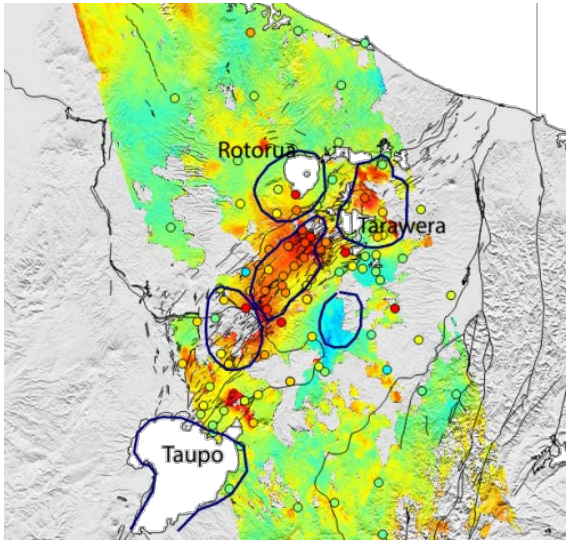


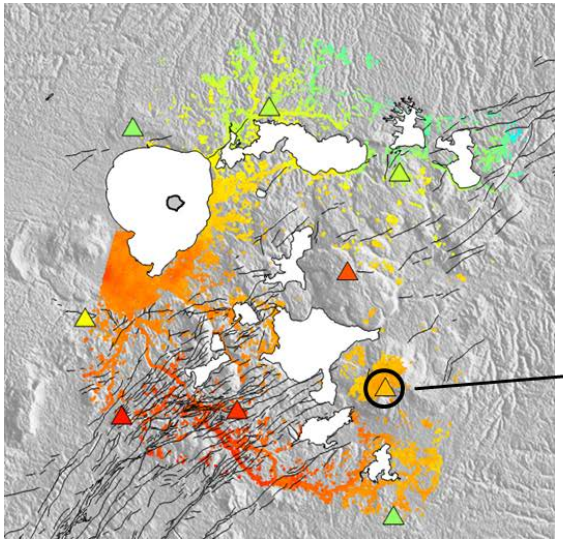


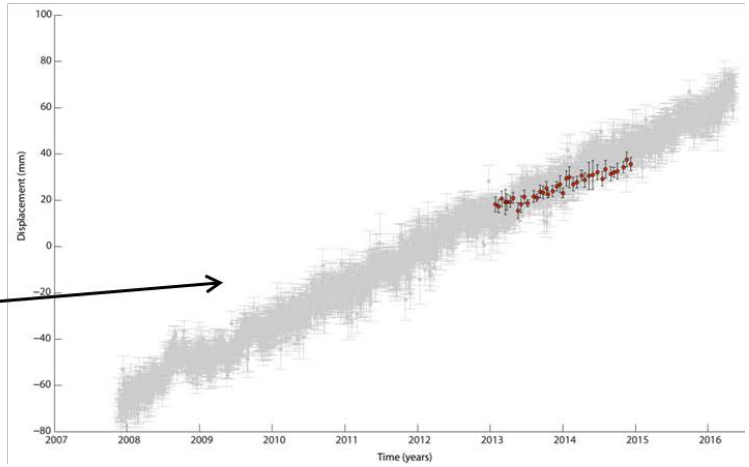
The InSAR and differential DEM (from TanDEM X) analyses allowed to observe the fast dynamics of magma migration between two subcaldera reservoirs, as well as to monitor an increase of Kilauea inflation in 2016-2017 suggesting that a change in eruptive activity within the coming months may occur.

Taupo Volcanic Zone Supersite

New InSAR observations used to study the magmatic system





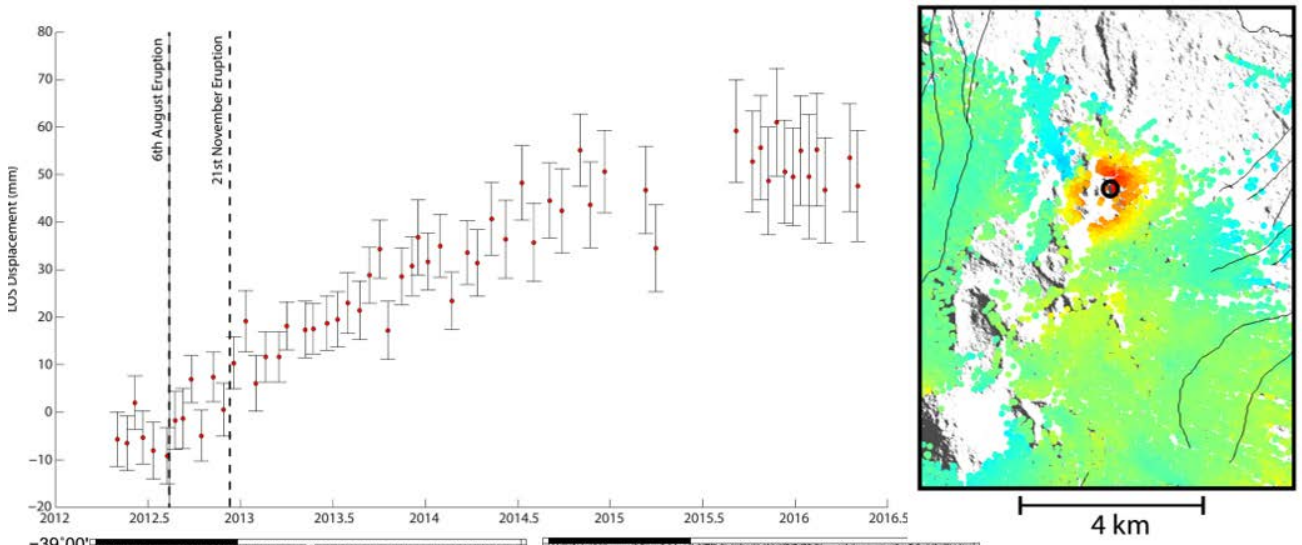


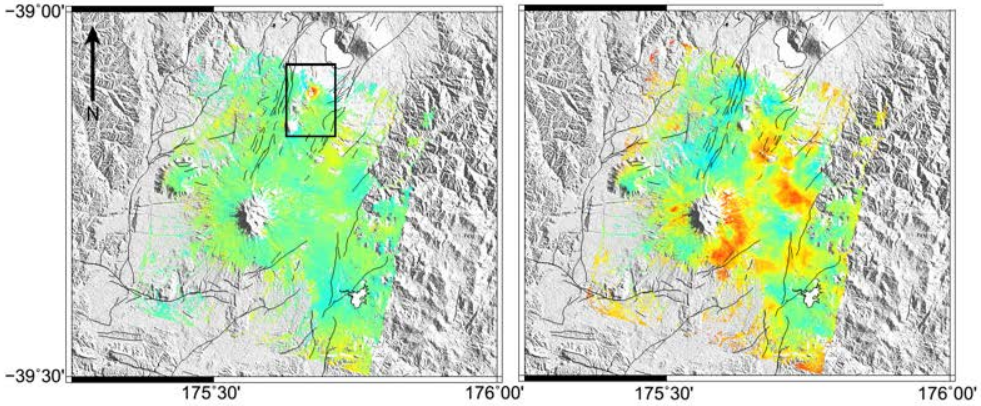
Pre-Supersite ENVISAT results

Ground displacements measured by CSK over the Okataina Caldera. On the right the comparison between the InSAR and GPS displacements. These results are used to study the magmatic plumbing beneath the northern TVZ, together with Magnetotelluric data and Finite element modelling.

Taupo Volcanic Zone Supersite

CSK data show post eruptive deformation over Tongariro

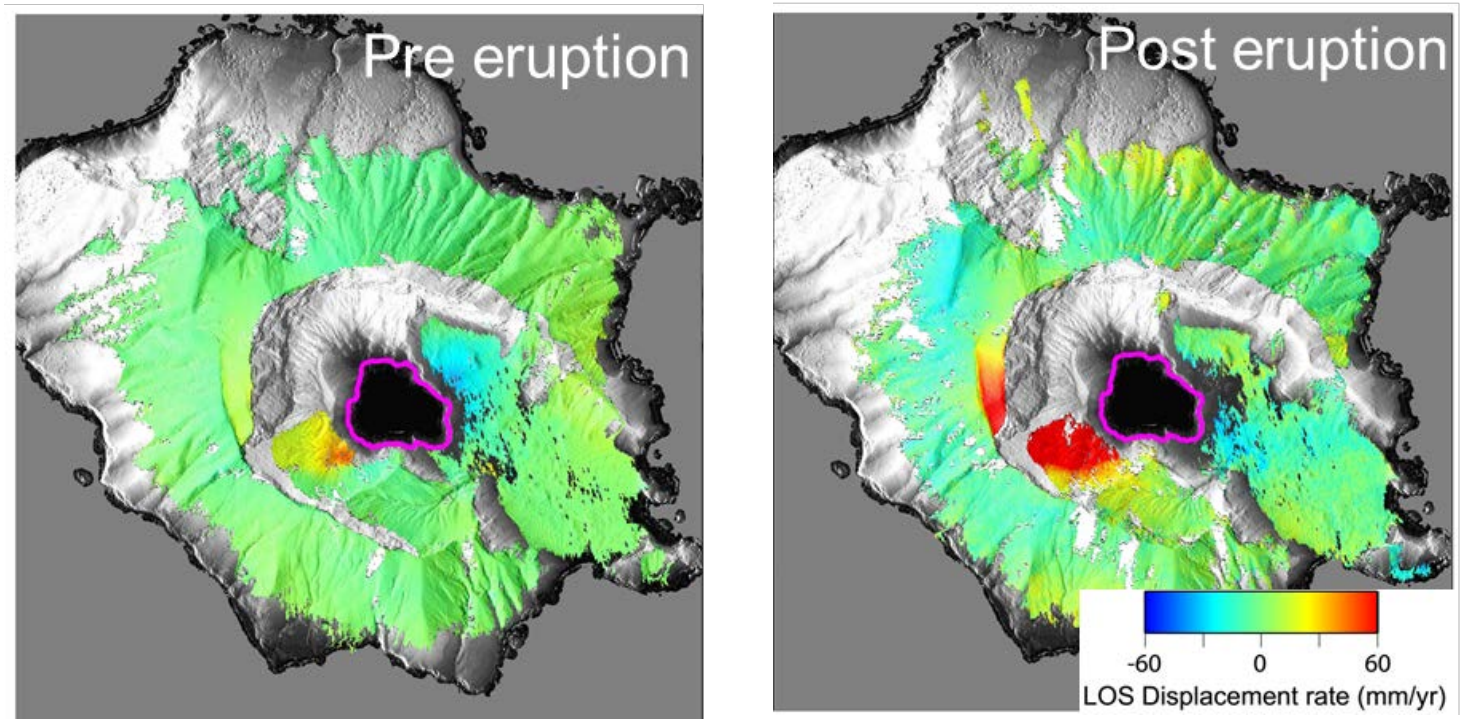




Significant subsidence is observed over the Te Maari eruption site since the last eruption in November 2012.

Taupo Volcanic Zone Supersite

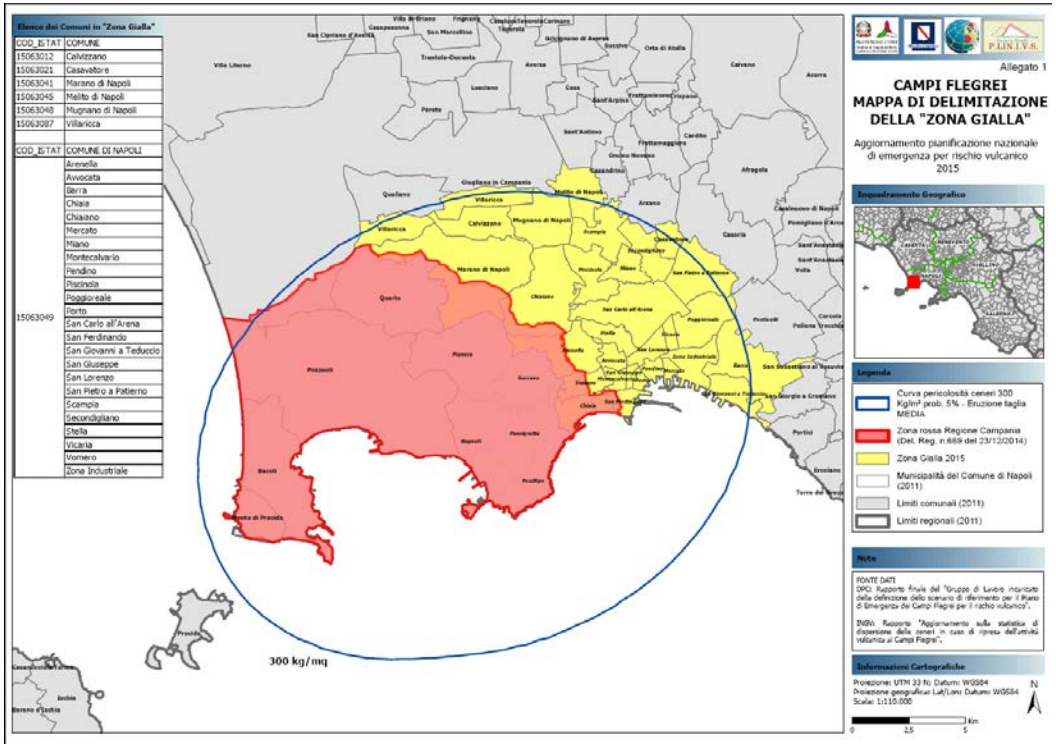
TerraSAR-X spotlight data show deformation over White Island



TSX data reveal previously unrecognized deforming areas, including a landslide reactivated along the south-western crater wall, which has been moving at rates of 20 cm/yr after the 2016 eruption. The fast deformation rates prompted an access ban in the area by the Ministry of Civil Defense, to which GNS Science provides the scientific information.

Campi Flegrei - Vesuvius Supersite

Scientific information is summarized in risk management maps

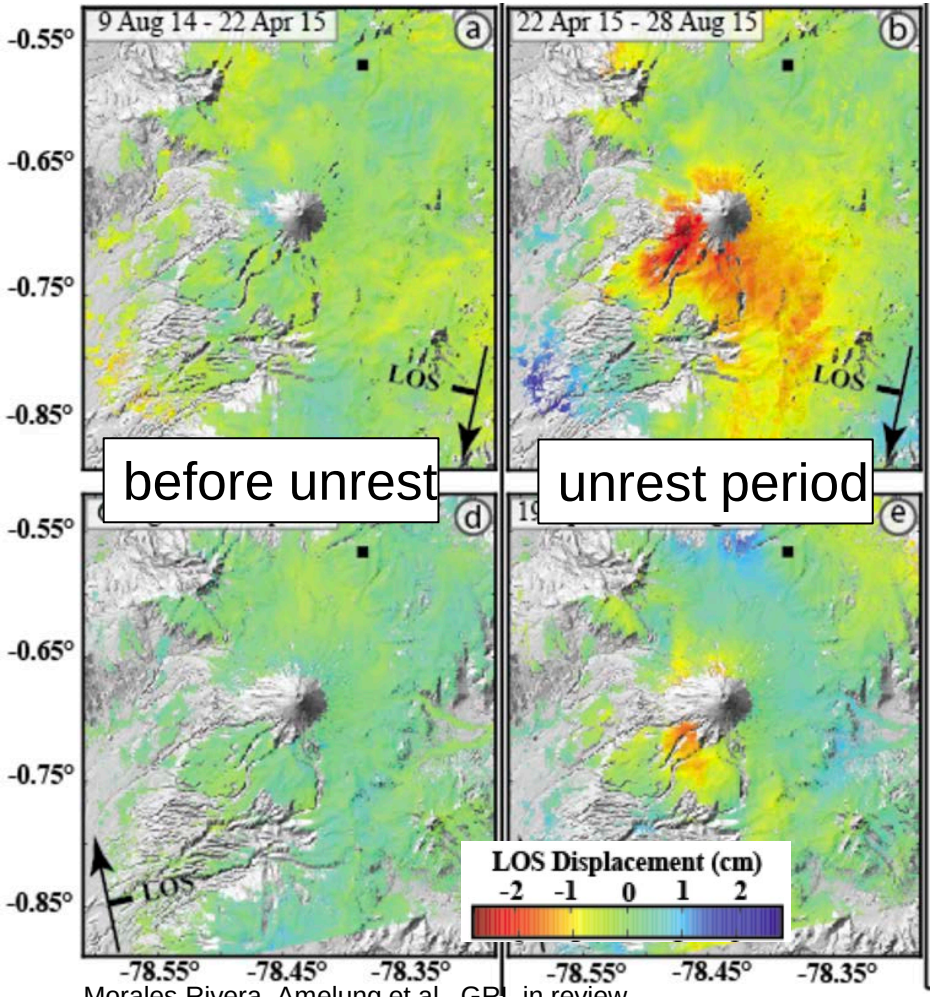


The new 2015 Emergency plan was developed based on several multidisciplinary scientific studies, including satellite data analyses.

The Red zone is potentially affected by fast pyroclastic flows (substantial damage is likely). The Yellow zone has >5% probability of ash fallout >300 kg/m2 (roof collapse threshold).

Ecuador Supersite

Precursory inflation from CSK time-series at Cotopaxi



Morales Rivera, Amelung et al., GRL in review

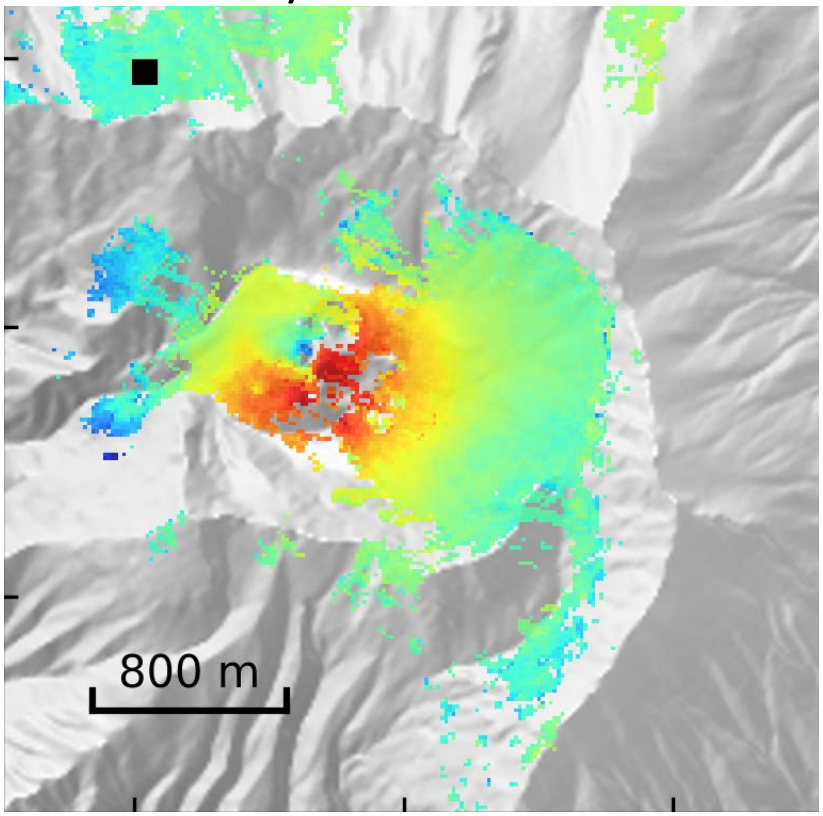
Key findings:

InSAR detected 3 cm inflation on SW flank **before the** eruption.

Ecuador Supersite

Inflation measured by TSX at Guagua Pichincha

Jan 2016-May 2017: 40 TSX scenes

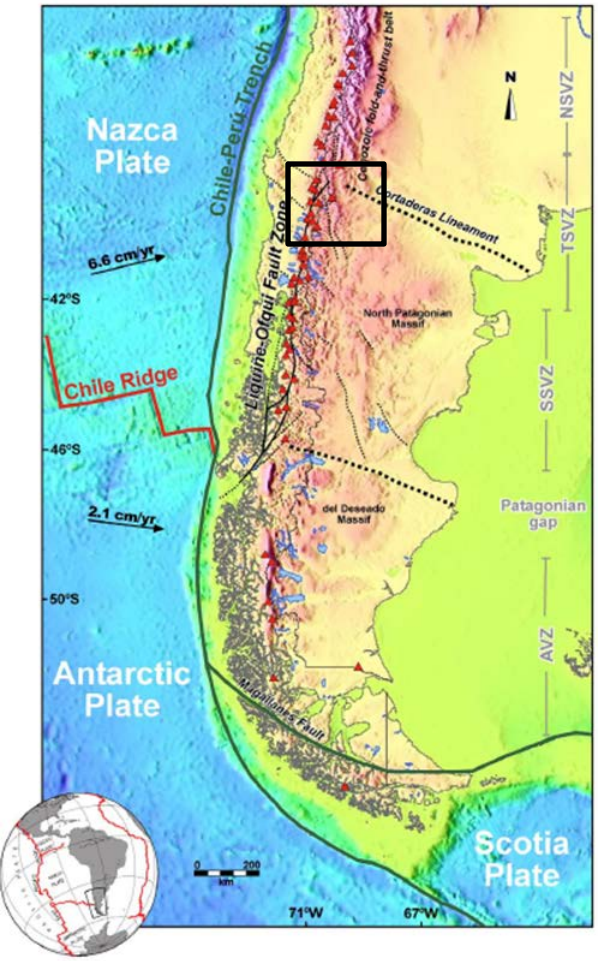


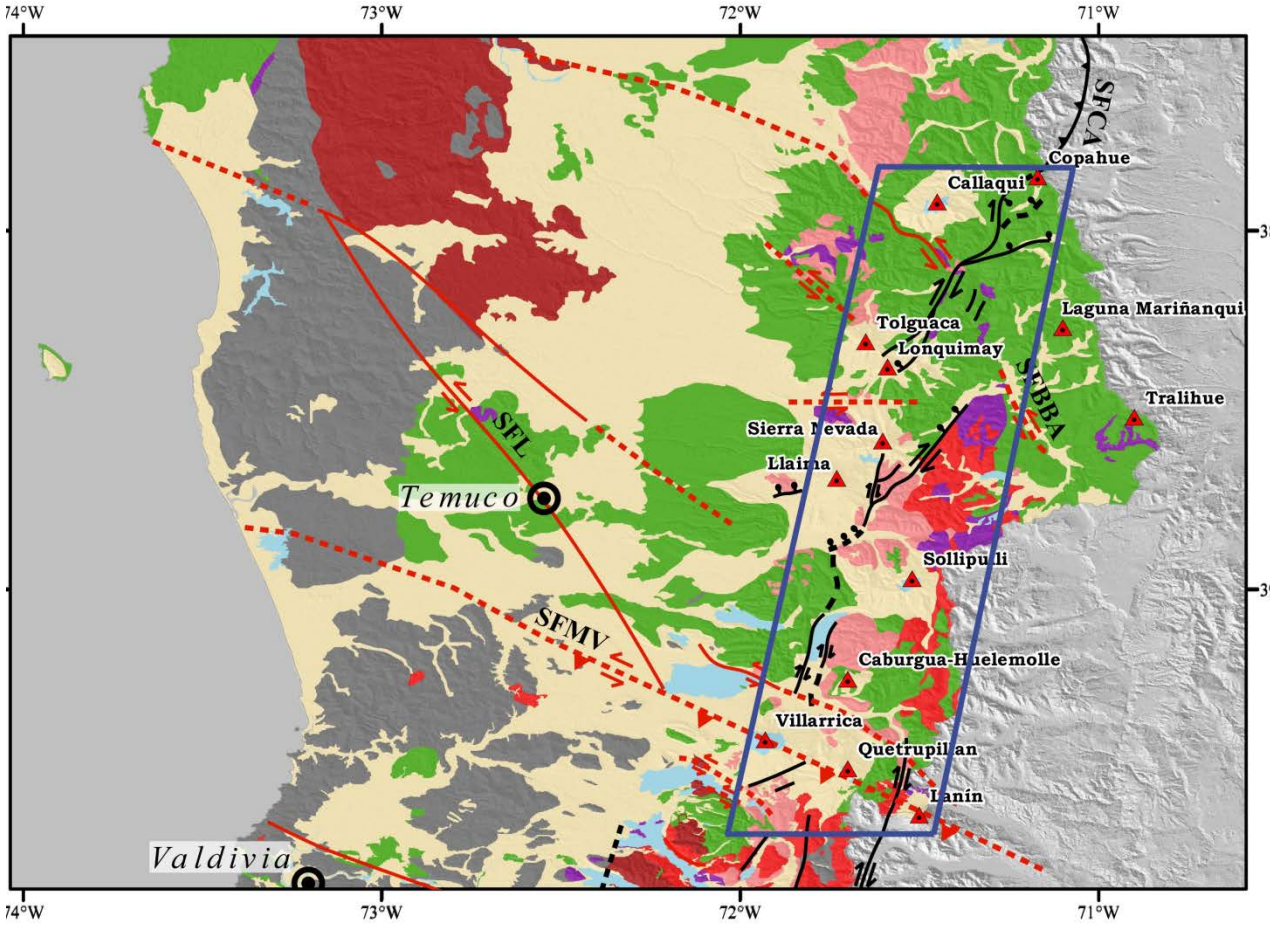
Supersite proposals submitted to the CEOS DCT for evaluation

- Coupled geohazards at Southern Andes (Chile): Copahue-Lanín arc volcanoes and adjacent crustal faults (GeoHaZSA)
- Virunga volcanic area (D.R. Congo)

Permanent Supersite proposal:

Coupled geohazards at Southern Andes: Copahue-Lanín arc volcanoes and adjacent crustal faults (GeoHaZSA)





Core team of the GeoHaZSA Supersite

1	Luis Lara	SERNAGEOMIN, Universidad de Concepción, Santiago, Chile
2	Maria Cordova	SERNAGEOMIN, Temuco, Chile
3	Francisco Delgado	Cornell University, Ithaca, NY, USA
4	Andrés Tassara	Universidad de Concepción, Concepción, Chile
5	Pablo Euillades	Universidad Nacional de Cuyo, Mendoza, Argentina
6	Leonardo Euillades	Universidad Nacional de Cuyo, Mendoza, Argentina
7	Felipe Aguilera	Universidad Católica del Norte, Antofagasta, Chile
8	Paul Lundgren	Jet Propulsion Lab/California Inst. of Technology, Pasadena, CA, USA
9	Charles Wicks	U. S. Geological Survey, Menlo Park, CA, USA
10	Lucia Lovison	Sat-Drones, Wellesley, USA

General features of the GeoHaZSA Supersite

- ~50 x 200 km area, covering 9 stratovolcanoes, 2 volcanic fields, a large strike-slip fault
- Strong volcanic hazards - lahars, tephra fallout, ash plumes; + seismic hazard
- 80 eruptions since the 1900
- Potentially affected population ~200 k
- EO data not widely used, little local capacity
- GEO Chile strongly supports the proposal

Main goals of the GeoHaZSA Supersite

- To establish regional source models for faults/volcanoes.
- To develop a rapid strategy for ground deformation monitoring based on InSAR.
- To develop an early warning system for volcanic unrest based on InSAR, GPS, seismicity and gas measurements.
- To improve capability to measure effusion/emission rates.
- To generate high resolution hazards maps.
- To provide information to first responders, society and scientific communities.

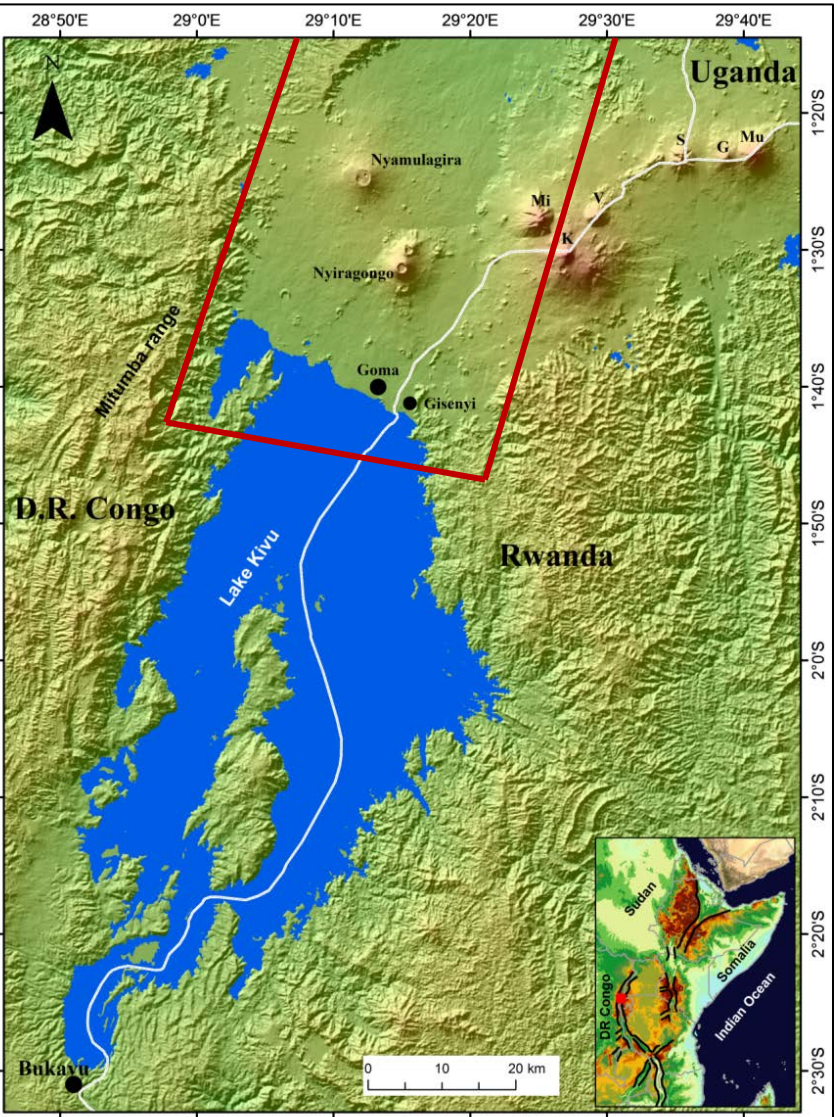
In situ data sets for the GeoHaZSA Supersite

Type of data	Data source	Data access
Seismic data	*SERNAGEOMIN (OVDAS) network (**35 stations**)*	*Open access with registration form; server to remote download scheduled. Time-series for registered scientists under specific agreements*
GNSS data	*SERNAGEOMIN (OVDAS) (**16**), IGM (**1**) and CSN (**1**) network and **GPS** Campaigns*	*Open access to GNSL scientists*
DOAS and Gas measurements	*SERNAGEOMIN (OVDAS) network (**5 continuous stations**) and Campaigns*	*Open access to GNSL scientists*
Infrasound	*SERNAGEOMIN (OVDAS) **2 stations***	*Open access to GNSL scientists*

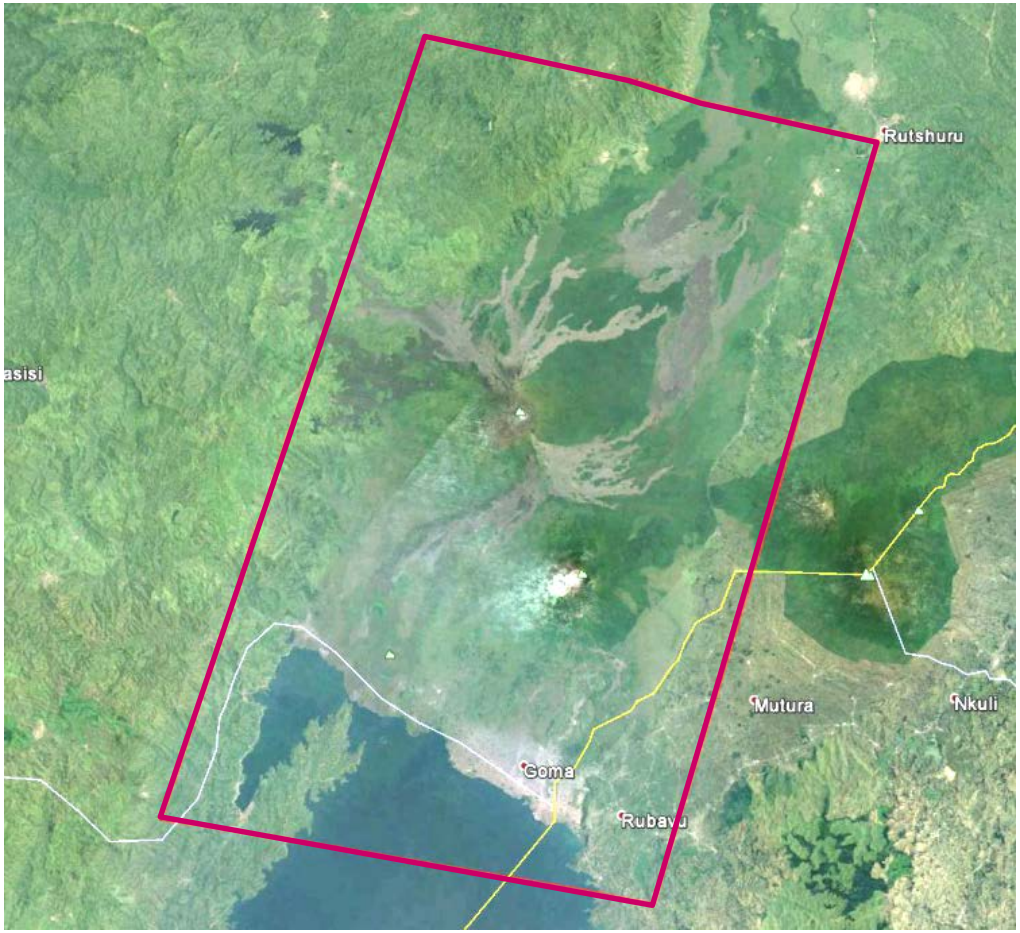
EO data requests for the GeoHaZSA Supersite

Sensor	Source	Data requested
SAR X-band **CSK**	ASI	*Entire archive: ~ 1000 images, + ascending/descending coverage every 16 days for 9 volcanic areas: ~ 450 images/yr* *Monitoring should be intensified in case of unrest, rapid delivery would be needed.*
SAR X-band **TSX-TDX**	DLR	*Entire archive + ascending/descending coverage for DEM production: ~ 150 images/yr.* *The plan is to build one initial reference DEM for each volcano, then after any eruption new acquisitions are planned to update the DEMs.*
SAR C-band **Rsat 2**	CSA	*Entire archive + ascending/descending coverage for monitoring in quiescent times: ~ 150 images/yr.* *The Rsat 2 data should be synergic with S1, i.e. with different angles/orbits, dates.*
SAR C-band **Sentinel 1**	ESA	*Open. However, they request ascending/descending coverage **every 6 days** when volcanoes are under unrest.*
SAR L-band **ALOS 2**	JAXA	*Entire archive + ascending/descending coverage: ~ 150 images/yr. **Very important over strongly vegetated areas**, that is in the lower parts of the cones.*
Optical data **Pleiades**	CNES	*One initial tri-stereo coverage for each volcano, then one more each time there are substantial morphological changes (1 coverage per year on average). Used for HR DEM creation and photo-analysis.*
Optical data **Sentinel 2**	ESA	*Open. Used for geological and morphological analyses*

Permanent Supersite :
Virunga volcanic area (Democratic Republic of Congo)



The Supersite covers two active volcanoes, **Nyragongo** and **Nyamulagira**



Core team of the Virunga Supersite

1	Charles Balagizi	Goma Volcano Observatory, Goma, DR Congo
2	Georges Tuluku	Goma Volcano Observatory, Goma, DR Congo
3	Katcho Karume	Goma Volcano Observatory, Goma, DR Congo
4	Celestin Mahinda	Goma Volcano Observatory, Goma, DR Congo
5	Honoré Mateso	Goma Volcano Observatory, Goma, DR Congo
6	Mathieu Mapendano	Goma Volcano Observatory, Goma, DR Congo
7	Bo Galle	Chalmers University of Technology, Göteborg, Sweden
8	Mike Poland	USGS – Cascades Volcano Observatory,Vancouver, WA, USA
9	Marcello Liotta	Istituto Nazionale di Geofisica e Vulcanologia, Palermo, ITALY
10	Yosuke Aoki	Earthquake Research Institute, University of Tokyo

General features of the Virunga Supersite

- Nyragongo and Nyamulagira volcanoes account for 40% of historical African eruptions
- Erupted on average every 6 years in the last 150 years
- High volcanic risk for over 1.5 M people (Goma city), additional risk of disrupting vital agricultural resources by ash fall
- Potential for huge disaster (affecting 3 M people) if volcanic activity triggers catastrophic discharge of CO2 and CH4 stored in the thermally stratified waters of Lake Kivu
- Strong need for scientific investigations of the volcanic systems
- Poor in situ monitoring capacities
- No local capacities for EO data usage

Main goals of the Virunga Supersite

- To increase the international collaboration for improved scientific understanding of the volcanoes, sharing data and knowledge
- To improve geohazard assessment and monitoring in the Virunga
- To improve local capacities to issue Volcano Observatory Notice for Aviation (VONA) messages to aviation authorities and VAACs
- To obtain satellite data for scientific and monitoring applications
- To develop a strategy for rapid volcano deformation monitoring based on InSAR
- To attract attention from international agencies to develop local monitoring, scientific and DRM capacities
- To provide scientific information for DRM to the national government

In situ data sets for the Virunga Supersite

Type of data	Description	# of stations
Seismic waveforms	*Broadband Sensor*	*14*
SO_2 data	*FIX DOAS*	*4*
GPS	*Leica GNSS high performance system*	*7*
Soil temperature and gas emissions	*Gas: Radon, CO_2*	*25*
Virunga river water geochemical data	*Monthly field campaigns for Physicochemical parameters, major and trace elements, stable and radiogenic isotopes , Gas concentrations (e.g. CO_2, CH_4, N_2O)*	*14 rivers* *7 cold springs* *7 hot springs*
Virunga rainwater geochemical data	*Monthly field campaigns for Physicochemical parameters, major and trace elements, stable and radiogenic isotopes*	*14*
Lake Kivu physicochemical parameters profile	*Field campaigns, profiles of physicochemical parameters, major and trace elements, stable and radiogenic isotopes , secondary mineral saturation*	*Main basin* *Kabuno Bay*

EO data requests for the GeoHaZSA Supersite

Sensor	Source	Data requested
SAR X-band **CSK**	ASI	*Entire archive: ~ 400 images, + ascending/descending coverage every 16 days for 2 volcanic areas: ~ 100 images/yr* *Monitoring may be intensified in case of unrest, also with Spotlight mode images.*
SAR X-band **TSX-TDX**	DLR	*Entire archive + TDX ascending/descending coverage for building one initial reference DEM for each volcano, then after any eruption new TDX data would be needed to update the DEMs. TSX for ground deformation in synergy with CSK, ~ 100 images/yr*
SAR C-band **Rsat 2**	CSA	*Entire archive. Descending/descending coverage for long term monitoring in quiescent times: ~ 50 images/yr.* *The Rsat 2 data should be synergic with S1, i.e. with different angles/orbits, dates.*
SAR C-band **Sentinel 1**	ESA	*Open. However, they request ascending/descending coverage **every 6 days** when volcanoes are under unrest.*
SAR L-band **ALOS 2**	JAXA	*Entire archive + ascending/descending coverage: ~ 25 images/yr.* ***Very important in this Supersite, considering the strong vegetation coverage.***
Optical data **Pleiades**	CNES	*One initial tri-stereo coverage for each volcano, then one more each time there are substantial morphological changes (1 coverage every 5 years on average). Used for HR DEM creation and photo-analysis.*

Issues with the Virunga Supersite

- Concern was raised by one reviewer and one SAC member on the capacity of the GVO to be able to carry out its duties, given the rather scarce resources and the limited capacities of its personnel.
- The proposers replied that the Supersite is their best occasion to raise the level of attention on the area, and through that they expect international agencies and scientific communities to support further development of capacities at GVO and in DRC.
- The SAC and GEOSec shared this view and thus approved the Supersite.
- As an initial result, the Copernicus EMS Risk & Recovery Mapping (RRM) service has been activated and is generating a high resolution DEM of the area and volcanic hazard maps.

New GSNL website and Twitter account

GEO GROUP ON EARTH OBSERVATIONS

GSNL

HOME ABOUT SUPERSITES DATA OUTREACH

Welcome to Geohazard Supersites and Natural Laboratories GEO initiative

The GEO Geohazard Supersites and Natural Laboratory initiative (GSNL) is a voluntary international partnership **aiming to improve, through an Open Science approach, geophysical scientific research and geohazard assessment in support of Disaster Risk Reduction**.

GEO-GSNL is compliant with the new GEO Strategic Plan, and with the role of science as envisioned in the Sendai Framework for Disaster Risk Reduction 2015-2030.

HOME

- Scientists and data providers
- DRR end-users, decision-makers, practitioners
- Decision makers and funding agencies – Public

UPCOMING EVENTS

Strengthening Disaster Risk Reduction across the Americas
September 3 - September 8

GEO-XIV Plenary 2017
October 23 - October 27

View All Events

FOLLOW US

To be published in October

Issues with EO data access

- DLR portal ok but still has some issues, e.g. multiple data sets in one tar file
- Some satellite datasets (CSK, RSAT, Pleiadés) are only available through the Supersite coordinators at the moment. We need to find a definitive solution to allow users easy access to the data collections (also for GEOSS).
- UNAVCO already hosts some datasets (not Pleiadés data).
- The ESA GEP has offered to host all data sets. It already provides discovery to TSX data on the DLR portal.
- ASI now agrees that all Supersite data can be hosted on the GEP. We will repatriate all the global Supersite data on the ESA/GEP. The Supersite coordinators will maintain the control, providing access coordinates only after license signature.
- A similar approach should be used for CSA and CNES data. Any problem?
- Critical ALOS-2 data still not provided to GSNL. **Need to find a solution**.

Outstanding issues

- The 2014-2016 Biennial Reports of the Taupo and Ecuador volcano Supersites should be approved at the Plenary. Questions/issues?
- The proposal for a new Supersite in Chile Southern Andes (focus on volcanoes + fault) should be approved at the Plenary. Status, questions/issues?
- The proposal for a new Supersite in D. R. Congo (two volcanoes in the Virunga volcanic area) should be approved at the Plenary. Status, questions/issues?
- Discussion on the maximum number of Supersites that the agencies can support (separate meeting?).