Final Report on Volcano Pilot Project

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Overview

- What was achieved against objectives?
- What are the issues?
- What lessons have been learned?
- What did the users say?
- Where does it go from here?

Objectives

- **Demonstrate the feasibility of integrated, systematic and sustained monitoring of Holocene volcanoes using space-based EO**

- **Demonstrate applicability and superior timeliness of space-based EO products to the operational community (such as volcano observatories and Volcanic Ash Advisory Centers) for better understanding volcanic activity and reducing impact and risk from eruptions**

- **Build the capacity for use of EO data in volcanic observatories in Latin America as a showcase for global capacity development opportunities.**

Criteria for success

- **Identification of new areas of unrest through regional InSAR monitoring**
- **Uptake by Latin American volcano monitoring agencies of EO-based methodologies for tracking deformation, as well as gas, thermal, and ash emissions**
- **Utilization of EO data for operational monitoring by volcano observatories at Supersite targets**
- **Interest expressed by volcano community to broaden approaches adopted in pilot (especially regional monitoring and new methodologies for EO-based monitoring) through representative bodies such as IAVCEI, WOVO or GVM**

Issues

- **Participating research scientists are volunteers that depend on outside funding**
- **Lack of a dedicated source of L-band SAR is problematic in many areas**
- **Timely delivery of SAR data is critical for hazards assessment and mitigation**
- **Satellite acquisitions need to be flexible (nighttime thermal data, ready changes to tasking, etc.)**
- **Systematic background missions are essential**

Lessons learned

- A diversity of SAR data is important for any regional or global volcano monitoring strategy
- Background SAR missions that are dedicated to volcano observation are essential
- Tight orbital control is extremely advantageous for mapping deformation and topographic change over time
- Freely available datasets, especially with high temporal resolution (and hopefully high spatial resolution), are a foundation for near-real-time detections of thermal anomalies and ash detection
- Close collaboration between research scientists, space agency representatives, and end users—especially scientists based at volcano observatories—is critical for transferring the insights from volcano remote sensing data to actions for mitigating volcanic hazards and risk

Summary document

RESEARCH

Towards coordinated regional multi-satellite InSAR volcano observations: Results from the Latin America pilot project

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Abstract

Within Latin America, about 319 volcanoes have been active in the Holocene, but 202 of these volcanoes have no seismic, deformation or gas monitoring. Following the 2012 Santorini Report on satellite Earth Observation and Geohazards, the Committee on Earth Observation Satellites (CEOS) developed a 4-year pilot project (2013-2017) to demonstrate how satellite observations can be used to monitor large numbers of volcanoes cost-effectively, particularly in areas with scarce instrumentation and/or difficult access. The pilot aims to improve disaster risk management (DRM) by working directly with the volcano observatories that are governmentally responsible for volcano monitoring as well as with the international space agencies (ESA, CSA, ASI, DLR, JAXA, NASA, CNES). The goal is to make sure that the most useful data are collected at each volcano following the guidelines of the Santorini report that observation frequency is related to volcano activity, and to communicate the results to the local institutions in a timely fashion. Here we highlight how coordinated multi-satellite observations have been used by volcano observatories to monitor volcanoes and respond to crises. Our primary tool is measurements of ground deformation made by Interferometric Synthetic Aperture Radar (InSAR), which have been used in conjunction with other observations to determine the alert level at these volcanoes, served as an independent check on ground sensors, guided the deployment of ground instruments, and aided situational awareness. During this time period, we find 26 volcanoes deforming, including 18 of the 28 volcanoes that erupted – those eruptions without deformation were less than 2 on the VEI scale. Another 7 volcanoes were restless and the volcano observatories requested satellite observations, but no deformation was detected. We describe the lessons learned about the data products and information that are most needed by the volcano observatories in the different countries using information collected by questionnaires. We propose a practical strategy for regional to global satellite volcano monitoring for use by volcano observatories in Latin America and elsewhere to realize the vision of the Santorini report.

Keywords: Remote sensing; Latin America; InSAR

1 Introduction

Unlike most other types of geohazards, many volcanic eruptions are presaged by volcanic unrest lasting a few hours to years (e.g., Passarelli and Brodsky, 2012; Phillipson et al., 2013). Unrest has been measured by satellite before several erup-

Summary of SAR aspects of Latin America pilot project are given in a manuscript that is in review at the Journal of Applied Volcanology

User feedback

- **Patricia Mothes**, Geophysicist, Instituto Geofísico (Ecuador)
- **Luis Lara, Director**, Observatorio Volcanológico de los Andes del Sur (OVDAS, Chile)
- **Carlos Andrés Laverde**, Geohazards Direction team, Colombian Geological Survey (Colombia)
- **Gustavo A. Chigna**, volcanologist, INSIVUMEH (Guatemala)
- **Lourdes Narvaes Medina**, volcanologist, Observatorio Vulcanologio y Seismologico de Pasto (Colombia)
- **John Pallister**, Chief, Volcano Disaster Assistance Program, U.S. Geological Survey (USA)
- **Ing. Victor Aguilar Puruhuaya**, Jefe de Sismología, Instituto Geofísico, Universidad Nacional San Agustin de Arequipa (Perú)
- **Armando Saballos**, Dirección Gral. de Geología y Geofísica, INETER (Nicaragua)
- **Christina Neal**, Scientist-in-Charge, Hawaiian Volcano Observatory, U.S. Geological Survey (USA)

Next steps

Two options:

1) **<u>Pilot extension</u>. No new funds are needed, but space agencies should continue to provide data at no cost and with quotas similar to those provided thus far for regional volcano monitoring activities. Teams of academic researchers will write proposals for data and summarize results in regular reports**
2) **<u>Dedicated effort</u>. One or more full-time employees will serve as bridges between academics, space agencies, and end users to ensure that user needs are met, and that space agencies receive the proposals and reports that are needed to justify their continued support.**

Plan for the future

Going global:

Year 1: Continue working with volcano observatories in Latin America on data analysis and capacity building. Develop partnerships with research institutions around the world who are interested in contributing to a global monitoring effort.

Year 2: Expansion of operational monitoring efforts to volcanoes in Africa (where there are few volcano observatories).

Years 3–4: Expansion to Indonesia and the Philippines—both countries with abundant volcanic activity but little ability for the uptake of remote sensing.

Year 5: Demonstrate that global volcano monitoring from space is possible, and engage agencies with a volcano monitoring mandate to establish a permanent and funded program to sustain global volcano monitoring from space.

Additional considerations

- **Focus will be on the highest-risk volcanoes in developing nations**
- **Quotas of SAR data will not simply be scaled, based on the Latin American pilot project, by the numbers of volcanoes in the countries to which monitoring will be expanded, but rather the hazard potential, activity history, and environment of those volcanoes**
- **Primary need is for SAR and very-high-resolution optical data, which are not freely available in most cases**
- **A particular focus will be topographic data**
- **Need better integration with the Geohazards Supersites and Natural Laboratories (GSNL) initiative**
- **Capacity building will continue to be a priority, with the goal of making volcano observatories and/or research institutions in developing countries self-sufficient with respect to obtaining, processing, and interpreting remote sensing data**

Fin

Thank you