University of Reading

IMPACT CASE STUDY

Volcanic monitoring

Safeguarding the lives of the people of Montserrat

Research at Reading has proposed, developed and implemented techniques to improve the monitoring of active volcanoes using radars that give operational warnings of eruptions and safe 'all-clears' following activity. To date, their use has been mainly in collaboration with the Montserrat Volcano Observatory (MVO) and the local government civil protection committee on Montserrat. Early rescinding of a precautionary evacuation was made possible by these techniques in 2008 on the Soufrière Hills Volcano in Montserrat. No event has yet tested the early-warning capability, but the deployment of a permanent, operational instrument on Montserrat shows that the system provides a capability for more advanced and timely warnings than was available during the last major eruption.

Without this work, the means to continuously monitor many active volcanoes would not exist

Research

The Department of Meteorology at the University of Reading has a long-standing programme of work directed to developing new methods of measuring the dynamism of volcanic activity and incorporating these measurements into models that can be used to mitigate the resultant hazards.

About 7% of the global population, 500 million people, live within striking distance of active volcanoes. Montserrat, a small island of 10 x 16 km in the West Indies, had a population of 12,000 prior to 1995. However, an eruption which resulted in the loss of the main town, and difficult living conditions, has meant that many people have migrated away from the island, and the population is now only 5,000. Montserrat is a UK Overseas Territory, and the UK has direct responsibility for public safety there and providing financial aid which has been estimated as approximately £1b since 1995. Following an eruption in 1997, which cost 19 lives, the research team contacted Montserrat Volcanic Observatory knowing that radar research showed great promise, and a working partnership was formed.

During volcanic eruptions people living within a few tens of kilometres of the volcano may have their lives and livelihoods threatened. This may be a short-lived crisis or one lasting years. In addition, volcanic ash can impact aircraft safety hundreds to thousands of kilometres away. The activity during eruptions is generally unpredictable in detail, but more general forecasts are possible, and these are practically useful to help mitigate hazards and lower risks. The instrumental observations used to inform these forecasts include those of earthquakes, ground deformation, gas emission and temperature. A particular difficulty at volcanoes is that often the summit, where the activity originates, may be obscured by clouds. In such cases radar, which can see through cloud is the only way to maintain direct observations.

Research at Reading has involved the development and interpretation of radars for various applications, including monitoring weather conditions, and in the application of remote-sensing data from space. This research uses the concept of using radars on the ground and in space to monitor the state of active volcanoes. These two strands of research have been bought together so that the ground-based radars are able to give continuous monitoring of volcanic activity, whilst each overpass of the satellites can be used to better define areas at risk during an eruption.

The ground-based radars were developed in collaboration with the University of St Andrews (UoSA) and Lancaster University (LU), and the space–based radars with DLR (German Aerospace Center), Astrium (Europe's largest space company) and ESA (European Space Agency).

Impact

Without this work, the means to continuously monitor many active volcanoes would not exist. Many volcanoes dominate the lives of the population living nearby, and the means to generate both reliable warnings and all-clears, are vital contributions to their safety, quality of life and to the local economy.

The data and techniques developed have, to date, mainly been applied to Montserrat through the Montserrat Volcano Observatory (MVO), but have recently been extended to Papua New Guinea and Ecuador. Monitoring this particular type of volcano and predicting both eruptions and areas at risk is a long-standing issue, because traditionally observations of the peak of the volcano require it to be visible and not obscured by weather. The development of these radar systems also enables monitoring during an eruption, which has previously been very difficult.

From 27 to 28 July 2008 Soufriere Hills Volcano, Montserrat experienced an intense swarm of long-period seismicity that culminated in an explosion and eruptive column collapse. The resultant pyroclastic flows set buildings alight in the remnants of Plymouth, the largely destroyed former capital.

Together with the Montserrat Volcano Observatory, the research team activated the International Charter for Space and Major Disasters via the Cabinet Office on 29 July 2008 to obtain the most up-to-data remotely sensed data on the state of the volcano. The volcano was covered in cloud and so the effects of the explosion on the stability of the large lava dome could not be determined visually. By 1 August high-resolution specialist radar images from satellite had been obtained, and together with earlier, equivalent data, these were able to show the source and scale of the explosion's effects on the lava dome. The Montserrat government's civil protection committee were informed of this and were able to revoke the precautionary evacuation of people at risk from the dome on 6 August, a week or so before the dome was next seen by eye.

It was always the intention of the research team to transfer the technology to MVO. As of 2011, both the space-borne and the ground-based radar techniques are now part of MVO operations. Although early rescinding of a precautionary evacuation was made possible by these techniques in 2008, no event has yet tested the eruption early-warning capability of the radars; however, the current deployment of such instrumentation shows that the system provides a capability for more advanced and timely warnings than was available during the last major eruption in 2009–2010.

The techniques proposed, developed and implemented during this research to improve the monitoring of active volcanoes using radars have helped to safeguard the lives of the inhabitants of Montserrat. Based on a variety of monitoring and instrumentation, MVO can initiate a warning procedure that starts with notifying the police, who sound warning sirens, and continues with a phone and text message cascade to notify all the relevant authorities and civil protection agencies who are trained in the appropriate response.

Early rescinding of a precautionary evacuation was made possible by these techniques in 2008

Funding:

The research to develop, apply and test the technology was funded through a series of NERC grants. Montserrat Volcanic Observatory have subsequently contributed approximately £50k over a period of 10 years in the form of laboratory use, staff time and helicopter flights for testing and calibration

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NATURAL ENVIRONMENT RESEARCH COUNCIL

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