A Job Well Done at Pinatubo Volcano

David Harlow was on the run. It was pitch-dark at midday on 15 June and mud mixed with golfball-sized chunks of pumice was raining down as he and his Filipino colleagues beat a hasty retreat from their monitoring post. But retreat did not mean defeat. Thanks to close international cooperation, high-tech gadgetry, good scientist-policy maker relations, and a bit of cooperation from the thundering Pinatubo volcano, the group had pulled off what volcanologists are calling a model response to a volcanic crisis, delivering clear, timely warnings to the local populace.

Sadly, their alerts couldn't save the nearly 500 Filipinos who died. But several hundred thousand had been at grave risk, so without the solid emergency response the death toll would have been far higher. "We were frightened of this volcano," says Harlow, a volcanologist at the U.S. Geological Survey (USGS) in Menlo Park, but the actions of all involved were "about as good as they can get; this was a historic response."

The success at Pinatubo was a welcome break from the string of volcanic disasters of the 1980s that decimated helpless populations, including El Chichón in Mexico (2000 dead) and Nevado del Ruiz in Colombia (22,000 dead). That dismal record wasn't just a run of bad luck. The emergency responses in both Mexico and Colombia broke down. Worse, population growth in past decades has pushed people into closer and closer proximity to the 600 active volcanoes of the world, notes volcanologist Robert Tilling of the USGS in Menlo Park. Offering up grim proof of the consequences, Tilling has calculated that volcanoes killed 315 persons per year on average from 1600 to 1900, but in the 20th century the rate jumped to 845 per year. And it could get worse—unless volcanologists can somehow replicate their Pinatubo success at other sites.

That won't be easy. The foundations for minimizing the Pinatubo death toll, in the form of a long-standing working relationship between Filipino and U.S. volcanologists, were laid long before the mountain awoke from its 635-year slumber. When an explosion devastated a square kilometer of forest near the summit on 2 April, Raymundo Punongbayan, director of the Philippine Institute of Volcanology and Seismology, rushed a seismometer to the slopes of Pinatubo to monitor the mountain's rumblings, and then contacted Christopher Newhall of the USGS in Reston, Virginia, who had worked with Punongbayan in the Philippines. As minor volcanic activity continued, Newhall parlayed this informal contact into a radio-linked network of U.S. instruments—7 seismometers and 2 tiltmeters—that he helped install on Pinatubo within a month.

Along with hardware unavailable in a developing country, the Americans brought with them a unique software package for the acquisition and analysis of seismic data. Recently developed by seismologist William Lee of the USGS in Menlo Park, this personal computer-based system allowed the team of Filipino and U.S. scientists monitoring the volcano to follow easily and rapidly the creaking and bulging of the mountain as fresh magma welled up within it.

The volcano did its part, too, by giving the scientists time to put this technology to work. Pinatubo took more than 2 months to build to its climax; some destructive volcanoes have gone from somnolence to full fury in a week. And Pinatubo displayed all the classic warning signs of a major eruption. Local earthquakes, which presumably were triggered by moving magma, were at first dispersed over an area centered 5 kilometers from the mountain. Within a week of the main eruption, however, these signs of magma movement had concentrated beneath the summit, where the surface started to bulge.

Seismic signals characteristic of magma being pressurized (*Science*, 21 December 1990, p. 1660) also suggested an eruption was imminent. And when the amount of magmatic gas escaping from the mountain suddenly dropped, scientists inferred that the mountain had largely sealed itself, further increasing the pressure. The surging tempo of the seismicity and of moderate eruptions of ash made Pinatubo's intentions still easier to read.

Once the volcanologists had some idea of what the mountain was doing, they were able to get the message to the public—the final link in a successful response. The massive death toll at Ruiz in Colombia, after all, was the result not of poor science but of a breakdown in communication, which stymied efforts to warn of the volcanic mud slide that wiped out an entire town. The public-relations success at Pinatubo began with the scientists themselves. Harlow credits "a great sense of professionalism on both sides," Filipino and American, for the scientists' ability to reach a consensus and speak to elected officials and the media with one voice. Then, through May and June, Philippine officials, with the possible exception of the mayor of the city of Angeles, effectively translated the escalating, clearly stated scientific concerns into a progressive evacuation of more than 80,000 people that stayed ahead of the threat from Pinatubo.

For all their exemplary performance at Pinatubo, volcanologists know one success won't reverse the trend toward higher volcanic death tolls. Some volcanoes will not be as cooperative as Pinatubo was, and many developing countries—where 99% of volcano deaths have been concentrated—lack the kind of ties with researchers in developed countries the Filipinos had. To improve the odds, Tilling has argued, geoscientists should create long-term programs to replace the present "ad hoc, ephemeral, and utterly inadequate" responses to volcanic crises. The United Nations' ongoing International Decade for Natural Disaster Reduction is intended to do just that. Still, Tilling is not encouraged; he has witnessed too much talk and not enough action. "So far, I don't see any signs of real commitment," he says. ■ RICHARD A. KERR

A dirty killer. *Many died when rain-soaked ash collapsed roofs.*

Wide World