Lessons learned from a bi-national exchange between Colombia and the United States: Real-life emergency planning and preparedness from a worst-case scenario

BEASON, Scott R.[1], DRIEDGER, Carolyn L.[2], LOCKHART, Andrew B.[2], SCHELLING, John D.[3], GIBSON, Zane D.[4], BURKHART, Frances[5], BANKS, Dan C.[3], BUSTAD, Kyle D.[6], ALLEN, Robert H.[7], and SCOTT, Marci R.[8]

(1) Mount Rainier National Park, 55210 238th Ave E, Ashford, WA, 98304, Scott_Beason@nps.gov; (2) Cascade Volcano Observatory, U.S. Geological Survey, 1300 SE Cardinal Court, Building 10, Suite 100, Vancouver, WA 98683; (3) Washington State Military Department's Emergency Management Division, 20 Aviation Drive, Building 20, Camp Murray, WA 98430; (4) Orting Valley Fire and Rescue, P.O. Box 386, Orting, WA 98360; (5) Whatcom County Sheriff's Office Division of Emergency Management, 311 Grand Ave, Bellingham, WA, 98225; (6) Pierce County Department of Emergency Management, 2501 S 35th St, Suite D, Tacoma, WA 98409; (7) Pierce County Economic Development Department, 950 Pacific Ave, Tacoma, WA 98402; (8) Emergency Response Training, 25324 217th Pl SE, Maple Valley, WA 98038.

I. Abstract

On 13 November 1985, after almost a year of increased activity, Nevado del Ruiz volcano in Colombia's Cordillera Central range of the Andes erupted violently. Pyroclastic flows swiftly melted glacial ice and snow to generate lahars (volcanic mudflows) that swept down river valleys through urban and rural areas tens of kilometers from the volcano. Despite several hours of warning and potential evacuation time, lahars caused more than 23,000 casualties, largely due to an uninformed populace and ineffective emergency protocols. Since the event, Colombian geologists, emergency planners, and elected officials have greatly improved community education and emergency evacuation systems near multiple active volcanoes and these new systems have proven highly effective during subsequent events.

As an opportunity to learn from the Nevado del Ruiz disaster and the subsequent planning by Colombian authorities, a ten-member delegation from Washington State representing federal, state and local emergency managers, planners, and scientists visited Colombia in August 2013 as part of a bi-national exchange with their Colombian counterparts. Participants viewed effects of the 1985 eruption and the Colombians' more recent mitigation efforts. The most striking lessons learned by U.S. participants concerned the importance of pre-designated and well publicized evacuation routes, information hubs, community involvement in all aspects of planning and preparedness, and frequent exercising of notification devices and evacuation. Subsequently, nine Colombians visited Washington State in September 2013 to learn from our efforts in volcano preparedness and mitigation.

Using new knowledge about effective eruption preparations, U.S. bi-national exchange participants are expanding efforts for preparedness and mitigation in communities at risk. Some examples include: preliminary development of a statewide volcano awareness/preparedness plan in Washington; upgraded Pierce County evacuation maps; information kiosks placed around the volcano; development of new Mount Rainier Volcano Hazards website (http://www.piercecountywa.gov/activevolcano); local FEMA-USGS Volcano Crisis Awareness trainings and plan exercises; and almost two dozen public presentations during the 2014 Volcano Preparedness Month.

II. Location

Location map showing both Mount Rainier and the Nevado del Ruiz volcanoes. Other cities visited during exchange and referenced on poster in Colombia noted in inset map.

III. Background

Mount Rainier (4,392 m) in Southwest Washington State and Nevado del Ruiz (5,390 m) in the Cordillera Central range of Colombia are both andesitic stratovolcanoes with similar geography and hazards. Both volcanoes have extensive populations at their bases and have had histories of major lahars.

In November 1984, Nevado del Ruiz began showing increasing seismicity. By February 1985 under increasing activity, geologic investigations began. On September 11, 1985, a strong ash eruption occurred. In October 1985, the activity decreased while a new hazard map showed the risk of lahars as "high" to downstream low-lying communities. This map was generally dismissed as being too alarming. In November, activity increased again.

On November 13, 1985, the following events occurred at Nevado del Ruiz:
- 3:06 PM: Steam eruption.
- 9:08 PM: Dacitic tephra eruption, 30 km high eruptive column (VEI = 3).
  - Pyroclastic flows caused 4 lahars.
  - 17 km^2 snow and ice melted during the eruption.
  - $2x10^7$ m^3 meltwater produced within 30 minutes of the eruption.
- 10:30 PM: Lahar reaches Chinchiná (west of Nevado del Ruiz) (1,800 casualties).
- 10:45 PM: Armero (east of Nevado del Ruiz) warned to evacuate.
- 11:35 PM: Lahars reach Armero (21,000+ casualties).

Following the eruption, extensive humanitarian efforts occurred to save as many victims as possible. Additionally, Colombians undertook numerous efforts to learn from the disaster and prepare for future geologic events in their country.

IV. Bi-National Exchange

United States of America:
- USAID Office of Foreign Disaster Assistance
- United States Geological Survey - Cascades Volcano Observatory
- National Park Service - Mount Rainier National Park
- Washington State Emergency Management Division
- Washington State Department of Health
- Pierce County Department of Emergency Management
- Pierce County Economic Development Department
- Whatcom County Sheriff's Office Division of Emergency Management
- Orting Valley Fire and Rescue

Colombia:
- Servicio Geológico Colombiano (SGC - Colombian Geological Service)
- Unidad Nacional para la Gestión del Riesgo de Desastres (UNGRD - National Unit for Disaster Risk Management)
- Observatorio Vulcanológico y Sismológico de Manizales (OVSM - Volcanological and Seismological Observatory of Manizales)
- Gestión de Riesgo de Desastres - Gobernacion de Caldas (Risk Management - Caldas)
- Bomberos Manizales (Manizales Fire Department)
- Defensa Civil Colombiana - Caldas (Civil Defense Department - Caldas)
- Gestión de Riesgo de Desastres - Gobernacion de Tolima (Risk Management - Tolima)
- Cruz Roja Colombiana (Red Cross Colombia)

V. Lessons Learned from Bi-National Participants

Everyone has a role in preparedness: Scientists, officials, and people at risk.

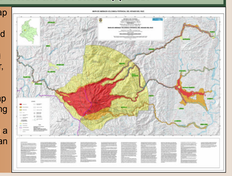
Right: Bi-National participants look over a map of the lahar hazards from Nevado del Ruiz near the Rio Azufrado on the peak's east side. Bi-National exchange participants learned how Colombian scientists, political officials, and the public work together to increase emergency preparedness.

Affected populations need to be trained in what to do when a warning sounds. Then they need to practice doing it regularly.

Right: Bridge crossing the Rio Claro near Nuevo Rio Claro. Structures like this allow low-lying populations to cross physical barriers and get to safe locations.

Know your hazards. Know how to prepare. Know how to respond. Know where to get reliable information. ACT when the event happens.

Right: Lahar hazard map for Nevado del Ruiz. The original map created just prior to the event was dismissed as being "too alarming." However, Lahars from the 1985 event followed paths shown in the hazard map almost perfectly. Knowing hazards is the first step to preparing and having a proper response when an event happens.



Effective warning systems need to be in place.

Left: Example of the volcano warning system in Nuevo Rio Claro. The system is redundant in three ways: it can be activated by satellite, cellular phone, and manually by a button at the base of the structure. Bi-National exchange participants from the United States were surprised by the availability of communication in Colombia, especially considering its rugged topography.

"It's not enough to tell people to evacuate; You have to tell them <u>where</u> to go." - Armero Survivor

Education from early childhood is very important. Preparedness needs to begin at an early age.

Left: SGC Geologist Marta Calvache asks two children in Nuevo Rio Claro about evacuation routes; The children knew exactly where to go when the alarm sounded. Colombian children are taught from an early age about the effects of volcanic eruptions and how to properly train for an eruption and what to do.

Community building after a disaster is challenging. Life is going to be different after a disaster.

Right: Most of the surviving residents of Armero moved north to the city of Armero-Guayabal ("New Armero"). Some survivors moved to other locations in Colombia. One thing was common to all survivors: Life would never be the same again.

Collective memories about disasters are short. (1985 disaster was a repeat of those in 1595 and 1845)

Right: A Colombian survivor (in red) relates a story about surviving the event and losing his family members (mother pictured). While this event is fresh in the minds of Colombians, most of the population of the United States has never experienced an event like that in Colombia.

BELIEVE it can happen.

Right: Oblique aerial view of Armero immediately after the event. Armero was completely destroyed in the event. Even as pumice was falling and lahars were entering the town, victims refused to believe or understand what was happening.

The "Ghost of Armero" is as a powerful symbol for the importance of working together. Colombians are determined to never let a similar event happen again.

Left: The buried first floor of Armero's community hospital is a stark reminder of the power of the 1985 lahars. The former site of Armero has been left as a memorial to the disaster and nature has taken over the remains. The site serves as a powerful reminder of the event and the lessons learned from the disaster.

"(A lahar event) may not happen in our lifetimes, our children's lifetimes, or even our grandchildren's lifetimes, but we owe it to our community to develop a culture of preparedness." - Armero Survivor

Known local officials are more often trusted than unknown scientists or bureaucrats.

Left: The mayor of Armero-Guayabal (center) talks to Scott Beason (left) and translator (right) about the disaster. During the 1985 event, victims were vulnerable to accepting information from the most convincing speakers rather than from scientifically-knowledable authorities.

It is human nature to wait until the last minute before taking action.

Right: Walking amongst the remains while hearing stories of the night of the lahars is an indescribable experience. There are many stories of victims that were killed by panic-stricken motorists just trying to leave the city. Warnings were unheeded and lead to an atmosphere of disbelief as the waves of lahars entered the city the night of November 13, 1985.

A few dedicated individuals can effect great change. There is great value in scientists and emergency officials talking to local people and gaining their trust.

Right: USGS and SGC geoscientists at the Mount St. Helens Visitor Center in September, 2013. The scientific community is a vital component of an effective emergency preparedness plan. Information compiled by scientists needs to be disseminated to communities at risk in language and with context such that non-scientists can understand and be motivated to action.

Rebuilding a community is much more than fixing the infrastructure: it's important to facilitate rebuilding in a way that does not exacerbate the original problem.

Right: Remains of a church in Nuevo Rio Claro abandoned after lahars of November 13. The church stands as a reminder of the event and has been left abandoned since. It also serves as a reminder about the threat of future lahars and building in areas delineated on hazard maps as "high risk".

VI. Moving Forward

WA State Emergency Management Division/Department of Natural Resources:
- Developed and deployed an interpretive kiosk sign in potentially affected communities
- Development of a web portal with hazard map overlay
- Supporting volcano preparedness month across the state

Pierce County Department of Emergency Management:
- 1998 evacuation routes updated and new routes being created
- Emergency coordination plan being regionalized
- New Mount Rainier hazards website developed: http://www.piercecountywa.gov/activevolcano
- Coordinating posting of Mount Rainier hazard interpretive signs
- Working on plans for Emergency Information Hubs

Orting Valley Fire and Rescue:
- Officially adopted Manizales and Armero fire departments as "sister fire departments"
- Evacuation plans being reevaluated for 2014 improvements
- Updating operational plan and participation in annual evacuation drills
- Planned coordination with adjacent fire departments
- Planned preparedness trainings

Whatcom County:
- Volcanic crisis awareness courses
- Exercised the Mount Baker-Glacier Peak coordination plan, now revising and updating it.
- Increase volcano hazards presence in outreach programs and work with USGS/CVO to develop enhanced mapping and educational materials.

In Colombia:
- Nevado Del Ruiz Full Scale Evacuation Exercise - 9-10 November 2013: Successful event involving 1,700 responders (federal, 2 departments, 22 municipalities); 37 sites; 36 crisis rooms; and 26,000+ evacuees.

Mount Rainier Regional Working Group is currently making improvements to the regional volcanic crisis work plan and meets every other month.

A second Bi-National Exchange is being planned for Summer 2015.

VII. Conclusion

The Colombian people experienced a terrible tragedy during the 1985 eruption of Nevado del Ruiz. The event was a wake-up call for a largely ineffective emergency preparedness culture in the country. Since the 1985 event, the country has taken great strides in improving its emergency preparedness. With the exception of Mount St. Helens in 1980, the United States has not experienced an event like that in Colombia and has little to no human history about the effects of volcanic eruptions. By using lessons learned from the Colombian people, the United States is able to glean important information from the Colombian emergency preparedness plans and actions. We can also use stories from survivors and photos of devastated areas to prepare Americans for a future eruption of Mount Rainier. Products like the information kiosks (below) that are being placed across Pierce County, as well as public presentations and information dissemination during volcano preparedness months will enlighten communities at risk about the hazards from future events at Mount Rainier and other volcanoes in the Pacific Northwest.

Above: Information kiosk sign created by Pierce County officials and placed in various cities around Mount Rainier.

Acknowledgements

The corresponding author would like to thank the following individuals with the National Park Service and Department of Interior for approving travel and facilitating this life-changing event: Randy King, Donna Rahier, Roger Andrascik, Darin Swinney, Barbara Samora, Celeste Gray, Sara Jivanjee, Dee Sousa, April Brooks and Paul Kemppainen. Thanks to Tom Pierson at the USGS for providing background information. We also thank the tremendous work by USGS/CVO Scientist-in-Charge John Ewert for arranging all aspects of the trip (but staying home to let someone new go!). The Colombians were truly gracious hosts and we acknowledge the numerous individuals in Colombia for safely getting us around, sharing their stories and hospitality, and showing us their beautiful country.

Bi-National Agencies