Managing Risky Volcanoes

Despite Colombia’s well-earned reputation for risk reduction and disaster management since the formulation of the National Plan for Prevention and Relief in 1989, most communities are not well prepared for the next natural event (earthquake, volcano, and flood). For reasons such as low technical capacity or lack of access to information, Colombian municipalities have had difficulty analyzing risk and implementing disaster risk management plans. Moreover, regardless of investments in monitoring of seismic, volcanic, and hydrometeorological (processes related to rainfall) events, risk assessment of these and other phenomena remain weak. As Julián Escallón, Civil Engineer in the National Unit for Disaster Risk Management, has said, these difficulties reflect a lack of capacity to apply new methodologies and technologies and the need for more and improved information. The new methodologies, according to Escallón, “are best used with in-depth information of very high quality.”

In the area around Galeras Volcano in Southwestern Colombia, residents and authorities are strengthening their capacity to analyze risk and prepare for the next natural event and avoid natural disasters using the CAPRA Probabilistic Risk Assessment Initiative. The CAPRA software suite is a free, modular, open source, and multi-hazard tool for risk assessment. CAPRA provides a risk calculation platform (CAPRA-GIS) integrating exposure databases and physical vulnerability functions under a probabilistic approach. The CAPRA platform evaluates risk in terms of physical damage (buildings and infrastructure) and estimates economic and human life losses. CAPRA uses a display platform geographical information system (GIS) to estimate the disaster risk of earthquakes, tsunamis, floods, hurricanes and volcanoes.

The CAPRA Initiative was originally developed to assist Central American governments in the assessment of threats from natural events (earthquakes, floods, and volcanoes) and the adoption of standards to reduce the risk of natural disaster. The Initiative is currently under implementation as a part of Technical Assistance Projects (TAPs) in Central America, South America, and South Asia.

The Galeras Volcano TAP is sponsored by Colombia’s National Planning Department (Departamento Nacional de Planeacion, DNP) and the National Unit for Disaster Risk Management (Unidad Nacional para la Gestión del Riesgo, UNGRD). The Colombian Geological Service...
Project highlights

(Servicio Geológico Colombiano, SGC) is the implementing agency. The Galeras Commission (Proceso Galeras, part of the UNGRD) also participated in the project, and the World Bank provided the funding.

The Galeras Volcano and its Neighbors

The Galeras Volcano is a stratovolcano, characterized by many layers (strata) of hardened lava, pumice, and volcanic ash. It is located at the confluence of the Cordillera Central and the Cordillera Occidental in the Department of Nariño, nine kilometers west of the departmental capital, San Juan de Pasto. Its summit is 4,276 meters above the sea. Although it is not one of Colombia’s most destructive volcanoes, it is one of the most active. The current active cycle began in 1989. The most recent eruption occurred in January 2010.

Volcanic hazard is not a singular phenomenon, according to María Luisa Gonsalve, Geologist in SGC. Rather, it is one “where many phenomena may potentially occur.” In the case of the Galeras Volcano, the hazard is more than just ash fall. The high hazard level area also corresponds to pyroclastic flows (a fluidized mixture of solid to semi-solid fragments and hot expanding gases flowing down the side of a volcano).

The Galeras Volcano’s area of coverage is around 888 square kilometers with three hazard levels: high, middle, and low. At the high level, there is a 20 percent probability that the volcanic event will result in the complete destruction of property and the death of all the inhabitants. The medium

“The CAPRA initiative helps to bring knowledge of probabilistic risk management to many different types of people working in the public sector (not only to experts), which will help public administrators develop informed public policies on disaster risk management.”

—Julian Escallón, Civil Engineer of the Office for Disaster Risk Management.
hazard level corresponds to ballistic projectiles, shock waves, and minor lava flows with a 10 to 20 percent of occurrence. The low hazard level area includes pyroclastic flows and less than 10 percent threat probability. Parts of the municipalities of La Florida, Nariño, Sandoná, Consaca, and Pasto, Yacuanquer, Tangua, Ancuya, Linares, El Tambo, and Chachagui are in the high hazard level area. Map 1 shows Galeras’s location and the areas with the three hazard levels.

**The Government Responds**

The Colombian government responded to Galeras’s increased activity and the probability of a catastrophic eruption with the creation, in 2005, of an intersectoral commission to coordinate activities of the participating agencies and support the local authorities in the effort to reduce risk. After a review, the municipalities of Pasto, Nariño, and La Florida were declared disaster zones. The government ordered a specific management plan for the region. The Galeras Commission was also created to advance the management process.

The complexity of a disaster management response to volcanic threat points to a number of challenges for the government. The main challenge is to reduce the extremely high levels of vulnerability. This requires investment in structural mitigation and a program to resettle affected populations. It further includes the improvement and application of risk management planning tools to reduce the creation of new and unacceptably high vulnerability levels. Given this challenge, the UNGRD’s objective is to move forward in the resettlement plan for the affected areas in the face of local resistance. The success of the resettlement plan will be based on effective communication of the acceptable risk levels and an understanding of the concerns of the affected populations.

**CAPRA Activities**

The goals of the Galeras CAPRA TAP include strengthening the technical capacity to evaluate and make decisions regarding the risk of natural disasters. The specific objectives include increased local institutional capacity in the CAPRA platform, strengthened capacity in probabilistic evaluation of risk, vulnerability, and loss evaluation, the promotion of interchange and transfer of capacity to other parts of the country.

The CAPRA TAP’s four general activities are:

- identification of hazards, historical review, and probabilistic analysis;
- inventory and categorization of exposed and vulnerable buildings;
- evaluation of disaster risk by natural events; and
- creation of hazard and risk maps and examples of applications of risk management.

The presence of strong institutions, the region’s strategic importance, and excellent historical and cartographic documentation makes the Galeras area a good candidate for a CAPRA TAP. The Galeras TAP’s activities include: (i) compiling and organizing the pre-existing information on past events, (ii) building exposure databases, (iii) defining vulnerability functions, and (iv) developing proposals for further progress in risk assessment. Sources of information include cadastral databases (size, value, and ownership of land), and databases that include the architecture, construction type, roofing, building height, and other building characteristics.

The activities include the development of a relative measure of explosiveness, which includes information on wind direction, velocity, and size, distribution, average volume, and density of particles. SGC provided information on the three types of volcanic hazards, lava flow (maximum distance covered), pyroclastic flows (height of the eruption column collapse), and ash fall (height of eruption column and material expelled). The databases will contribute to the growing knowledge base on exposure and vulnerability of the population and infrastructure developed by Proceso Galeras and SGC. These data include population, essential buildings, public services, and housing, among others, all of which are included in the geographic information system (GIS).

The TAP participants organized and formatted the pre-existing data for compatibility with the CAPRA platform. They
also conducted a comparative analysis of the results from the CAPRA software and the volcanic hazard maps developed by SGC. This allows the project to analyze the sensitivity differences between the different methodologies and models used, with the goal of proposing strategies to advance the methods and tools for the evaluation of volcanic hazard.

The CAPRA TAP’s first workshop took place in May 2011. Participants were introduced to the CAPRA platform and its various modules as applied to volcanic threat analysis. They discussed the visualization tool, threats, scenarios, and generation of hazard maps. They reviewed concepts of vulnerability and hazard exposure. Participants used the CAPRA platform to analyze the pre-existing information from the sources and create a model of the hazard level for the communities surrounding Galeras Volcano. At the second workshop, in September 2011, participants reviewed the volcanic hazard model (lava flow, pyroclastic flows, ash fall), the exposure level model (cadastre, population, definition of urban zones), and vulnerability functions. At the third workshop, in March 2012, participants reviewed the final analysis and made plans for future activities.

**Outcomes**

The quality of the vulnerability analysis on pyroclastic flows and volcanic ash fall has also improved. In addition, the CAPRA platform, according to María Luisa Monsalve, encourages “interaction among the institutions.” Information included in the database “facilitates the coordinated use of all the data.”

In conclusion, the outcomes of this TAP are strengthened capacities in probabilistic risk modeling and risk assessment among the local and national institutions in charge of risk management.

“I think the CAPRA initiative is a very useful tool and helps us apply all the knowledge that we have on hazard evaluation for volcanic risk evaluation.”

—María Luisa Monsalve, Geologist of the SGC.

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