

Volcanoes: Protecting the Public's Health



Pan American Health Organization
Regional Office of the
World Health Organization

The Pan American Health Organization would like to express special gratitude to Peter Baxter (Institute of Public Health, Cambridge University, United Kingdom) and John Tomblin (vulcanologist, Antigua, West Indies) for the technical contributions and conceptual support they made to the content of the video "Volcanoes: Protecting the Public's Health."

VOLCANOES:
VOLCANOES:
PROTECTING THE
PROTECTING THE
PUBLIC'S HEALTH
PUBLIC'S HEALTH

The publication of this guide has been made possible thanks to the financial support of the Division of International Humanitarian Assistance of the Canadian International Development Agency (IHA/CIDA), the Office of U.S. Foreign Disaster Assistance of the U.S. Agency for International Development (OFDA/USAID) and the Department for International Development of the United Kingdom (DFID).

© Pan American Health Organization, 2002

ISBN 92 75 12396 9

Introduction3

Part I

Major health hazards of volcanoes5

What are the major health hazards from volcanic eruptions?6

Lava6

Rocks and debris6

Ash6

Contamination of water supplies8

Acid rain8

Gases9

Tsunamis10

Pyroclastic flows10

Mudflows and debris flows11

Part II

Planning for volcano emergencies13

Getting the right information13

Establish emergency scenarios and plans14

Health sector contingency plan15

Citizen participation:making yourself heard19

Introduction

This instructional guide is meant for use before, during and after the viewing of the video "Volcanoes: Protecting the Public's Health." It uses a simple format to present the most important aspects of the video, providing technical information for health personnel who may be involved in prevention, preparedness, or response activities in volcanic emergencies.

The information in the video and guide are based on experiences in the Americas, addressing the major health risks associated with volcanic eruptions and basic planning measures that the health sector should undertake to reduce potential losses. The video is divided into two distinct but complementary sections that can be used together or separately.

The first section addresses the main health risks posed by volcanic eruptions. It dispels certain myths about the effects that lava, rocks, or volcanic debris can have on public health, and focuses on the most dangerous hazards. Pyroclastic flows, mudflows and debris flows have been responsible for nearly 99 percent of volcano-related deaths in Latin America and the Caribbean.

The second part of the video focuses on emergency plans and the prevention and preparedness measures that the health sector should take to avoid injuries, deaths and damage to health infrastructure. The plans should cover various possible scenarios, be realistic and flexible, and be developed with the participation of scientists specializing in the study of volcanoes and disaster management agencies.



Part I

Major health hazards of volcanoes

Volcanoes are part of our world. With massive force, they create and destroy in an endless cycle. Many volcanoes remain dormant for decades or for centuries, and neighboring communities forget the potential danger of eruptions. The soil around volcanoes is rich and fertile, and towns grow and flourish—at least temporarily—in volcanic areas.

Ten percent of the world's population—some 500 million people—live in areas where there are potentially active volcanoes. New volcanoes appear in unexpected sites, and dormant volcanoes can have unexpected, violent eruptions.

Latin America and the Caribbean is a high-risk region for volcanoes. In the twentieth century, 76 percent of the deaths caused worldwide by volcanic eruptions were in this region. In the last 10 years, nearly half of the strongest eruptions in the world occurred in Latin America and the Caribbean.

It is only a matter of time before another major disaster strikes. The question is: will your country and its health services be prepared to handle it?

Planning for a possible volcanic crisis can be an enormous challenge, but it is vital to learn what can be done before the event, and take measures to avoid its consequences. It is the only way to save lives.

What are the major health hazards from volcanic eruptions?

Each volcano presents its own distinct risks, and each hazard can have a different consequence. There are different approaches to how governments can either avoid these hazards or prepare to cope with them.

Lava

Although most think that the spectacular flow of lava is what causes the most devastation, in fact, most lava fronts move very slowly, rarely advancing more than a few meters per hour. Lava flows are not usually a significant danger during volcanic activity and are therefore not a high priority for health planning.

Rocks and debris

An active volcano can spew out huge rocks and blocks of cooling magma—sometimes many kilometers away from the crater. The thought of being hit by one of these fiery projectiles is frightening, but the possibility of this actually happening is low. Rocks and debris do not present a major health hazard during a volcanic crisis.

Ash

During a volcanic eruption, a thick layer of ash may fall. It is a myth perpetuated by the media, however, that ash fall is a major health hazard for otherwise healthy individuals. In fact, there is very little serious danger posed by volcanic ash. Although it may affect those with ongoing respiratory illnesses, there is currently no evidence of excessive mortality due to cardiopulmonary problems caused by inhaling ash.



Photo: PA/NO/WFO

Studies done after the 1980 eruption of Mount St. Helens in the United States showed that coarse ash near the volcano and the fine powder-like layer that can fall even hundreds of miles a way caused only few—and very minor—health problems.

Ash falls, however, can pose several other challenges for communities:

- ◆ Ash falls can fill the air with a smoke-like mist that will significantly reduce visibility. Impaired vision will increase the numbers of traffic and other accidents. Roads can be slippery when covered with ash, and windshields will be smeared with a thin deposit of wet ash.

- ◆ A major hazard is the collapse of roofs in heavy ash falls, especially if the eruption is accompanied by rain, as this doubles the weight of the ash. Deaths have resulted from the collapse of roofs and the resulting ash fall into homes, constituting a major volcanic hazard in Latin America and the Caribbean.
- ◆ Eye irritation may lead to cases of conjunctivitis and corneal abrasions, especially for those wearing contact lenses. While this places more demands on health workers, the treatment is relatively simple and should not pose a serious problem.
- ◆ For persons with pre-existing lung diseases, inhaling ash can create breathing problems. Only the smallest particles—under 10 microns—can be inhaled, and their effects depend on factors such as their acid content (or pH). For most otherwise healthy people, lung problems will not be a health issue.

Contamination of water supplies

The water supply from springs or rivers on a volcano may become contaminated as a result of the activity inside the volcano. But heavy ash falls can also contaminate surface sources of drinking water such as rivers and reservoirs. Fluorine is a toxic element that can be emitted in large quantities in certain volcanoes, and the ash can kill animals grazing in the vicinity as well as contaminate drinking water. Chemical testing of the ash and water is required to rule out this possibility. Heavy collections of ash can also clog drains and sewers and damage machinery in water treatment plants.

Acid rain

Although uncommon, there is the possibility that chemicals

or acid rain could contaminate some water supplies. Rainfall in the area of an erupting volcano will dissolve the acid gases—in particular the highly soluble gas, hydrogen chloride—creating acid rain.

Acid rain burns and kills vegetation, and while it does not present a direct health hazard acid rain can corrode metal roofs and pipes and contaminate water supplies collected in outdoor cisterns. Over time, it could affect soldered pipes and weaken galvanized nails and steel roofs as well, increasing the number of household accidents and causing more water and sewage problems. Harmful concentrations of metals such as aluminum, lead, and zinc can contaminate drinking water where rain is collected from metal roofs. Because of this, water supplies must be checked periodically for excess fluorine or toxic metals.

Even if water quality is found to be safe, ash falls impact the delivery of water to homes and health facilities. Falling ash may clog pipes, and power outages could interrupt water pumping. All of these factors must be considered when planning for a volcano crisis.

Gases

Along with the lava and ash, volcanoes spew out gases such as water vapor and carbon dioxide. Sulfur dioxide can pollute the air a long distance from the volcano, causing breathing problems in healthy individuals as well as asthma sufferers. Fortunately, in most eruptions these gases are quickly dispersed by winds and rendered harmless. However, certain relatively heavy gases, like carbon dioxide or hydrogen sulfide, may collect in low-lying areas of the volcano and occasionally cause fatalities. In addition, gases from certain low-lying volcanoes can flow into populated areas, but this should not be a widespread health concern for the exposed population.

Tsunamis

When a volcano is under water, especially in shallow areas, it is like a ticking time bomb. Because of the lethal combination of magma and water, it could explode at any moment. Tsunamis are enormous waves that can flow for several kilometers inland, causing serious damage. There are volcanoes in the Caribbean that could trigger tsunamis should they become active and erupt. *The risk is small, but the consequences so serious they cannot be ignored.*

Pyroclastic flows

Unlike the volcanic dangers already discussed, the avalanches of hot ash, pumice, rock fragments and volcanic gas that rush down the sides of a volcano—known as pyroclastic flows (or *nuée ardente*, the French term for “glowing cloud”)—do pose major risks. *In Latin America and the Caribbean, nearly 60 percent of all deaths due to eruptions are caused by pyroclastic flows.* Gases, which can approach temperatures of 900 degrees Fahrenheit, propel solids and debris at an alarming speed—sometimes reaching hundreds of kilometers per hour.

These flows of red hot rock and ash and gas that advance very rapidly are not the same as lava flows, because they are not liquid. They are a mixture of solids and gases that will destroy everything in their path. Everything living—animals, plants, and people—will be literally carbonized by the extreme temperatures and swept away by the cyclone of ash and rock. *There is no chance for survival in the direct path of a pyroclastic flow. Evacuation is the only solution.*

People lucky enough to escape by being at the edges of the flow may survive. But survivors will have severe and

extensive burns, not only to their skin but also to their respiratory tracts. *Pyroclastic flows pose a serious danger to communities.*

Mudflows and debris flows

Almost as devastating as pyroclastic flows, *mudflows, debris flows, or lahars—to use the Indonesian word adopted by scientists—are responsible for 42 percent of the recorded volcano-related fatalities worldwide.* Snow and icecaps, under the intense heat of the eruption, suddenly begin to melt. Enormous mudflows, carrying debris as they surge through river valleys, can completely sweep away cities, leaving little time to evacuate.



Photo: PATOMPO

In 1985, the eruption of the Nevado del Ruíz volcano in Colombia, caused huge avalanches of mud and rocks which buried the city of Armero, leaving more than 20,000 people dead or missing.

If the area around the volcano has large icecaps or crater lakes, mud flows present a serious threat. Heavy rainfall at the same time as an eruption can trigger extensive runoff and severe flooding. The rainwater can also cause new or old ash deposits to form lahars that rush through valleys,

overwhelming settlements in their path. Lahars can recur during rainy seasons, displacing people from their homes and land.

Torrential rain on hillsides, even months or years after an eruption, can cause loose ash and volcanic material to slide down hills, threatening populations.

Clearly, volcanic eruptions and the hazards they create are of great concern to health officials. The majority of fatalities caused by volcanoes in Latin America have resulted from pyroclastic flows, mudflows, and debris flows. Not as dangerous, but still safety issues, are volcanic gases and ash falls. Other threats like tsunamis, lava, rocks and acid rain, although not usually as deadly, may pose problems for communities depending on their location and proximity to the volcano.

Part II Planning for volcano emergencies

Unlike many other disasters, volcanic disasters are not short-lived. It is necessary to be prepared, to take a variety of scenarios into consideration and to try to reduce damage and other problems when planning emergency response.

It is also important to put the risks associated with volcanoes into perspective, and concentrate on those that truly present a severe challenge to public health. The major dangers are pyroclastic flows and mudflows, which cause nearly 99 percent of the fatalities. However, medical attention is often diverted to other risks (such as ash, acid rain, and others), and while they are of concern to the public, they do not represent a major threat to public health.

The health sector has an enormous responsibility in planning for volcanic emergencies. The first step in planning for such an emergency is to gather vital information about the areas where there are active and inactive volcanoes.

Getting the right information

Knowing where the potential trouble spots are is necessary when planning for possible disasters. Local civil defense or emergency committee members should be consulted about the status and potential for activity of nearby volcanoes. Volcanologists can give information about the history of eruptions and whether hazard maps exist for a specific area.

It is also important to find out whether settlements have

been rebuilt in the path of former mudflows or pyroclastic flows. The location of populations at highest risk should be identified.



Photo: PAHO/WPAO

On the island of Montserrat, a hazard map was created a few years before the 1995 eruption of the Soufriere Hills volcano. It provided an accurate forecast of events, but was ignored when it was first published. As a result nothing was done in advance to protect the infrastructure of the island. A new hospital in Plymouth had to be abandoned almost immediately after it was opened. When the population of Plymouth was evacuated most of the essential infrastructure of the island was deserted.

Establish emergency scenarios and plans

With the cooperation of scientists, local leaders and disaster professionals, plans should be developed for what to do in case of the most likely type of eruption and in the worst-case scenario. These plans should take the following into account:

- ◆ Ash fall, sometimes lasting for many hours, can block all roads and reduce visibility for days until it rains and clears the air of ash;

- ◆ All water and electricity services might be interrupted. There may be radio and telecommunications blackouts, also affecting satellite communications.
- ◆ Supplies included in the plan will most likely not be available at the needed time. Contingency plans must anticipate personnel and supply needs.
- ◆ Even with the best of plans, many things will go wrong. Flexibility is necessary to overcome aspects of the plan that fail.

The best way to avoid mass casualties is to keep populations away from areas around volcanoes. It is critical to work with planning officials to convince them not to allow communities to grow or health facilities to be built near volcanoes. This will help prevent deaths and injuries in the event of an eruption—and save governments millions in later costs.

When settlements already exist near a volcano showing signs of new activity, early evacuation of populations away from exposed areas is the best plan.

Health sector contingency plan

Every area should have a health sector contingency plan. This plan should be designed by everyone involved in responding to a volcanic crisis. It must include everything from financing arrangements, to medical treatment plans, and the creation of temporary sites for accepting evacuees. The contingency plan should take into account, at a minimum, the following:

- ◆ Since there are already many communities established in volcanic areas, the plan must allow for the *possibility of mass evacuations*. People do not relocate

easily. Give communities factual, objective information about the hazards they are facing and steps being taken to help them. Good public information and compassion will be more effective in evacuating populations than law enforcement alone.

- ◆ In the chaos following a volcanic eruption, many workers and people living in areas around the site will need special information or protective gear.
- ◆ Advise people with respiratory problems to stay indoors as much as possible or to wear lightweight masks to avoid inhaling fine particles. Provide emergency workers and those working to remove ash from streets and roofs with masks and protective eyewear.
- ◆ In case of heavy ash fall, distribute high-efficiency, lightweight masks to everyone in the affected area. Provide hard hats to workers where there is a risk of volcanic debris falling.
- ◆ Monitor air and water quality carefully and continually, keeping the public informed about safety issues. Ash is not the only potential hazard: toxic gases, although generally occurring in harmless concentrations, can cause serious air pollution. The odor can be horrible and frightening to those who do not know that it is not toxic at this concentration. Many will seek medical help because of fear..
- ◆ Assessments of health needs and epidemiological surveillance are vital for health administrators. It is critical to keep track of reports from hospitals and emergency rooms, health centers, and shelters to determine what types of injuries and illnesses the affected population is facing, and give health workers the chance to target

services and resources where they are most needed.

- ◆ Include mental health issues in the emergency plan, taking into account how to address the stresses of relocation and loss as well as dealing with populations who are at high risk. Evacuees are likely to suffer from depression and other mental disorders. Medical personnel and disaster workers will also need access to these support services.
- ◆ The emergency plan must allow for ongoing training programs for everyone involved with mass casualty management, stress management, first responders, and incident command systems. Having well trained staff members who know what to expect is important for keeping everyone safe and calm during a crisis.
- ◆ Environmental health issues such as adequate water quality and supply, food sanitation, vector control, sewage and solid waste disposal, and proper disposal of the dead must also be included in the plan. Include any equipment that may be needed to monitor air and water quality and to survey respiratory diseases among the affected population.
- ◆ Medical attention is a vital part of health sector contingency plans. This includes detailed search and rescue plans; mass casualty plans, taking into account the provision of temporary morgues and emergency field stations; triage instructions; and plans for transporting the injured to hospitals and emergency clinics.
- ◆ Be transparent in managing information about the situation. Emergency officials and the mass media need to know public health implications of any actions being considered. The information shared can alleviate fears, dispel myths about the dangers people are facing, and

give them hope about what is being done to lead them back to normal lives.

- ◆ Test the plan and practice it with medical staff and other health workers to make sure they feel comfortable and prepared. Update the plan periodically to account for changes in personnel and resources.

There are tremendous needs to be met during a volcanic crisis. If the health sector has a good contingency plan, they will be ready to deal with budget concerns; personnel training and assignments; evacuations; and plans for providing safe water, food, and sanitation.

Citizen participation: making yourself heard

Input from the entire health sector about emergency team planning before, during, and immediately after an eruption is absolutely essential.

- ◆ Learn who the disaster coordinators are; find the scientists and political authorities who are the decision makers, and let your voice be heard.
- ◆ Be a key member of any emergency team; collect useful information for your own plans and protect the health interests of the public.
- ◆ Emergency officials and the mass media need to know your opinion about the public health implications of any actions being considered.
- ◆ The information that you provide can alleviate fears, dispel myths about the dangers people are facing, and give them hope about what is being done to lead them back to normal lives.



We have accumulated a great deal of experience and knowledge about volcanoes. We know now that many past human tragedies could have been avoided. There is no need for thousands to die if we are properly prepared to respond. As public health officials, our job is to make sure that our people have vital health services. Working with government decision makers and other agencies; identifying areas at risk for volcanic eruptions; creating a strong contingency plan for the health sector; and making sure that our health workers, facilities, and supplies are prepared are the best ways to ensure safety for our communities and offer them hope for the future.

Program on Emergency Preparedness and Disaster Relief

Pan American Health Organization

Regional Office of the

World Health Organization

In 1976, PAHO established the Emergency Preparedness and Disaster Relief Coordination Program in response to requests of the Member Governments of Latin America and the Caribbean to create a technical program to help the health sector strengthen disaster preparedness, response, and mitigation activities.

Since its creation, the Program's main objective has been to assist the Region's health sector to strengthen national programs for disaster reduction and to support interaction with other sectors involved in disaster reduction. Three principal areas have been strengthened through this support: disaster preparedness; disaster mitigation; and disaster response.

In addition to the ongoing promotion of disaster preparedness programs within the ministries of health, training activities (accomplished through hundreds of classes and workshops), and the development and distribution of training materials (books, slides, and videos) are regular activities of the Program.

The area of disaster mitigation is particularly important, since investment in disaster preparedness is futile if a hospital, health center, or drinking water system fail in a disaster situation, just when these lifelines are most needed. PAHO supports and promotes the inclusion of mitigation activities in national disaster reduction programs.

In the area of disaster response, PAHO works with affected countries to identify and assess damage and needs, carry out epidemiologic surveillance and inspection of drinking water supplies, mobilize international humanitarian assistance, and manage humanitarian supplies. PAHO has established the Voluntary Emergency Relief Fund, which collects money for post-disaster activities.

The Program has also invested in a number of special technical projects such as Disaster Mitigation in Hospitals and Drinking Water Systems; Humanitarian Supply Management Systems (SUMA); Use of the Internet for Disasters and Emergencies; and the Regional Disaster Information Center (CRID).