Pan American Health Organization
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REGIONAL OFFICE FOR THE Americas

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Reducing Exposure to Air and Water Pollution Due to Volcanic Eruptions

Pan American Health Organization. Unit of Climate Change and Environmental Determinants of Health. Department of Communicable Diseases and Environmental Determinants of Health

General Overview

Volcanic eruptions are a complex health emergency with several health risks and harmful health outcomes. Volcanoes can produce ash, toxic gases, mudflows (lahars), lava flows, and fast-moving flows of hot gases and debris (pyroclastic flows). The direct health effects caused by volcanic eruptions include traumatic injuries, burns, suffocation, skin irritation, eye injuries, conjunctivitis, respiratory problems, and even death. Volcanic eruptions may also increase exposures to toxins in air and water. Ash and gases emitted by volcanoes can be toxic and are linked to eye, skin and throat irritation, cardiac events, and a range of respiratory effects, including asthma attacks. Such emissions can be deposited on water bodies, affecting both surface and ground water supplies. Emissions can travel long distances affecting population beyond the immediate area of the eruption.

This factsheet includes key recommendations for public health authorities to reduce population exposure to air and water pollutants during volcanic eruption events.

Recommendations

The implementation of these recommendations should be coordinated by the Health Emergency Response Team considering the specificities of the situation and conjunction with other health risks.

Reducing Exposure to Ash and Gases

What is volcanic ash? Volcanic ash is pulverized rock. A one-inch layer of dry ash weighs ten pounds per square foot as it lands. It often contains small pieces of light, expanded lava called pumice. Fresh volcanic ash may be harsh, acid, gritty, glassy, smelly, and thoroughly unpleasant.

What are the gases emitted from a volcanic eruption? The gases emitted from a volcanic eruption include carbon dioxide, sulfur dioxide, hydrogen sulfide and hydrogen halides which are all potentially hazardous to people, animals, agriculture, and property. They are colorless and although the human nose is very sensitive to the hydrogen sulfide odor, pungent like that of rotten eggs, care should be taken not to enter areas with potentially high levels of these gases. Some may be soluble in water and contaminate it, as well as be carried on volcanic ash for large distances.

What is acid rain? Gas or ash from the volcano mixes with rain to form acid rain. Acid rain may irritate or cause stinging in the eyes. Acid rain may cause metals to rust faster damaging essential equipment and damage crops.

Population in condition of vulnerability: Infants, elderly people, and people with respiratory conditions such as asthma, emphysema, and other chronic lung diseases are vulnerable to volcanic ash

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Key messages to the public:

- The best way to protect yourself and your family is to follow the advice of national Health and Emergency Management officials.
- Minimize time outdoors. Reduce exposure to volcanic ash and gases by staying at home or in a designated shelter.
- Close windows and doors when volcanic ash is falling.
- Use facemasks(N95) and goggles. If N95 masks are not available use surgical or cloth masks. However, be aware that these masks provide less protection to volcanic ash and do not protect against volcanic gases.
- Drink water from treated sources (bottled or from bowsers) until told otherwise. Rainwater might be contaminated.
- Do not use air conditioners.
- Use water sparingly. Drinking water, cooking and personal hygiene are the priorities for usage.
- Wash sore eyes – don't rub them. The ash can scratch them.
- Drink water and stay cool using compresses and fresh water to prevent heat stress.

Key actions by water service providers:

- Assess water supply quality.
- Provide safe water for households, shelters, and health care facilities.
- Monitor the water quality supply at distribution points and ensure a free chlorine residual of 0.5mg/L, especially in shelters and health care facilities and at household level.
- Options for disinfection include filtration, adding chemical disinfectant such as bleach, or boiling. If the water is visibly cloudy, the suspended solids need to be reduced by settling filtering or adding flocculating agents before chemical disinfection.
- Temporarily restrict agricultural; industrial, commercial and recreational uses until water supply can be guaranteed for the priority areas (households, shelters, and health care facilities, followed by livestock).
- Test water to ensure WHO Guidelines for Drinking-water Quality are met. The most commonly affected parameters are pH, turbidity, aluminum, manganese, iron, calcium, sodium, chlorine, fluoride, potassium, zinc, and copper.
- Monitor water organoleptic characteristics. If noticeable changes are detected limit water sources to those systems able to provide safe water and demonstrate quality control and testing results.
- Do not use untested water for drinking.
- Protect water treatment systems: 1) volcanic ash suspended in surface water sources can cause turbidity levels to exceed operating thresholds; 2) Uncovered pump motors used for extracting groundwater may be vulnerable to volcanic ash; 3) Fine volcanic ash may penetrate into sand filters; coarser ash may form a cap on sand filter.
- The most common reasons for interruptions to water production following ashfall are high turbidity levels and electrical power outages.
- Plan for high water demand during the cleanup phase.

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Key actions by public health authorities:

- Provide health responders with adequate respiratory protection and other Personal Protection Equipment (PPE).
- Ensure windows and doors are closed and gaps are sealed.
- Increase cleaning routine and ensure cleaning done with mops and damp cloths to reduce ash resuspension in the air.
- Turn air conditioners off.
- Prioritize water for cleanup of health care facilities once drinking needs are met.
- Ensure shelters have enough food and water supplies, and sanitation and hygiene facilities.
- Establish surveillance of the affected population for respiratory complaints associated with exposure to volcanic ash and gases.
- Create communication channels with the affected population to understand their challenges and provide information and feedback.
- Provide mental health and psychosocial support services to the affected population.
- Consider the provision of protective facemasks (N95 or similar).
- If N95 masks are not available provide surgical or cloth masks. Please be aware that these masks provide less protection to volcanic ash and no protection to gases.
- Be aware of the signs and symptoms of heat stress in the population and staff.

Key actions for air quality monitoring & testing

- Sample air quality for particulate matter and gases (PM2.5, SO_2).
- Conduct analytical characterization of ashes.
- Consider the following sources for air quality monitoring information.

Source	Type	Coverage	Weblink
NASA HEALTH AND AIR QUALITY APPLIED SCIENCES TEAM (HAQAST)	Earth Observations	Regional	List of Satellite and Modeling Tools for the St Vincent Volcanic Eruption (List) Compilation provided by NASA HAQAST in support to St Vincent Volcanic Eruption
Copernicus. European Commissions	Earth Observations	Regional	https://atmosphere.copernicus.eu/global-forecast-plotsNOO
Windy Community	Earth Observations	Regional	https://www.windy.com/-SO2-tcso2?tcso2,14.137,-43.594,4
Environmental Management Authority of Trinidad and Tobago	Air Quality Monitoring Network	Trinidad and Tobago	https://ei.weblakes.com/RTTPublic/DshBrdAQI

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Specific Messages to the Public

Always Follow the recommendations of the health and emergency management authorities.

When	Key Recommendations
During Evacuation	- Tune in to the radio or television for volcano eruption updates. - Wear respiratory protection and goggles when outdoors.
In homes and shelter during the eruption and ashfall (indoors)	- Do not go out unless instructed by the authorities. Close all windows, and outside doors. - Turn off all air conditioning systems. - Using ceiling or tower fans where possible once dust has been removed from surfaces. - Place wet towels at the bottom of doors and other places where there are drafts. - Stay indoors, as long as it doesn't get too hot. - Monitor for heat stress symptoms: headache, nausea, dizziness, weakness, irritability, thirst, heavy sweating, elevated body temperature, confusion, altered mental status, slurred speech. - Watch people with breathing conditions closely. If possible, they should wear a facemask but take care that this does not restrict their breathing. - Consume bottled water or water approved for drinking by the health authorities. - Drink water, and cool using compresses and fresh water to prevent heat stress. - Keep water barrels and tanks covered and cover wells where possible. - Use water sparingly. Drinking water, cooking and personal hygiene are the priorities for usage.
During the eruption and ashfall (outdoors)	- Seek shelter indoors. - Wear respiratory protection and goggles. - Wear long-sleeved shirts and long pants. - Avoid contact with ash as much as you can. Stay away from ashfall areas. - Do not drink water from untreated water bodies (ponds, lakes, rivers) or untreated underground water sources (wells).
Clean Up	- Avoid contact with ash as much as you can. - Put on your mask and protective equipment before starting to clean. - Use a dustless method of cleaning such as a mop or damp cloth, or vacuuming. Do not clean by blowing with compressed air or dry sweeping. - Use water sparingly. Drinking water, cooking and personal hygiene are the priorities for usage. - For several months after an ashfall, filters for indoor air-cooling systems may need to be replaced often. Air conditioner filters need careful attention. Clean refrigerator air intakes. Clean any surface that may blow air and recirculate the ash. Stove fans and vents should be cleaned thorough. - Keep children indoors and discourage play in dusty settings. - Follow indications of health authorities on regard to water consumption. Do not assume your usual water sources are safe.

References

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3. United States Geological Survey. Volcanic Ash Impacts & Mitigation. Available at: https://volcanoes.usgs.gov/volcanic_ash/

4. United States Geological Survey. Understanding volcanic hazards can save lives https://www.usgs.gov/natural-hazards/volcano-hazards/understanding-volcanic-hazards-can-save-lives

5. IVHHN. Guidelines on Preparedness Before, During and After an Ashfall. Available at: https://www.ivhhn.org/information/preparedness-ashfall#cleanupash

6. United States Geological Survey. Advice for Water Supply Managers. Available at: https://volcanoes.usgs.gov/vsc/file_mngr/file-118/Advice_for_Water_Supply_Managers.pdf

7. Preliminary Ambae eruption VMGD-WASH-FSAC-HEALTH Volcanic Gas, Acid Rain and Ash key messages – Version 3.1 Available at: https://www.vmgd.gov.vu/vmgd/images/geo-media/docs/Volcano-Advice-Key-Messages-Version-3-1.pdf

Annex 1. Principal health effects of ashfall.

CONSEQUENCES	IMPACT ON THE COMMUNITY	PREVENTIVE MEASURES
Respiratory		
Inhalation of fine ash (<10 microns in diameter)	Asthma, exacerbation of pre-existing lung disease	Laboratory test for particle size; Wear high-efficiency masks; Protect homes/offices from ash infiltration
Inhalation of siliceous dust (presence of crystalline silica, e.g., cristobalite, quartz)	Risk of Silicosis, if exposure heavy and continuous (years): an outdoor occupational hazard	Laboratory tests for crystalline silica, respiratory protective equipment
Toxic		
Ingestion of water contaminated with fluoride, possibly also heavy metals (e.g., cobalt, arsenic)	Gastrointestinal upset, even death in vulnerable (chronic sick)	Laboratory tests for leachable toxic elements; avoid surface waters for drinking supplies (i.e., use well water)
Ingestion of contaminated food (as above), including milk	As above	Laboratory tests for bioavailability of toxic elements; Observe health of foraging animals, laboratory analyses of milk
Ocular and Skin		
Foreign bodies in eyes	Conjunctivitis, corneal abrasions	Goggles for heavily exposed (e.g., outdoor workers)
Acid rain	Eye and skin irritation; Possible toxic contamination	Laboratory tests for bioavailability of toxic elements; Observe health of foraging animals, laboratory analyses of milk
Mechanical		
Roof collapse and falls from roofs	Trauma	Prevent build-up of ash; exercise care if in danger of falling from a roof
Automobile accidents (slippery roads and poor visibility)	Trauma	Traffic control
Aircraft engine damage	Trauma	Radar warning of an eruption
Radio and TV interference	Unable to receive warnings	Pre-eruption: advisory leaflets to all homes
Electricity outages (moist ash on horizontal insulators)	Breakdown of public utilities, home heating, etc.	Cover insulators or organize emergency repair crews
Poor visibility	Cessation of emergency transport; stranded homes and travelers; trauma	Designate emergency shelters

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