FORUM: United Nations Office for Disaster Risk Reduction (UNDRR)

QUESTION OF: Reassessing the Volcano disaster risk management during crisis

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POSITION: President

INTRODUCTION

Volcanic disasters pose significant threats to communities around the world; the unpredictable nature of eruptions has led to multiple catastrophic events. Examples of such are the destruction of entire areas, disruption of air traffic, and damaging effects on agriculture, climate and economies.

The development of volcanic catastrophe risk management has changed over time, largely due to technological improvements and the consequences of previous eruptions. Modern practices now emphasise on the integration of scientific research with community involvement to create resilient systems capable of responding to volcanic crises. Enhancing early warning systems and community resilience is a constant issue in the ongoing attempts to manage the risk of volcanic disasters while keeping ethical considerations in mind. Technological developments present hopeful answers, but they also need to be combined with a dedication to involve and empower impacted people. By using two approaches, scientists and the local community may work together and build trust. It also guarantees that disaster management plans are successful and culturally appropriate. In order to create a safer future for those who reside in volcanic impacted areas, it is imperative that we give both technology innovation and community involvement top priority as we reassess the current state of volcanic catastrophe risk management.

DEFINITION OF KEY TERMS

Volcano Disaster Risk Management

Volcano disaster risk management is the implementation of disaster risk reduction policies and strategies to prevent the disaster risk associated with volcanic activity.[1]

Crisis Management

The processes, strategies, and techniques used to prevent, mitigate, and terminate crises.[2]

Volcanology Early Warning Systems

Monitoring volcanoes according to their threat.[3]

Mitigation

The act of reducing how harmful, unpleasant, or bad something is.[4] In this case, reducing the risks that volcano disasters cause during a crisis.

Volcanic craters

"A volcanic crater is a bowl- or funnel-shaped depression that usually lies directly above the vent from which volcanic material is ejected. Craters are commonly found at the summit of volcanic edifices, but they may form above satellite (flank) vents of composite and shield volcanoes."[5]

Volcanic threat

The qualitative risk posed by a volcano to people and property.[6]

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[1] Andreastuti, Supriyati D, et al. "Volcano Disaster Risk Management during Crisis: Implementation of Risk Communication in Indonesia." *Journal of Applied Volcanology*, vol. 12, no. 1, 20 May 2023, https://doi.org/10.1186/s13617-023-00129-2

[2] "Crisis Management | Government." *Encyclopedia Britannica*, www.britannica.com/topic/crisis-management-government

[3] "National Volcano Early Warning System - Monitoring Volcanoes according to Their Threat | U.S. Geological Survey." *Usgs.gov*, 5 Oct. 2021, www.usgs.gov/programs/VHP/national-volcano-early-warning-system-monitoring-volcanoes-according-their-threat#:~:text=About- Accessed 13 Aug. 2024

[4] Cambridge Dictionary . "MITIGATION | Meaning in the Cambridge English Dictionary." *Dictionary.cambridge.org*, dictionary.cambridge.org/dictionary/english/mitigation

[5] "Volcanic Craters (U.S. National Park Service)." *Nps.gov*, 2022, www.nps.gov/articles/000/volcanic-craters.htm.

[6] "National Volcano Early Warning System - Monitoring Volcanoes according to Their Threat | U.S. Geological Survey." *Usgs.gov*, 5 Oct. 2021,

Lahars

It is an Indonesian term that describes a hot or cold mixture of water and rock fragments that flows down the slopes of a volcano and typically enters a river valley. They are also sometimes known as volcanic mudflows.[7]

Pyroclastic flows

A pyroclastic flow is a hot (typically >800 °C, or >1,500 °F), chaotic mixture of rock fragments, gas, and ash that travels rapidly (tens of meters per second) away from a volcanic vent or collapsing flow front. Pyroclastic flows can be extremely destructive and deadly because of their high temperature and mobility.[8]

Sediment

A soft substance that is like a wet powder and consists of very small pieces of a solid material that have fallen to the bottom of a liquid.[9]

Magma

Molten rock material within the earth from which igneous rock results by cooling.[10]

Tephra

"It defines all pieces of all fragments of rock ejected into the air by an erupting volcano. Most tephra falls back onto the slopes of the volcano, enlarging it. But, billions of smaller and lighter pieces less than 2 mm diameter (less than one tenth of an inch), termed ash, are carried by winds for thousands of miles."[11]

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www.usgs.gov/programs/VHP/national-volcano-early-warning-system-monitoring-volcanoes-according-their-threat#:~:text=About-. Accessed 13 Aug. 2024.

[7] "Lahars Move Rapidly down Valleys like Rivers of Concrete | U.S. Geological Survey." *Www.usgs.gov*, www.usgs.gov/programs/VHP/lahars-move-rapidly-down-valleys-rivers-concrete#:~:text=Lahar%20is%20an%20Indonesian%20term.

[8] "How Dangerous Are Pyroclastic Flows? | U.S. Geological Survey." *Www.usgs.gov*, www.usgs.gov/faqs/how-dangerous-are-pyroclastic-flows#:~:text=A%20pyroclastic%20flow%20is%20a.

[9] "SEDIMENT | Meaning in the Cambridge English Dictionary." *Cambridge.org*, 2019, dictionary.cambridge.org/dictionary/english/sediment.

[10] "Definition of MAGMA." *Merriam-Webster.com*, 2019, www.merriam-webster.com/dictionary/magma.

[11] "Tephra Fall Is a Widespread Volcanic Hazard | U.S. Geological Survey." *Www.usgs.gov*, www.usgs.gov/observatories/cvo/science/tephra-fall-a-widespread-volcanic-hazard#:~:text=The%20term%20tephra%20defines%20all.

BACKGROUND INFORMATION

Volcanic eruptions

How volcanoes erupt

"A volcano is like a chimney that allows hot liquid rock, called magma, to flow from a layer within the Earth and erupt onto the surface"[12]. More specifically, deep beneath the Earth, rocks start to melt due to the extremely high temperatures and become magma. Magma then rises and collects in magma chambers due to the fact that it's lighter than the solid rock around it. Then the magma will eventually push out of the vent, as seen in figure 1, to the Earth's surface; the magma that has erupted is called 'lava'. Of course, each volcano eruption is different - some are explosive and some are not. It depends on the composition of the magma; so, if the magma is thin and runny, gases can escape easily from it, meaning when it erupts lava flows outside. Nevertheless, there are rare instances in which deaths have occured due to the slow speed of the lava and therefore the ability for people to get out of the way.[13] On the other hand, if magma is thick and sticky, gases can't escape easily therefore causing a pressure buildup until they escape and explode. These eruptions are extremely dangerous and at times fatal since 'magma blasts into the air and breaks apart into pieces called tephra, which can range in size from tiny particles of ash to house-size boulders'[14]. It is at times fatal since hot tephra destroys everything in its path and the ash erupted, if thick enough, can cover and hence suffocate plants, animals and humans. Additionally, lahars can also bury entire communities such as the incident of the 2010 Mount Merapi eruption.[15]

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[12] Salleh, Anna. "Here's What Happens When a Volcano Erupts." *ABC News*, 22 Nov. 2017, www.abc.net.au/news/science/2017-11-22/volcanoes-heres-what-happens-when-they-erupt/8997014.

[13] USGS. "How Do Volcanoes Erupt?" *Www.usgs.gov*, www.usgs.gov/faqs/how-do-volcanoes-erupt#:~:text=Deep%20within%20the%20Earth%20it

[14] USGS. "How Do Volcanoes Erupt?" *Www.usgs.gov*, www.usgs.gov/faqs/how-do-volcanoes-erupt#:~:text=Deep%20within%20the%20Earth%20it

[15] "2010 Eruptions of Mount Merapi." *Wikipedia*, 12 Dec. 2023, en.wikipedia.org/wiki/2010_eruptions_of_Mount_Merapi#:~:text=The%202010%20eruption%20of%20Merapi%20was%20the%20volcano.

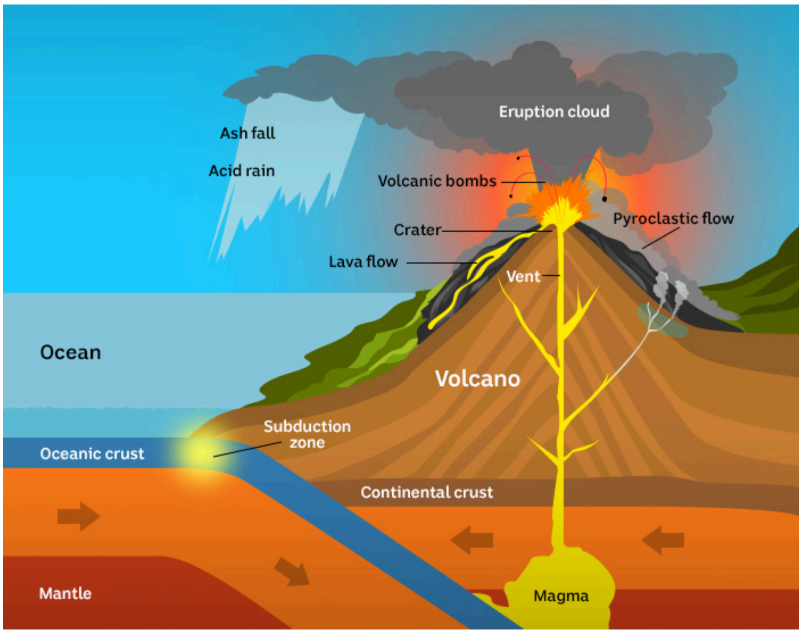

Figure 1 - Simple diagram of how stratovolcanoes erupt and what happens when they do.[16]

Impacts of volcanic eruptions [17]

As mentioned above, depending on the type of volcanic explosion, the impacts can differ, however, there is always an aftermath after an explosion - that could be environmental, social, economical or humanitarian. Volcanic ash is made of tiny fragments of rocks, minerals and volcanic glass, which is hard, abrasive and does not dissolve in water - those particles are tephra. Wind can carry these particles at great distances, meaning that plumes of volcanic ash can spread over large areas of sky reducing visibility and creating darkness. This makes it dangerous, specifically, to moving aircraft since it might affect the engine and there is limited visibility. There are also multiple environmental impacts. For example, "volcanic winters" occur due to the volcanic ash and gases sometimes reaching the stratosphere, the upper layer in Earth's atmosphere. The Earth's temperature can drop as a result of this volcanic debris's ability to both absorb and reflect incoming solar radiation and outgoing land radiation. This, of course, causes weather patterns to change around the globe causing often widespread crop failure, deadly famine, and disease.

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[16]Salleh, Anna. "Here's What Happens When a Volcano Erupts." *ABC News*, 22 Nov. 2017, www.abc.net.au/news/science/2017-11-22/volcanoes-heres-what-happens-when-they-erupt/8997014

[17]National Geographic. "Human and Environmental Impacts of Volcanic Ash | National Geographic Society." *Education.nationalgeographic.org*, National Geographic, 27 Sept. 2022, education.nationalgeographic.org/resource/human-environmental-impact-volcanic-ash/.

In addition, it can also damage ecosystems. Volcanic ash can accumulate carbon dioxide and fluorine, two gases that are potentially harmful to people. The ensuing ash fall can cause disease in people, crop failure, and animal abnormalities and death. The sharp particles in ash have the potential to cause discomfort and inflammation by scratching the skin and eyes. Volcanic ash can harm the lungs and create respiratory issues if inhaled. Suffocation can occur from breathing in a lot of ash and volcanic gases; the most frequent cause of mortality from a volcano is asphyxia.

Furthermore, volcanic ash is also extremely difficult to clean up due to the tiny size of it - it could enter your car engines or even your phone. It often causes machinery to fail due to the fact that it corrodes everything that it contacts. Thus, it is a very time-consuming and costly procedure which needs communities to make coordinated efforts to be able to safely dispose of the ash. A prime example of managing a volcanic eruption crisis is when Yakima declared a state of emergency. One of the ways they cleaned it was through the donation of maintenance equipment and workers, who were then dispatched throughout the city in a grid pattern. It took seven full days of nonstop work and cost the city $5.4 million; this ash cleanup operation is frequently an efficient and cost-effective example.

Historical Context of Volcanoes and Volcano Disaster Management

Evolution of volcano eruptions

Throughout history, volcanic eruptions have varied in intensity, but they have always been strong forces. The real severity and frequency of these occurrences have stayed largely constant over time, despite the argument of some that increased infrastructure and human population close to volcanoes make eruptions appear more catastrophic. But our understanding of and reaction to volcanic risks have changed dramatically as a result of advances in monitoring and disaster management techniques. Significant eruptions like those of Mount St. Helens in 1980 and Mount Pinatubo in 1991 have acted as wake-up calls, causing risk management plans to be reevaluated and more organised monitoring systems to be established. The importance of community involvement, efficient communication, and real-time data gathering to mitigate the risk of volcanic eruptions becomes more apparent as we keep learning from the past.

Significant volcanic events that shaped current policies

Major volcanic eruptions had a major impact on the development of modern disaster management strategies. The catastrophic eruption of Mount St. Helens in 1980 led to the development of the Volcanic Risk Management System (VRMS) in the United States, which emphasises coordinated monitoring, hazard assessment, and community preparedness[18]. The Volcano Merapi eruption in Indonesia has also had a significant influence on the nation's approach to managing volcanic risk, emphasising the importance of community engagement and education. As we continue, existing policies—like the Sendai Framework for Disaster Risk Reduction—suggest integrated risk management approaches that involve local communities, improve capacity building, and guarantee efficient communication in times of emergency. These frameworks aim to create resilient communities capable of responding to volcanic hazards while minimising the potential for loss of life and property.

Current Volcano Monitoring and Early Warning Systems

A variety of innovative technology and techniques are used in modern volcano monitoring to offer thorough data on volcanic activity. Ground-based techniques provide full understanding into the inner workings of volcanoes. These techniques include seismometer-based seismic monitoring, GPS-based ground deformation measuring, and gas sampling[19]. With the use of satellite remote sensing techniques, such as optical, thermal, and synthetic aperture radar (SAR) sensors, it is possible to map eruptive products, indicate thermal signals and ash clouds, detect ground deformation, and monitor rapid topographic changes at high spatial and temporal resolutions.[20] Differential SAR interferometry (DInSAR), one of the most popular satellite-based methods, enables the centimeter-to-millimeter

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[18] ---. "Development of a Volcanic Risk Management System at Mount St. Helens—1980 to Present." *Bulletin of Volcanology*, vol. 85, no. 10, 8 Sept. 2023, https://doi.org/10.1007/s00445-023-01663-y.

[19] "Monitoring Volcanoes (U.S. National Park Service)." *Www.nps.gov*, 25 Jan. 2018, www.nps.gov/articles/volcano-monitoring.htm.

[20] "The Global Volcano Monitoring Infrastructure Database (GVMID)." *Frontiers*, www.frontiersin.org/journals/earth-science/articles/10.3389/feart.2024.1284889/full

accuracy research of deformation events[21]. For instance, using data from DInSAR and Copernicus Sentinel-1, researchers in Italy have created an operational service for tracking deformation of the crust in active volcanoes like the Campi Flegrei caldera. Another essential tool for researching volcanic phenomena including lava flows, lava domes, and high-temperature fumaroles is thermal remote sensing by satellites like Copernicus Sentinel-2.[22] Moreover, the Philippine Institute of Volcanology and Seismology (PHIVOLCS), which has established a thorough monitoring network that has greatly enhanced evacuation protocols during eruptions, is a prime example of an early warning system that has been successful. For Mount Merapi in particular, Indonesian authorities have improved resilience and response capacities by incorporating community involvement and local knowledge into risk management procedures and by establishing explicit evacuation protocols.[23] A;

Although significant progress has been made in volcano monitoring and early warning systems, challenges persist in terms of funding constraints, technological limitations, and the need for enhanced public awareness. These challenges will be further analysed below.

Challenges in Volcano Disaster Risk Management

Issues such as funding, technological limitations, and public awareness

Risk management for volcanic disasters has many obstacles that prevent efficient planning and response. Lack of sufficient financing is one of the key problems, since it makes it difficult to set up and keep up thorough monitoring systems and early warning systems. Many nations, particularly those with little financial resources, find it difficult to provide adequate funding for managing the risk of volcanic eruptions, which results in outdated machinery and inadequate staff

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[21] "OBSERVER: Copernicus Sentinel Satellites Bring New Insight to Volcano Monitoring | Copernicus." *Www.copernicus.eu*, www.copernicus.eu/en/news/news/observer-copernicus-sentinel-satellites-bring-new-insight-volcano-monitoring.

[22] "OBSERVER: Copernicus Sentinel Satellites Bring New Insight to Volcano Monitoring | Copernicus." *Www.copernicus.eu*, www.copernicus.eu/en/news/news/observer-copernicus-sentinel-satellites-bring-new-insight-volcano-monitoring.

[23] Doocy, Shannon, et al. "The Human Impact of Volcanoes: A Historical Review of Events 1900-2009 and Systematic Literature Review." *PLoS Currents*, 2013, https://doi.org/10.1371/currents.dis.841859091a706efebf8a30f4ed7a1901.

training. [24]Technological constraints might sometimes make it difficult to gather and analyse the crucial data required for precise forecasting.

Difficulty in predicting eruption timing and magnitude.

Predicting the timing and magnitude of eruptions is a critical challenge in managing the risk of volcanic disasters. Although there has been significant progress in understanding the behaviour of volcanoes, short-term forecasting is still a difficult and frequently unpredictable task. The presence of external triggers and rapid rise of magma are two factors that might cause abrupt eruptions and complicate prediction efforts. For example, the 1980 Mount St. Helens eruption showed how sudden changes in geology could cause explosive activity that could surprise people[25]. Moreover, advances in time and location predictions have not kept up with the explosive size of approaching eruptions. Emergency management personnel responsible with creating evacuation plans and response methods may encounter difficulties as a result of this uncertainty. Therefore, it is essential to continue researching and integrating new technologies to improve predictive skills in order to improve the management of volcanic catastrophe risk and protect people from the aforementioned effects of eruptions.[26]

MAJOR COUNTRIES AND ORGANISATIONS INVOLVED

Japan

Japan is an island located on the Pacific's Ring of Fire and is threatened by many types of natural disasters such as earthquakes, tsunamis, floods and volcano eruption; these disasters have happened again and again which has shown the resilience of the Japanese citizens[27]. The cause of multiple volcanic eruptions in Japan is due to the fact that most of its mountains are of volcanic origin. These of course are significant tourist attractions due to

[24] Wilkinson, Emily. "Beyond the Volcanic Crisis: Co-Governance of Risk in Montserrat." *Journal of Applied Volcanology*, vol. 4, no. 1, 24 Jan. 2015, https://doi.org/10.1186/s13617-014-0021-7.

[25] Wright, Heather, et al. "Development of a Volcanic Risk Management System at Mount St. Helens—1980 to Present." *Bulletin of Volcanology*, vol. 85, no. 10, 8 Sept. 2023, https://doi.org/10.1007/s00445-023-01663-y.

[26] Weir, Alana M, et al. "Approaching the Challenge of Multi-Phase, Multi-Hazard Volcanic Impact Assessment through the Lens of Systemic Risk: Application to Taranaki Mounga." *Natural Hazards*, 16 Jan. 2024, https://doi.org/10.1007/s11069-023-06386-z

[27]"Crisis Management." JAPAN Educational Travel, education.jnto.go.jp/en/why-japan/crisis-management/.

their scenic landscapes, hiking trails and hot springs - therefore, even though they cause massive destruction during eruptions they are not completely enclosed. To be able to allow visitors in active volcano zones, the Japan Meteorological Agency (JMA) maintains a 5-level warning system for volcanic activity. In order to do this the JMA installs seismographs and other monitoring equipment around fifty highly active volcanoes. The first level as seen on the graph is a normal level in which visitors should just know that they are approaching an active volcano. Level 2 does not allow entry around the crater whilst in level 3 it is prohibited to climb up the mountain; they are both warning levels. Moving on, level 4 and 5 are both emergency warnings since an eruption is impending. In level 4 nearby residents are prepared to evacuate whilst level 5 calls for an urgent evacuation because the residential area is in danger of an approaching eruption.[28] Another way Japan is reducing the Volcano disaster risk during crises is by collaborating internationally. A prime example is when the United Nations Development Programme (UNDP), which is in charge of implementing development, along with Japan International Cooperation Agency (JICA) and United Nations Office for Disaster Risk Reduction (UNISDR) agreed to work together to strengthen the Sendai Framework for Disaster Risk Reduction.[29]

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[28] "Volcanoes." *Japan-Guide.com*, 22 Oct. 2023, www.japan-guide.com/e/e2327.html#:~:text=The%20Japan%20Meteorological%20Agency%20maintains . Accessed 19 Aug. 2024

[29] "JICA Activities ︱ What We Do - JICA." *Jica.go.jp*, 2015, www.jica.go.jp/english/activities/issues/disaster/activity.html#:~:text=Collaboration%20with%20International%20Partners&text=In%20this%20memorandum%2C%20JICA%20and. Accessed 19 Aug. 2024.

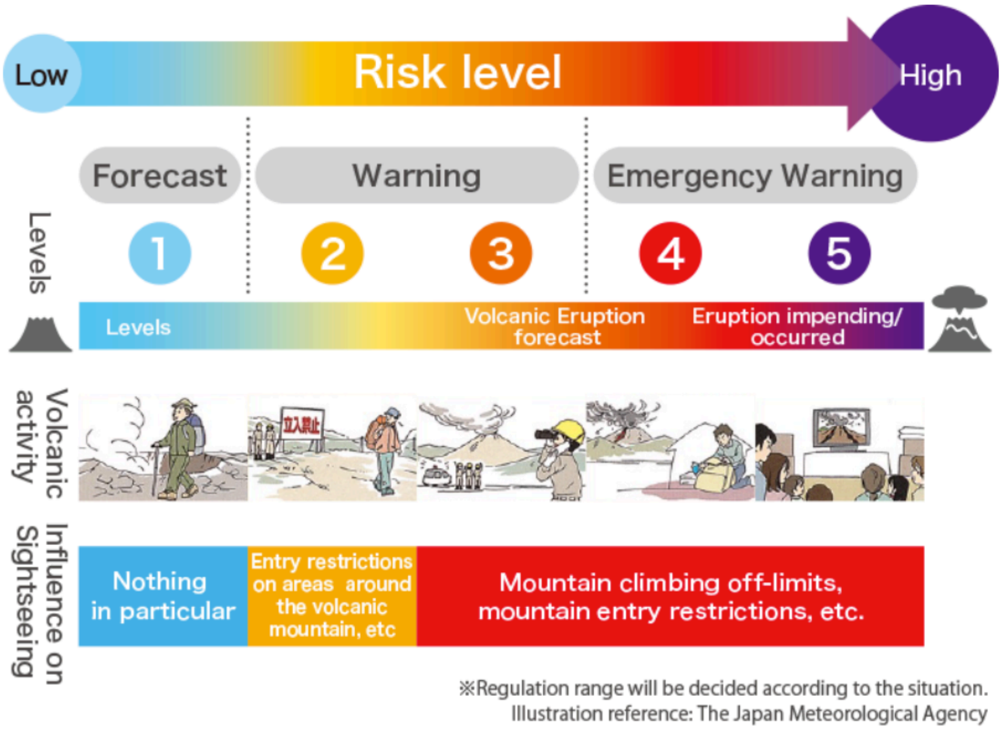

Figure 2 - The 5 warning levels of the JMA for active volcanoes. [30]

United States of America (USA)

There are 169 active volcanoes in the United States. Over half of them have a chance to erupt explosively, shooting ash as high as 20,000 or 30,000 feet, well above the flight path of commercial aircraft. The U.S. Geological Survey (USGS) assesses and monitors hazards at volcanoes within the United States and its territories. The USGS is a leader in volcanic research and monitoring and provides early warnings and risk assessments globally. Furthermore, its mission is to "enhance public safety and minimise social and economic disruption from volcanic unrest and eruption through *their* National Volcano Early Warning System" (NVEWS). [31] NVEWS is a national-scale initiative to ensure that volcanoes are monitored at levels commensurate with their dangers. So as to do that they "combine volcanic hazards (the dangerous or destructive natural phenomena produced by a volcano) and exposure (the people and property at risk from the volcanic phenomena)" to define

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[30] Reserved, Copyright © 2016-2020 Active Gaming Media All Rights. "What to Do during Volcanic Eruptions in Japan | Articles on Izanau." *Izanau | Jobs in Japan Made Simple*, izanau.com/article/view/volcanoes-in-japan.

[31] USGS. "Volcano Hazards | U.S. Geological Survey." *Www.usgs.gov*, www.usgs.gov/programs/VHP.

volcanic threat[32]. Basically, to be able to determine the overall threat, ranking numerical values are assigned to the hazard and exposure factors at individual volcanoes. An overall threat score is generated by all those factors that are individually summed into a hazard and exposure score which are then multiplied. Then, the scores are placed in relative ranking of volcanoes of 5 categories: "Very High and High threat categories requiring the most robust monitoring coverage, a Moderate threat category requiring basic real-time monitoring coverage, and Low and Very Low threat categories requiring lesser degrees of monitoring."[33]

Figure 3 - Volcanic threat potential helps to prioritize monitoring.

International Federation of Red Cross and Red Crescent Societies (IFRC)

The IFRC, the world's largest humanitarian network, was founded on May 15th 1919. More than 16 million volunteers are brought together for the good of humanity, to support the local Red Cross and Red Crescent action in more than 191 countries.[34] To begin with, it provides humanitarian aid and supports disaster preparedness programs. Some of their most significant work is done through disaster preparedness; it helps National Societies maintain a state of continuous improvement in their local response and readiness, thus minimising and mitigating the effects of disasters on communities. In order to do this, they use Preparedness for Effective Response (PER), which is their "cyclical approach designed to help analyse

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[32] "National Volcano Early Warning System - Monitoring Volcanoes according to Their Threat | U.S. Geological Survey." *Usgs.gov*, 5 Oct. 2021, www.usgs.gov/programs/VHP/national-volcano-early-warning-system-monitoring-volcanoes-according-their-threat#:~:text=About- . Accessed 13 Aug. 2024.

[33] "National Volcano Early Warning System - Monitoring Volcanoes according to Their Threat | U.S. Geological Survey." *Usgs.gov*, 5 Oct. 2021, www.usgs.gov/programs/VHP/national-volcano-early-warning-system-monitoring-volcanoes-according-their-threat#:~:text=About- . Accessed 13 Aug. 2024.

[34] IFRC. "About the IFRC | IFRC." *Www.ifrc.org*, 2024, www.ifrc.org/who-we-are/about-ifrc.

capacities, strengths and weaknesses within a National Society's response system"[35]. Simultaneously they focus on educating the world about PER and its importance through leaflets and case studies. Moving on, they also have a Disaster Response Emergency Fund (DREF) which allows fast and efficient funding directly to local humanitarian participants - both before and after a crisis hits.[36] The fact that it has evolved to include support for anticipatory action allows them to respond even more effectively to different crises thereby mitigating all the effects such as suffering and the saving of livelihoods. Furthermore, they also educate the population about crises such as volcano eruptions through their website, in which they explain how to prepare for it through videos, pictures, documents and condensed information.[37] Additionally the IFRC works with communities to build community resilience through a demand driven, people-centred approach. The IFRC teaches communities through volunteers on how to be resilient at times of disaster crisis and how their decisions might impact their futures; they not only focus on adults but also children since they are the generations who will be impacted mostly by disasters.

TIMELINE OF EVENTS

Date	**Description of Event**
May 15 1919	The IFRC was founded
1980	Eruption of Mount St. Helens and its impact on disaster management policies
1991	Eruption of Mount Pinatubo and the international response
1991	Eruption of Mount Pinatubo and the international response
2005	Hyogo Framework for Action
2010	Eruption of Eyjafjallajökull and its effect on European air traffic
2010	European Union's Volcanic Ash Crisis Coordination (2010)
2012	UN General Assembly Resolution 66/288 was adopted

[35]"Disaster Preparedness | IFRC." *Www.ifrc.org*, www.ifrc.org/our-work/disasters-climate-and-crises/disaster-preparedness.
[36]"Just a Moment..." *Just a Moment..*, www.ifrc.org/happening-now/emergency-appeals/ifrc-disaster-response-emergency-fund
[37]"Volcanic Eruptions | IFRC." *Www.ifrc.org*, www.ifrc.org/our-work/disasters-climate-and-crises/what-disaster/volcanic-eruptions.

2015	UN General Assembly Resolution 69/283 was adopted
June 2019	UNDRR's Global Assessment Report on Disaster Risk Reduction was published
2021	Eruption of La Soufrière and the evacuation strategies implemented

UN INVOLVEMENT: RELEVANT RESOLUTIONS, TREATIES AND EVENTS

UN General Assembly Resolution 69/283 (2015)[38]

The UN General Assembly Resolution 69/283 was adopted on June 3rd 2015. The Sendai Framework aims to significantly reduce disaster risks, including those posed by volcanic eruptions. In order to mitigate the effects of such disasters, this resolution calls for improved emergency preparedness, risk assessment, and response measures. It also highlights the necessity of a comprehensive approach to disaster risk management.[39] The adoption of this resolution has caused international cooperation as well as an increase in expertise in the risk management of volcanic disasters. Furthermore, it encourages countries to implement integrated approaches to disaster risk reduction, which have improved readiness contributing to the saving of lives and the minimisation of financial damage during volcanic crises. The Sendai Framework has increased vulnerability against volcanic disasters by promoting international cooperation and exchanging efficient methods; nevertheless, difficulties still exist in completely addressing the crisis of such threats in each country they occur in.[40]

UNDRR's Global Assessment Report on Disaster Risk Reduction (2019)[41]

The UN Global Assessment Report on Disaster Risk Reduction (GAR) is the flagship report of the United Nations on worldwide efforts to reduce disaster risk. The GAR is published by the UNDRR, and is the product of the contributions of nations, public and

[38] Annex I Sendai Declaration. 2015, www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_69_283.pdf

[39] "Sendai Framework for Disaster Risk Reduction 2015-2030 | Toolkit." *Cepal.org*, 2015, igualdad.cepal.org/en/digital-library/sendai-framework-disaster-risk-reduction-2015-2030. Accessed 16 Aug. 2024.

[40] "Chapter 1: How We Got to Now | GAR." *Undrr.org*, 2019, gar.undrr.org/chapters/chapter-1-how-we-got-now.html. Accessed 16 Aug. 2024.

[41] "Global Assessment Report on Disaster Risk Reduction 2019." *Www.undrr.org*, 2019,www.undrr.org/publication/global-assessment-report-disaster-risk-reduction-2019 .

private disaster risk-related science and research, amongst others.[42] The report highlights that in order to fully understand volcanic activity, robust monitoring systems and historical data analysis are necessary to be able to provide immediate responses.[43] Some examples of effective management strategies presented in this report include integrating scientific knowledge with community preparedness; this ensures that local populations are well equipped and aware to act during volcanic events. In addition, the GAR emphasises that although there has been progress, there are still major obstacles to overcome, specifically in low-income nations that are overwhelmingly affected by volcanic activity.

PREVIOUS ATTEMPTS TO SOLVE THE ISSUE

Hyogo Framework for Action (HFA) (2005-2015) [44]

The HFA was a significant international strategy aimed at enhancing disaster risk management, including volcanic hazards. It was adopted by 168 United Nations member states and emphasised the need for a methodical strategy to reduce vulnerabilities and increase resilience in communities and countries that are subject to disasters. Understanding hazards, improving preparedness and response skills, and making disaster risk reduction a national and community priority were among the five action goals it listed.[45] The framework particularly promoted community involvement and the development of early warning systems, both of which are essential during volcanic emergencies. Although the HFA established the foundation for better disaster management procedures, its ability to address problems associated with volcanic risk differed by location and was mostly dependent on local commitment and implementation. Overall, the HFA's principles have raised public awareness of the hazards associated with disasters and encouraged teamwork in the attempt

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[42] "Global Assessment Report on Disaster Risk Reduction (GAR)." *Www.undrr.org*, 12 July 2021, www.undrr.org/gar.

[43] Global Assessment Report on Disaster Risk Reduction (GAR) | GAR, gar.undrr.org/sites/default/files/chapter/2019-06/chapter_3.pdf

[44] "Hyogo Framework of Action." *Www.preventionweb.net*, 14 June 2021, www.preventionweb.net/sendai-framework/Hyogo-Framework-for-Action#:~:text=Hyogo%20Framework%20for%20Action.

[45] "Hyogo Framework for Action | Disaster Management Manual - PIARC." *Piarc.org*, 2015, disaster-management.piarc.org/en/management-disaster-reduction-framework/hyogo-framework-action.

to increase resilience; nevertheless, there are still obstacles to overcome before completely incorporating these practices into local and national policies.[46]

European Union's Volcanic Ash Crisis Coordination

In April 2010 the Eyjafjallajökull erupted, an Icelandic volcano, which sent a plume of volcanic ash over 9 kilometres into the sky. This small eruption caused a massive impact since Europe experienced air travel chaos for almost one month. The ash plume that spread around the world contained large amounts of microscopic particles of hard volcanic rock; this was discovered by scientists from the National Centre for Atmospheric Science, which worked closely with the Civil Aviation Authority and the Met Office to track the plume and its contents using scientific instruments fitted to two research aircraft, alongside a series of computer models.[47] This research showed that the plume could cause serious damage to any aircraft flying through so they stopped commercial airlines from flying in the areas which were affected by it. Since that volcano eruption the EU have responded differently to other Volcanic Ash Crisis. For example, the situation for the Grimsvötn volcano has been very different; this is due to the more precise risk assessment procedures that have been put in place in Europe – allowing for a much more graduated response and minimising closure of European airspace. In the first three days of the Eyjafjallajökull crisis, the number of flights that were cancelled was 42,600[48]. This is a very large number compared to the 900 flights cancelled for the first three days of the Grimsvötn crisis. Some of the changes that the EU conducted are the creation of a new EU aviation crisis cell, to manage a crisis in real time and the new European guidelines for managing volcanic ash.[49]

POSSIBLE SOLUTIONS

Enhancing Early Warning Systems

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[46] UNDRR. "Hyogo Framework for Action." *Www.preventionweb.net*, www.preventionweb.net/sendai-framework/Hyogo-Framework-for-Action.

[47] National Centre for Atmospheric Science. "Eyjafjallajökull 2010: How an Icelandic Volcano Eruption Closed European Skies." NCAS, 19 June 2020, ncas.ac.uk/eyjafjallajokull-2010-how-an-icelandic-volcano-eruption-closed-european-skies/#:~:text=Ten%20years%20ago%20the%20Icelandic.

[48] "Press Corner." *European Commission - European Commission*, ec.europa.eu/commission/presscorner/detail/en/MEMO_11_346.

[49] "Press Corner." *European Commission - European Commission*, ec.europa.eu/commission/presscorner/detail/en/MEMO_11_346.

In order to effectively manage the volcano disaster risk during a crisis, significant investment in advanced monitoring technologies is required. For example, real-time data analysis-based early warning systems have the ability to detect volcanic activity before it intensifies, giving time for evacuation and other preventative measures which could prevent the loss of lives. To properly adhere to changes in volcanic activity, these systems should be equipped with the newest geophysical and geochemical monitoring tools, satellite imaging, and ground-based sensors. In addition, a new change could be to integrate artificial intelligence and machine learning into these systems as it could improve predictive models, enabling more accurate forecasts and timely warnings. Effective early warning requires not only the use of technology but also the providing of information to individuals who are at danger, causing for the establishment of effective networks of communication between local communities and monitoring agencies.

Community-Based Disaster Preparedness Programs

As mentioned above, empowering local communities through education and training is a crucial step into having effective volcano disaster risk management. Community-based disaster preparedness programs should be adapted to the specific risks faced by those living near volcanic regions; so depending on the area and volcanic activity predicted programmes should be changed. These programs can include training sessions on how to respond to volcanic alerts, evacuation drills, and the distribution of emergency kits. Implementing volcano-related topics in school curriculums is also vital, ensuring that children and youth grow up with the knowledge and skills needed to protect themselves during a volcanic crisis. The loss of lives and large injuries can be prevented by reducing stress and panic during these crises; this can be done through awareness.

International Cooperation and Resource Sharing

Cooperation among nations is essential to improving the ability to handle volcanic disasters. Enhancing collaborations among countries and international organisations enables the sharing of skills, resources, and effective approaches. For example, cooperation is the possible alliance between Japan and CARICOM, or the Caribbean Community. Japan offers modern volcano monitoring technologies, disaster management expertise, and experience in creating strong infrastructure to CARICOM member states, which are often vulnerable to volcanic activity. This collaboration might include cooperative research projects, technological transfer, and attempts to increase infrastructure with the goal of reducing the effects of volcanic eruptions in the Caribbean.

Development of Resilient Infrastructure

An aforementioned factor of the extent of damage caused due to volcanic eruptions is the strength of infrastructure. Thus, constructing durable infrastructure is a proactive way to reduce the harm that volcanic eruptions may cause. In volcanic zones, infrastructure needs to be built to withstand pyroclastic flows, lahars, ashfall, and lava flows. This involves building secure escape routes and shelters in addition to strengthening roads, buildings, and bridges to withstand the pressures of an eruption. In addition, research on the economical and sustainable usage of volcanic materials for construction can be conducted. Investing in resilient infrastructure enhances the overall resilience of impacted communities by safeguarding people and property as well as ensuring the provision of necessary services both during and after a volcanic disaster.

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