

Commentary



Volcanic and limnic eruption: a potential threat to one health

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Volcanic and limnic eruption: a potential threat to one health

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Abstract

Nyiragongo volcanic eruption can cause a limnic eruption, which is a lesser-known disaster. The Nyiragongo volcano can stream into Lake Kivu and boil the water, resulting in a CH₄ explosion and CO₂ emission into the external environment. This potential overturn of Lake Kivu might result in multitudinous adverse effects. It would be a tragedy because residents of the lake basin would asphyxiate due to rising CO₂ concentration in the atmosphere. Therefore, it is critical to inform and educate the population regarding the danger and the appropriate behaviour if the emergency matters. Implementing mechanisms to extract and reduce CO₂ would significantly prevent the catastrophe and sustain the population. There is equally a need to strengthen Lake Kivu protection and monitoring measures and regulate human activities. We advocate for a multifaceted one health approach to establishing resilient prevention and preparedness mechanisms. This article aimed

to discuss the possible effects of the Nyiragongo volcanic eruption on Lake Kivu and how they might affect One Health, providing valuable and necessary information for public health practitioners and policymakers to consider.

Commentary

Democratic Republic of the Congo (DRC) has been riven by armed groups that took millions for decades. DRC's health security has not been dwindled by only armed conflicts. Other disasters related to climate change have caused significant casualties, with the most common being epidemics, floods, storms, volcanoes and landslides. The heavy equatorial rain in locations within the River Congo Basin results in flooding, landslides, and erosion. A recent landslide of July 20, 2020 in eastern DRC, South Kivu Province, has taken at least the life of 8 people. Democratic Republic of the Congo has six volcanoes (Karisimbi, May-ya-moto, Nyamuragira, Nyiragongo, Tshibinda, and Visoke) [1], amongst which two (Nyamuragira and Nyiragongo) are the ones of the most active globally, with one being a subject of concern. An active Nyiragongo volcano is situated near Lake Kivu at around 12Km [2] and the Congolese-Rwandese shoreline within the Western branch of the eastern African Rift Valley. Nyiragongo volcanic eruptions are notorious lava flows that stream into the city without sparing anything in its way. The havocs secondary to Nyiragongo volcanic eruption are multitudinous and could extend to Lake Kivu, which in turn could potentially cause unimaginable adverse effects in Goma. The potential danger of Lake Kivu on the community secondary to Nyiragongo volcanic activity is nonetheless not fully documented, much less the appropriate intervention. It is essential to understand the disaster in order to advise appropriate health policies. This article aimed to discuss the potential effects of the Nyiragongo volcanic eruption on Lake Kivu and how these affect the health of the community and one health, hoping to provide helpful evidence for implications for practice to enable advocacy and change.

Nyiragongo eruption's direct effects on the community have been described. Further, volcanic activity has been linked to the cholera outbreaks in the surrounding area [3]. Its influence on the Kivu's physicochemical properties makes bacillus resistant in the water, resulting in cholera for the community that consumes the water and fishes from Lake Kivu [3]. Under these circumstances, the Nyiragongo eruption impacted maritime health, negatively impacting residents' food and health security in Goma, eastern DRC. Lake Kivu is composed of a high concentration of carbon dioxide (CO₂) and Methane (CH₄) [4]. The association of the lake's geochemistry and factors that include landslide, earthquake, excess in gas or a very high temperature and, most importantly, an active volcano can be potentially harmful to the maritime health and surrounding communities. They can cause the dissolution of the accumulated gas in the lake and release the lethal gas at the end. Nyiragongo volcano has a shield volcano via a fissural and phreatomagmatic eruption that can flow beneath surfaces into Lake Kivu. The rivers of lava spewed into the lake, or seism activity that often follows volcanic eruption, can trigger a limnic explosion in the lake, meeting the same fate as Nyos Lake, which caused massive destruction in Cameroon on 21 August 1986 [5]. It has been proved the Nyos incident was caused by a CO₂ explosion, which resulted in CO₂ levels rise. Currently, the normal CO₂ level in the atmosphere is 0.041%. If the air contains 5% CO₂, it will extinguish candles or car engines, while 10% will cause hyperventilation and coma. Gasping and death are well-understood consequences of a 30% CO₂ concentration [6]. It is worth note that even a slight percentage increase of CO₂ in the air for an extended period can also cause deaths [7]. Hence, if sufficient lava streams to heat the water at the bottom of Lake Kivu, they would cause CH₄ explosion and CO₂ release in the surrounding atmosphere. This would result in staggering tragedy as inhabitants in the Lake basin would significantly suffocate because of high CO₂ concentration [8]. Needless to say, maritime health

in the waters of Lake Kivu, which hosts around 28 fish species [9], would be exterminated. Lake Kivu is surrounded by about two million people, amongst whom some owe their life to fishing. It is clear that they would be directly affected by anything that affects Lake Kivu. Rwanda has stepped a step forward in extracting methane from Lake Kivu in its project called 'KivuWatt'. Gas-laden is currently being removed, allowing the separation between methane and CO₂, minimising the potential hazard, boosting the country's economy, and providing electricity. However, the experts reported that the extracted methane quantity is far less to prevent the danger, and the extraction exempts CO₂ [10]. Interestingly, scientists insist that havoc from the potential Kivu limnic outbreak could be much more unfathomable than the Nyos disaster. Lake Kivu has remarkable characteristics that explain the possible worse outcomes compared to Nyos (Table 1).

Governance and mitigation policy: “prevention is better than cure.” Ignoring such a potential threat can result in wiping out the entire human and animal society in Goma. As such, implementing mitigation measures at the earliest opportunity is exigent. First, there is a need to educate the population on the appropriate behaviours during disasters. It is crucial to teach the fishers and the people nearby how to recognize a possible limnic eruption. Prodromal signs such as strange odour (like “rotten eggs”) and a cloud-like white-translucent colour, as well as hot lake water, have been reported by Nyos survivors [5] as precursors for limnic eruption. People on the shorelines of the lake should know that it is required to leave towards a higher area immediately before the limnic outburst occurs while holding their breath to avoid deadly CO₂ inhalation. However, it would be challenging for most people to comply with emergency guidelines as the city's transport system is a known issue. The 22 May 2021 Nyiragongo volcanic eruption revealed the disparities in emergencies evacuation. Further, CO₂ must be extracted from Lake Kivu. For instance, the gas can be released by using a pipe from deep in the Lake

as it can give a quick CO₂ gas dispersion in the air without adverse effects. This technique might be the cheapest and can serve low resource countries. Although expensive, gas can also be drained by digging down and creating a channel into the Lake's bed or neutralizing the gas by depositing a colossal quantity of lime into the Lake [6]. The concerned parts should discuss the appropriate method to extract CO₂. Another possibility would be to evacuate people. Such measures are vital as they can dampen the risks. They can protect not only human beings but also maritime health will benefit from any effort targeting the reduction of the lethal gas. Similarly, it is critical to monitor the potential trigger-Nyiragongo volcanic eruption. If there is an appropriate volcanic eruption monitoring, people would be warned early and prepare themselves conveniently. Notably, there is a need to set mechanisms aiming to monitor the gas in Kivu. Observation of CO₂ levels is an essential tool to document a possible abnormal increase and prevent the worst. This measure was applied in Cameron. After the tragedy of 1986, an automatic observation buoy was installed in Lake Nyos to report gas rise. Interestingly, that installation is connected to the satellite as an effective way to protect the population on the one hand. On the other hand, it provides accurate data to researchers, useful for scientific discussion. This approach to monitoring the potentially harmful Lake overturn is recommendable to lake Kivu-there must be an effective way to monitor the gas in the lake. The connection of Nyiragongo volcanic eruption, Lake Kivu, fishes, CO₂ in the space and human health is a typical example of one health. We advocate for a whole dimension approach to set a healthy, resilient mechanism of prevention and preparedness. Further coordinated global research is needed to provide more evidence and recommendations.

Conclusion

Nyiragongo volcanic eruption has caused multiple adverse effects among people. The blast, which has caused human loss, materials loss, and an exodus

of thousands, can cause staggering havoc to nearby water health-lake Kivu. The lava lake can spew into Lake Kivu, thus causing the explosion of CH₄ and CO₂, which would result in the Limnic eruption. Notably, health in water will be significantly affected. In addition, people and animals in the shores of the lake would suffocate due to high levels of CO₂. There is an urgency to implement preventive mechanisms towards a sustainable solution. Gas in Lake Kivu must be regularly monitored to prevent before the worst occurs.

Competing interests

The authors declare no competing interests.

Authors' contributions

Emery Manirambona, Don Eliseo Lucero-Prisno: conception of the study. EM designed the study, collected, analysed, and interpreted data, literature review and wrote original final draft. Yusuff Adebayo Adebisi and Don Eliseo Lucero-Prisno participated in formal writing, revised the manuscript critically for important intellectual content and approved the final version to be published. All authors read and approved the final manuscript.

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Table

Table 1: comparison between Lakes Nyos and Kivu

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Table 1: comparison between Lakes Nyos and Kivu

Lake	Nyos	Kivu
Depth (max)	210 m ^a	475 m ^b
Length	1.6 Km ^a	90 Km ^b
Width	1.2 Km ^c	50 Km ^b
Total area	1.58 km ^{2c}	2,700 km ^{2b}
Carbone dioxide (CO ₂)	100,000,000-300,000,000 m ³ (exploded during disaster) ^d	55 billion m ³ (current estimations) ^b
Magma under Lake	Yes	Yes
Limnic eruption	Yes	Potential
Volcanic area	Yes	Yes
Tropical climate	Yes	Yes
Surrounding population	1,4000 (at time of eruption) ^a	>2 million (todate) ^a

^aThe African lake with explosive power, BBC, 2020 ^aLake Kivu - Democratic Republic of the Congo, Rwanda, Global Nature Fund, 2021 ^aLake Nyos, Wikipedia, 2021 ^aLake Nyos Disaster, World Atlas, 2021