



War Displaced Persons Facing the Risks Associated with Mazuku In and Around the Goma City

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ABSTRACT

The town of Goma, located to the north of Lake Kivu and to the south of our two active volcanoes, Nyiragongo and Nyamulagira, is criss-crossed by fractures stretching out to around 15 km, emitting volcanic gases including carbon dioxide (CO₂), known locally as mazuku. The word "mazuku" means "evil wind" in the local language. It refers to depressions where carbon dioxide, heavier than air, is released and accumulates in lethal concentrations. Mazuku are abundant in the city of Goma, in the Kyeshero and Lac-Vert districts on the one hand, and in the Kamuronzza group on the other, mainly in the town of Sake, and the localities of Mubambiro and Nzulo on the north shore of Lake Kivu, close to networks of fissures. Generally speaking, the depressions that allow CO₂ to accumulate are created by the superposition of lava flows or collapsed cavities, or are directly associated with open fractures. The repeated wars in the eastern part of our country are forcing internally displaced populations to occupy high-risk areas, i.e. areas where mazuku are concentrated, resulting in the loss of human lives. Hardly a year goes by without the death of people, wild and domestic animals. The mazuku are currently an unparalleled natural hazard and the most significant in terms of loss of human life in the city of Goma and the surrounding area, which gives us a particular motivation to carry out research, to identify, map and monitor the mazuku more systematically in the Bulengo and Nzulo camps for displaced people, and to implement appropriate risk management.

Key words: Concentration, mazuku, risk, Goma, carbon dioxide, asphyxiation.

1. INTRODUCTION

Areas of high CO₂ concentration stretch from the town of Gisenyi in the Rwandan Republic to the town of Sake in Masisi Territory, around 27 km from the town of Goma on the northern shore of Lake Kivu. Mazuku are also found in localities further north in the vicinity of the Nyiragongo and Nyamulagira volcanoes. Although mazuku are found in the centre of Goma, they are more concentrated in the Kyeshero and Lac Vert neighbourhoods, and in the Sake housing estate to the west of the city (M.M. Kasereka et al. 2017). As mentioned, unfortunately, this is where the war-displaced populations have settled, unaware of any knowledge about the Mazuku and their dangers, which means that they are exposed and become victims. However, our study deals with the danger or risk of the Mazuku, a permanent danger for our displaced compatriots from Masisi and Rutshuru who have settled in the Bulengo sites and in the locality of Nzulo. In the Goma region, the local population is in the habit of calling them mazuku. Literally, mazukus means "evil winds" and refers to "gases that travel and kill people and/or animals" at night (Tuttle et al., 1990). Well-developed green grass is alternated by the absence of vegetation where the highest levels of CO₂ measured come from. We therefore expect fluctuations in the atmosphere, pressure and other climatic conditions (precipitation, winds, outside temperature) to control the level of CO₂ accumulation. Previous research has shown that the concentration of carbon dioxide in the open fractures of the recent Nyiragongo eruptions varies with volcanic activity and the occurrence of a major earthquake; but in the mazukus, there is almost no relationship between CO₂ content and volcanic activity. The north shore of Lake Kivu remains an area rich in carbon dioxide, the mazuku found on ancient fractures, most of which were located on flows that had oriented in a north-south direction (M. Yalire et al.2022).

Over the past few years, people, mainly the elderly and children, have died from Mazuku asphyxiation in several districts of Goma, including the Lac Vert district. Measurements of soil gas in and around the Bulengo and Nzulo camps for displaced persons have told us a great deal about the reasons for the deaths of a dozen of our compatriots who fled the new war of aggression that the DR Congo has been waging for nearly three years in Masisi and Rutshuru. The relatively thin layer of soil has developed in the lava where most of the mazuku are located. Possible lava flows favour the accumulation of cold CO₂-rich gas in closed depressions, forming small pools of gas when they emerge at the surface. Animals such as goats, birds, insects and reptiles are commonly found dead in these depressions.

Mazuku ('evil wind' or 'evil places' in the local dialect) are CO₂-rich and oxygen-poor places where people die of asphyxiation. The priority of our study is to

prevent risks in areas inhabited by new war-displaced occupants. Local populations also remain at risk because most of their daily activities take place in areas with high concentrations of mazuku.

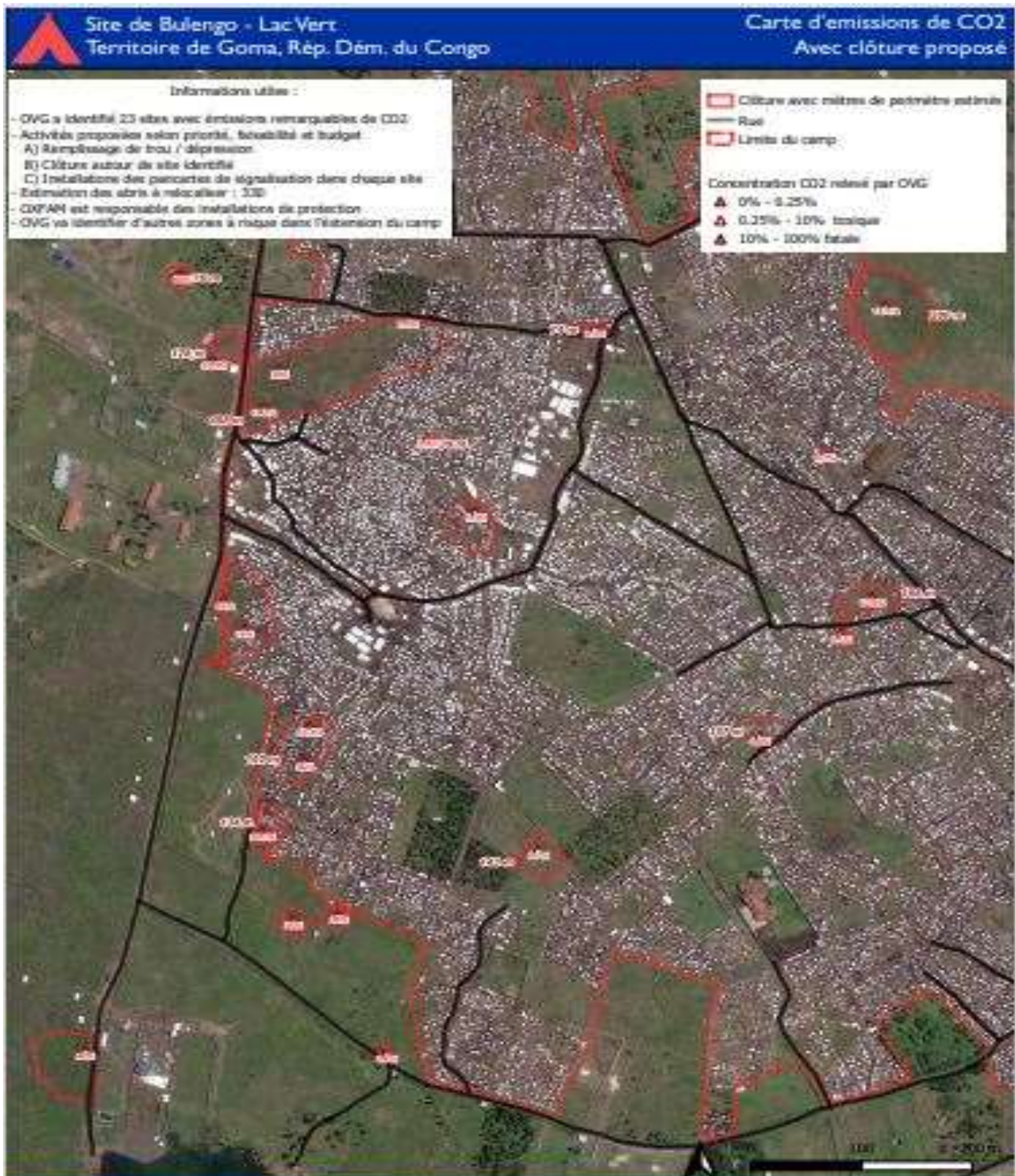


Figure 1: Location and boundaries of the Bulengo IDP camp.



Figure 2: CO levels₂ in the Bulengo camp for displaced persons

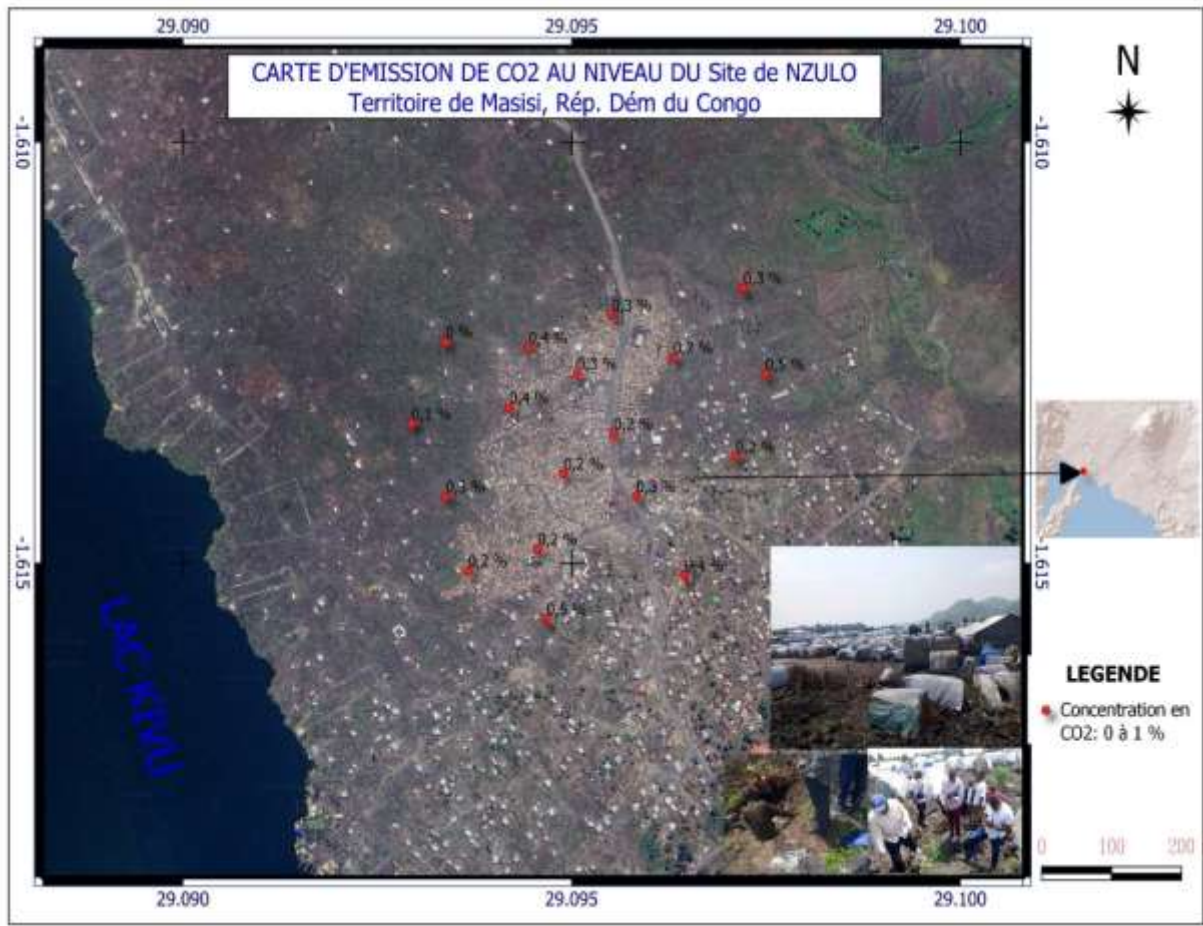


Figure 3: CO levels₂ in the Nzulo IDP camp.

2. MATERIALS AND METHODS USED

To find out what is happening in our study area and to help us understand the concentrations of CO₂ in the mazuku, we used the Geotech GA5000, a portable gas analyser that measures the main gases CH₄, CO₂, O₂, H₂S and CO. It is very easy to use, with a colour screen and intuitive menus, good measurement accuracy, neat ergonomics and low weight. It comes ready to use with a calibration certificate, sample tube, humidity filter, battery charger and rugged carrying case. As standard, it measures three gases: CH₄, CO₂ (with 0 - 100% measurement range for both) and O₂ (0 - 25% measurement range). As an option, additional gases can be measured. It's easy to handle and calibrate, benefiting from our industry-leading reliability and helping us to standardise monitoring routines, while supporting compliance with environmental legislation. The Garmin Oregon 750 handheld GPS has been useful in taking the geographical coordinates of all the sampling points visited in the IDP camps (Bulengo and Nzulo) in order to produce better and more accurate mapping.

3. RESULTS AND DISCUSSION

All the carbon dioxide measurements carried out in the Bulengo and Nzulo IDP camps have revealed the level of danger posed by the Mazuku to the war-displaced IDPs in Bulengo and Nzulo. The first wave of IDPs in Bulengo settled in the third week of the first month and in Nzulo at the beginning of the second month of 2023, fleeing the clashes between the loyalist army and the rebels in the Masisi and Rutshuru territories. The Bulengo IDP camp stretches along four avenues in the Lac-Vert district, including Katwa, Lushagala, Burungu and Mabanga (Fig. 1 & Chef de Quartier Lac-Vert). From our graphs below, supported by the maps, for the Bulengo camp for displaced persons, you will notice that the concentrations of carbon dioxide are very high at point 1 with 68% of volume, point 14 with 40% of volume, point 15 with 35% of volume, point 16 with 36% of volume and point 17 with 25.1%, above the legal threshold. Figure 2 provides ample proof that the concentrations of carbon dioxide in the mazuku in and around the Bulengo IDP camp are lethal, and that the victims will continue to be counted from one moment to the next, given the daily movements of new IDPs. The Nzulo camp for internally displaced persons does not present any risk at present, as the highest concentration of carbon dioxide is 0.7%, slightly lower than the 15% considered to be the lethal threshold (Fig. 3).

The number of displaced persons who died in the mazuku at the Bulengo camp in 2023 is shown below

Month	Deaths	Percentage
January	0	0
February	3	23.07
March	0	0
April	3	23.07
May	0	0
June	0	0
July	0	0
August	1	7.69
September	2	15.38
October	0	0
November	0	0
December	4	30.76
Total	13	100

The table above shows that around ten people died from asphyxiation in mazuku. The month of December 2023 recorded more deaths than any other during the period in which we were conducting our research, with four people victimised, giving a percentage of 30.76. The deaths recorded are proof of the high concentrations of CO₂ in Mazuku. Aside from these deaths, field investigations revealed that some victims had their lives saved after fainting and were rushed to health facilities for appropriate treatment and resuscitation.

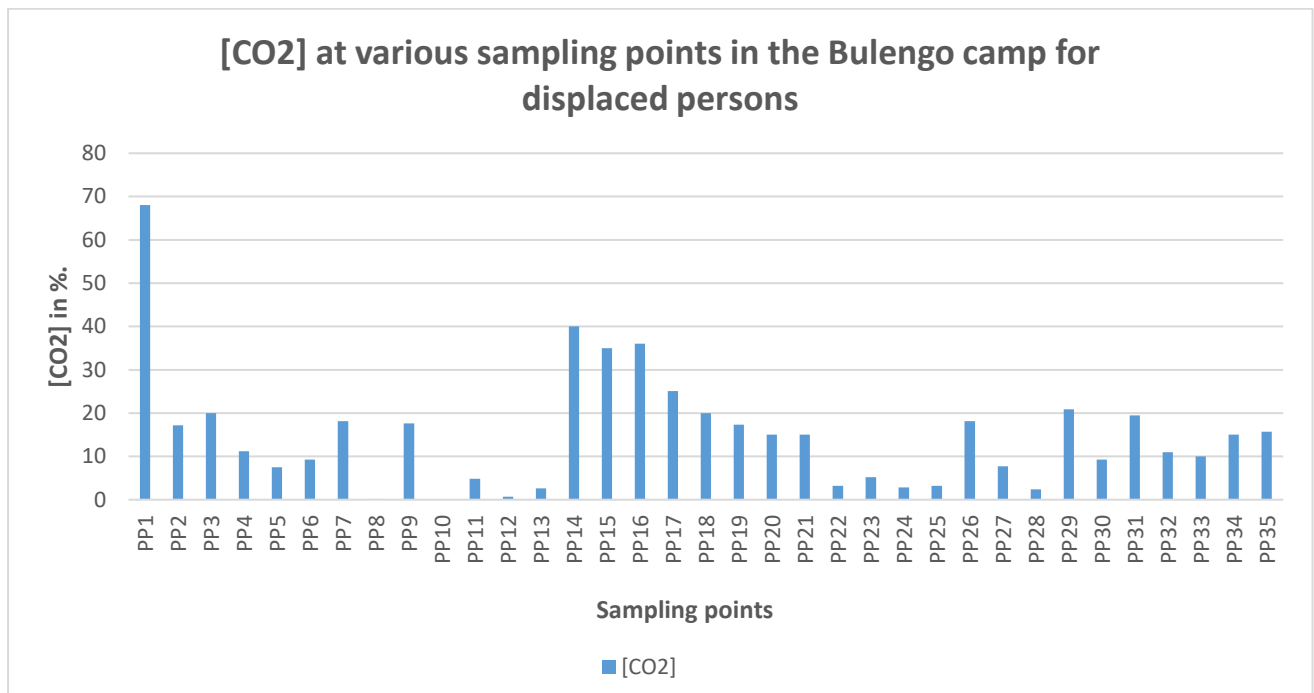


Fig.4 : CO₂ evolution in the Bulengo IDP camp

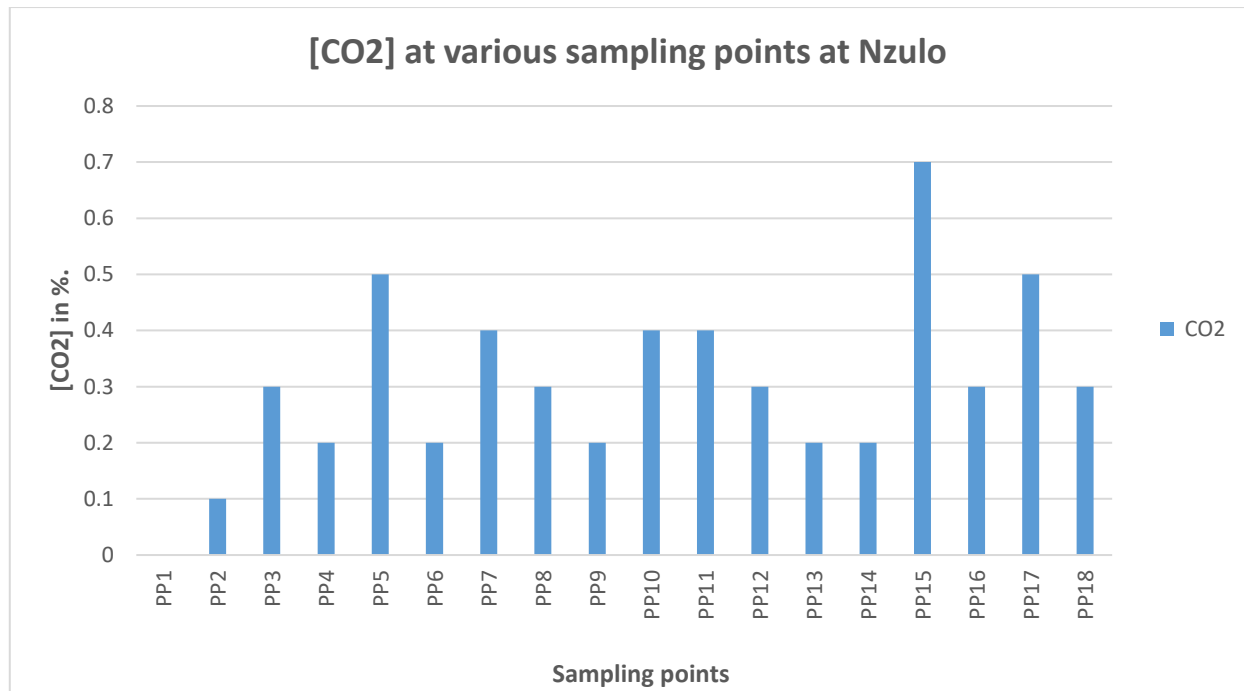


Fig.5 : Changes in CO2 concentration in the Nzulo IDP camp

4. CONCLUSION

Throughout our study, we assessed the risks associated with carbon dioxide in the Mazuku for IDPs in the city of Goma and the surrounding area. Mazuku remain an imminent danger to the lives of our compatriots displaced by war, particularly in Bulengo and Nzulo (Fig. 4). Over the past year, a total of 13 war-displaced people have died in the Bulengo camp, west of the city of Goma, after being asphyxiated, some in the early hours of the morning and others in the evening. The work to identify the points most harmful to carbon dioxide in and around these two camps, including Bulengo (Figs. 1 & 2) and Nzulo (Fig. 3), was successfully completed. Recommendations were made to the Congolese government and its national and international humanitarian partners to relocate the displaced persons camp to places deemed viable, or to put up warning signs in all the places identified as dangerous in order to limit the increase in the number of victims and save as many as possible. One death in the mazuku is too many for the whole of Congolese humanity. However, it is possible for the political and administrative authorities, through the Ministry of the Interior and Security, to take this situation in hand in order to save the lives of the displaced people in the Lac-Vert district of Bulengo before peace returns to their respective places of origin. The Goma Volcano Observatory and its government partners should consider a campaign to measure CO2 levels in the western part of the city of Goma, in order to draw up a new map of all the areas containing high concentrations of carbon dioxide. They should also set up teams to raise awareness, provide information and educate people about the risks associated with mazuku, as other deaths will be recorded in the city of Goma in the future if, and only if, other measures are not taken.

5. REFERENCES

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