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Lava flow hazard map and mitigation from artificial barriers at Nyiragongo volcano through numerical simulations of lava flow paths

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On January 17^{th}, 2002, Mount Nyiragongo, in the Democratic Republic of Congo, erupted producing the most relevant case of lava flow impact with a large town ever. Major lava flows on the south flank of the volcano originated along a fissure system extending about 12.5 km from the volcano to the south. Lava flows entered the town of Goma and devastated a significant portion of it, leaving more than 50,000 homeless and forcing the spontaneous exodus of nearly all of the population mainly into neighbouring Rwanda. The lava flows and fractures from the January 2002 eruption were mapped through field surveys and analysis of many satellite images. The simulation of lava flow paths were performed by the Downflow code (Favalli et al., 2006, doi: 10.1029/2004JB003527) using both a DEM obtained by a 1:10,000 topographic map of Goma and the SRTM DEM. The simulation code is based on the steepest descent path assumption, with spreading of lava flow front and obstacle overcoming accounted for through stochastic variations of the topography. The simulated paths very well reproduce the real 2002 lava flow paths. A lava flow hazard map was produced by simulating over 50,000 possible lava flow paths, after having divided the volcanic area into regions with different probability of vent opening. The town of Goma was found to be characterized by two high hazard areas corresponding to the two lava flows which devastated the town in 2002. The town of Gisenyi, in the Rwandan territory, was also found to be characterized by significant hazard by lava flows. A systematic study of the mitigating effects of the construction of artificial barriers to protect the two towns was performed by modifying the SRTM DEM to simulate the presence of such barriers. It has been found that depending on the size, shape and orientation of the barriers, their protective effects can be optimized, and that the local probability of lava flow invasion

in town can be reduced from 10-20% to negligible values. The area characterized by maximum lava flow hazard, in correspondence of the Goma international airport, can not however be protected due to the peculiar characteristics of the morphology of the terrain.