

## **Glacier Hazard: the case of secondary lahars in Yambo Rumi ravine at Chimborazo volcano (Ecuador)**

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Tropical glaciers may be the source of secondary lahars related to seismic, volcanic and meteorological phenomena (e.g. Carihuayrazo 1698, Huascarán 1970, Altar 2000, Tungurahua 2001, Cotopaxi 2015). Chimborazo volcano (1.47S, 78.81W, 6268 m asl) located 150 km SW of Quito, capital of Ecuador is a potentially active volcano with an important icecap spread over 22 glacier tongues covering 8.5 km<sup>2</sup>. Since December 2015 at least 4 secondary lahars have been reported at Yambo Rumi ravine, southeast of Chimborazo. These lahars have affected the local infrastructure and threaten several towns (1000 inhabitants). The Yambo Rumi basin has a total area of 14.82 km<sup>2</sup> of which only 5% is the glacierized surface. Fieldwork and several numerical simulations (VolcFlow, LaharZ, and MultiFlow) using a high resolution DEM (4m) allowed us to determine the area (1.34 km<sup>2</sup>), volume (300,000 to 700,000 m<sup>3</sup>) and the peak discharge (100-150 m<sup>3</sup>.s<sup>-1</sup>) of these lahars. Meteorological data indicate that 2015 has been the second warmest year (El Niño) since 2005. Besides, the glacier has lost 12% of its area since 1997 (climatic warming). Tungurahua's ashfall (40 km to the East of Chimborazo) could also be responsible of the glacier reduction due to the change in the glacier's albedo. These factors together might have led to the formation, rupture and overflow of superficial and intraglacier ponds providing the water source to generate secondary lahars. No change in volcanic activity has been detected ruling out this potential internal factor as a trigger mechanism. We conclude that the accelerated melting of Chimborazo glacier due to the combination of the external factors will certainly increase the probability of secondary lahar generation, not only in Yambo Rumi



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ravine, but also in other ravines around the volcano. Hazard maps should

be produced in order to manage the impact of these phenomena.