Cities on Volcanoes 9
November 20-25, 2016
Puerto Varas, Chile
'Understanding volcanoes and society: the key for risk mitigation'

Assessing the Impacts of Effusive Eruptions and Quantifying Associated Risks at Etna Volcano

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Key words: Lava flow impact, risk map, MAGFLOW model, lava flow hazard, Etna volcano

During the past few decades there has been an ever growing interest in understanding, quantifying and modelling lava flow hazards. This has produced some high quality physics-based models, such as the MAGFLOW lava flow emplacement model, which evaluate occurrence probabilities and spatial extents of lava flow hazards. These models have allowed a quantitative assessment of lava flow hazards and have greatly contributed to disaster risk reduction and management. To fully evaluate likely impacts and risk that future effusive eruptions may cause to life, property and environment, it is necessary to consider the hazard, the distribution of the exposed elements at stake and the associated vulnerability. Here we assessed the risk of lava flow inundation at Etna volcano using a GIS-based methodology that integrates the hazard with the exposure of elements at stake. The inundation hazard probabilities were obtained combining three different kinds of information: the spatiotemporal probability for the future opening of new eruptive vents, the event probability associated with classes of expected eruptions, and the overlapping of lava flow paths simulated by the MAGFLOW model. Different elements at stake were considered, including population, hospitals, facilities, buildings, infrastructures, gas and electricity networks, railways, roads, and land use. The final product of our analysis was a risk map showing the areas in which there would be the greatest amount of losses in case of future effusive eruptions at Etna. Finally, we quantified the lava flow impact of two past main effusive eruptions of Etna: the 1669, which is the biggest and destructive flank eruption to have occurred on Etna in historical time, and the 1981, lasting only 6 days, but characterized by an intense eruptive dynamics. All elements at stake were combined with the 1669 and 1981 lava flow fields to assess the social damage and economic loss.