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The future eruptions of Mount Etna: probabilistic modelling and lava flow hazard maps

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Improving lava flow hazard assessment is one of the most important and challenging fields of volcanology, and has an immediate and practical impact on society. Here, we present a methodology for the quantitative assessment of lava flow hazards based on a combination of field data, numerical simulations and probability analyses. Firstly, we conducted the statistical analysis of volcanic activity with the twofold aim of (i) constructing a probability map for vent opening of future flank eruptions and (ii) forecasting the expected number of eruptive events at the summit craters. Afterword, we calculated the recurrence rates (events expected per unit area per unit time) and produced different spatiotemporal probability maps of new vent opening in the next 1, 10 and 50 years. Finally, the results of the analysis of the persistent summit activity during the last 110 years indicate that the hazard rate for eruptive events is not constant with time, differs for each summit crater of Mt Etna, highlighting a general increase in the eruptive frequency starting from the middle of last century and particularly from 1971, when the SE Crater was formed. Therefore, with the extensive data available on historic eruptions of Mt. Etna, going back over 2000 years, it has been possible to construct two hazard maps, one for flank and the other for summit eruptions, allowing a quantitative analysis of the most likely future courses of lava flows. The effective use of hazard maps of Etna may help in minimizing the damage from volcanic eruptions through correct land use in a densely urbanized area with a population of almost one million people. Although this study was conducted on Mt Etna, the approach used is designed to be applicable to other volcanic areas.