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Combining probabilistic hazard assessment with cost-benefit analysis to support decision making in a volcanic crisis from the Auckland Volcanic Field, New Zealand

Laura Sandri (1), Gill Jolly (2), Jan Lindsay (3), Tracy Howe (3), and Warner Marzocchi (4)

(1) Istituto Nazionale di Geofisica e Vulcanologia, Bologna, Italy (sandri@bo.ingv.it), (2) GNS Science, Wairakei Research Centre, Taupo, New Zealand, (3) School of Environment, The University of Auckland, Auckland, New Zealand , (4) Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy

One of the main challenges of modern volcanology is to provide the public with robust and useful information for decision-making in land-use planning and in emergency management. From the scientific point of view, this translates into reliable and quantitative long- and short-term volcanic hazard assessment and eruption forecasting. Because of the complexity in characterizing volcanic events, and of the natural variability of volcanic processes, a probabilistic approach is more suitable than deterministic modeling. In recent years, two probabilistic codes have been developed for quantitative short- and long-term eruption forecasting (BET_EF) and volcanic hazard assessment (BET_VH). Both of them are based on a Bayesian Event Tree, in which volcanic events are seen as a chain of logical steps of increasing detail. At each node of the tree, the probability is computed by taking into account different sources of information, such as geological and volcanological models, past occurrences, expert opinion and numerical modeling of volcanic phenomena. Since it is a Bayesian tool, the output probability is not a single number, but a probability distribution accounting for aleatory and epistemic uncertainty.

In this study, we apply BET_VH in order to quantify the long-term volcanic hazard due to base surge invasion in the region around Auckland, New Zealand's most populous city. Here, small basaltic eruptions from monogenetic cones pose a considerable risk to the city in case of phreatomagmatic activity: evidence for base surges are not uncommon in deposits from past events. Currently, we are particularly focussing on the scenario simulated during Exercise Ruaumoko, a national disaster exercise based on the build-up to an eruption in the Auckland Volcanic Field.

Based on recent papers by Marzocchi and Woo, we suggest a possible quantitative strategy to link probabilistic scientific output and Boolean decision making. It is based on cost-benefit analysis, in which all costs and benefits of mitigation actions have to be evaluated and compared, weighting them with the probability of occurrence of a specific threatening volcanic event. An action should be taken when the benefit of that action outweighs the costs. It is worth remarking that this strategy does not guarantee to recommend a decision that we would have taken with the benefit of hindsight. However, this strategy will be successful over the long-tem. Furthermore, it has the overwhelming advantage of providing a quantitative decision rule that is set before any emergency, and thus it will be justifiable at any stage of the process.

In our present application, we are trying to set up a cost-benefit scheme for the call of an evacuation to protect people in the Auckland Volcanic Field against base surge invasion. Considering the heterogeneity of the urban environment and the size of the region at risk, we propose a cost-benefit scheme that is space dependent, to take into account higher costs when an eruption threatens sensible sites for the city and/or the nation, such as the international airport or the harbour. Finally, we compare our findings with the present Contingency Plan for Auckland.