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Probabilistic approach to decision making under uncertainty during volcanic crises. Retrospective analysis of the 2011 eruption of El Hierro, in the Canary Islands

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Understanding the potential evolution of a volcanic crisis is crucial to improving the design of effective mitigation strategies. This is especially the case for volcanoes close to densely-populated regions, where inappropriate decisions may trigger widespread loss of life, economic disruption and public distress. An outstanding goal for improving the management of volcanic crises, therefore, is to develop objective, real-time methodologies for evaluating how an emergency will develop and how scientists communicate with decision makers. Here we present a new model BADEMO (Bayesian Decision Model) that applies a general and flexible, probabilistic approach to managing volcanic crises. The model combines the hazard and risk factors that decision makers need for a holistic analysis of a volcanic crisis. These factors include eruption scenarios and their probabilities of occurrence, the vulnerability of populations and their activities, and the costs of false alarms and failed forecasts. The model can be implemented before an emergency, to identify actions for reducing the vulnerability of a district; during an emergency, to identify the optimum mitigating actions and how these may change as new information is obtained; and after an emergency, to assess the effectiveness of a mitigating response and, from the results, to improve strategies before another crisis occurs. As illustrated by a retrospective analysis of the 2011 eruption of El Hierro, in the Canary Islands, BADEMO provides the basis for quantifying the uncertainty associated with each recommended action as an emergency evolves, and serves as a mechanism for improving communications between scientists and decision makers.