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Quantifying probabilities of eruptions at Mount Etna (Sicily, Italy).

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One of the major goals of modern volcanology is to set up sound risk-based decision-making in land-use planning and emergency management. Volcanic hazard must be managed with reliable estimates of quantitative long- and short-term eruption forecasting, but the large number of observables involved in a volcanic process suggests that a probabilistic approach could be a suitable tool in forecasting.

The aim of this work is to quantify probabilistic estimate of the vent location for a suitable lava flow hazard assessment at Mt. Etna volcano, through the application of the code named BET (Marzocchi et al., 2004, 2008).

The BET_EF model is based on the event tree philosophy assessed by Newhall and Hoblitt (2002), further developing the concept of vent location, epistemic uncertainties, and a fuzzy approach for monitoring measurements.

A Bayesian event tree is a specialized branching graphical representation of events in which individual branches are alternative steps from a general prior event, and evolving into increasingly specific subsequent states. Then, the event tree attempts to graphically display all relevant possible outcomes of volcanic unrest in progressively higher levels of detail. The procedure is set to estimate an a priori probability distribution based upon theoretical knowledge, to accommodate it by using past data, and to modify it further by using current monitoring data.

For the long-term forecasting, an a priori model, dealing with the present tectonic and volcanic structure of the Mt. Etna, is considered. The model is mainly based on past vent locations and fracture location datasets (XX century of eruptive history of the volcano). Considering the variation of the information through time, and their relationship with the structural setting of the volcano, datasets we are also able to define an a posteriori probability map for next vent opening.

For short-term forecasting vent opening hazard assessment, the monitoring has a leading role, primarily based on seismological and volcanological data, integrated with strain, geochemical, gravimetric and magnetic parameters.

In the code, is necessary to fix an appropriate forecasting time window. On open-conduit volcanoes as Mt. Etna, a forecast time window of a month (as fixed in other applications worldwide) seems unduly long, because variations of the state of the volcano (significant variation of a specific monitoring parameter could occur in time scale shorter than the forecasting time window) are expected with shorter time scale (hour, day or week). This leads to set a week as forecasting time window, coherently with the number of weeks in which an unrest has been experienced.

The short-term vent opening hazard assessment will be estimated during an unrest phase; the testing case (2001 July eruption) will include all the monitoring parameters collected at Mt. Etna during the six months preceding the eruption. The monitoring role has been assessed eliciting more than 50 parameters, including seismic activity, ground deformation, geochemistry, gravity, magnetism, and distributed inside the first three nodes of the procedure. Parameter values describe the Mt. Etna volcano activity, being more detailed through the code, particularly in time units.

The methodology allows all assumptions and thresholds to be clearly identified and provides a rational means for their revision if new data or information are incoming.

References

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