Mapping the hazard from lava flows: the perspective of vulnerable communities

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Summary. *We present a new procedure for rapidly evaluating hazard from lava flows at the start of an eruption. The new maps complement traditional versions by adapting information to the needs of vulnerable communities.*

1. Hazard maps for lava flows.

Maps of lava-flow hazard conventionally use the distribution of known lavas to illustrate the potential of inundation across a volcano (Harris et al., 2011). They are especially suited to strategic land-use planning in the medium- and long-term.

During an emergency, however, the primary concern of a vulnerable community is whether an effusion will threaten their homes. In this case, the first questions to be raised are:

- How likely is it that a flow will reach our property?
- How soon could the lava arrive?

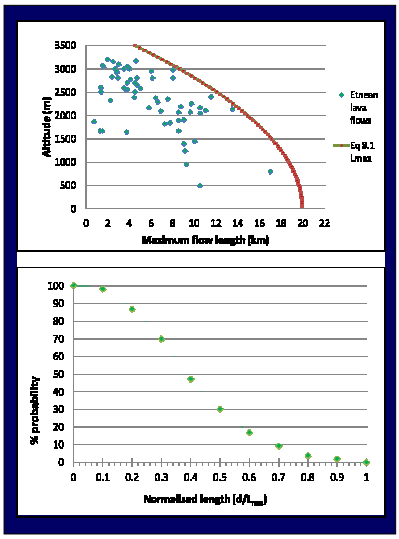
To address these questions, we have developed a methodology for preparing community-perspective hazard maps and applied it to the principal towns on the flanks of Mt Etna, in Sicily. We have focussed on aa lavas, because this type has dominated historical effusions from the volcano.

3. Results

Results of the procedure are illustrated for Zafferana Etnea (*near* right), together with maps (1) comparing the hazard to Randazzo, Passopisciaro, Milo-Fornazzo, Nicolosi and Brontë (*far right, clockwise from top*), and (2) showing the outlines of catchment areas for principal settlements around Etna (*far right, inset*).

The guidelines (*right*) illustrate how different emergency responses can be presented for each colour-coded probability of inundation by lava.

The crucial point is that local authorities can make an initial hazard assessment from the **start** of an eruption *knowing only the location of the effusive vent.* This favours the rapid implementation of a response, especially when the hazard may be imminent (*e.g.*, purple and red categories).



Mount Etna (*left*, seen from Catania) is one of Europe's most spectacular active volcanoes. About 40 km across, it rises 3350m above the eastern coast of Sicily and is home to nearly one million people.

Major flank eruptions occur regularly, at intervals of years (Guest & Murray, 1979). These are commonly effusive, and can feed basaltic lava flows into populated areas. The most destructive event on record occurred in 1669, when a lava flow effused at only 800m altitude travelled 17 km before entering the city of Catania on the south-eastern foot of the volcano (Chester et al., 1985).

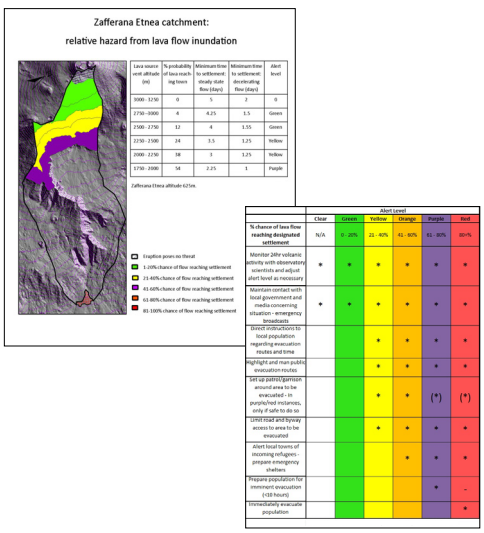
2. Method.

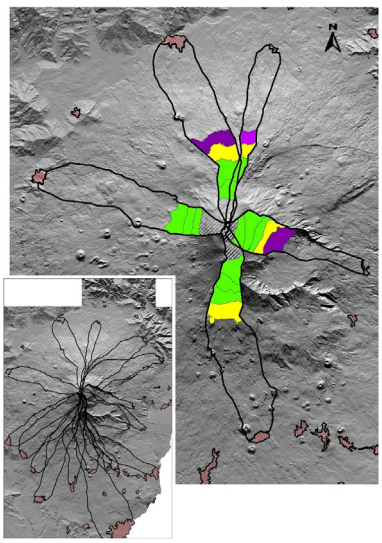
Stage 1*. Probability that a flow will reach its maximum potential length (left).* Etna's aa flows reach greater maximum lengths when effused from lower altitudes (Walker, 1974). A limiting curve for maximum flow length (L_{max}) was obtained empirically (following Chester et al. (1985)). Each flow length was normalised against L_{max} and then converted into a cumulative frequency graph, to show the probability that a flow will reach a given fraction of L_{max}.

Stage 2*. Delineating lava catchment areas.* The catchment area defines the area in which an eruption must occur to affect a specific settlement (Guest & Murray, 1979). GIS software and a DEM of Etna (Pareschi et al, 1999) were used to map catchment areas for specific settlements, and then to measure the distance between potential future vents (at a given altitude) and those settlements. These distances were normalised against L_{max} for the vent altitude. The probability that a flow erupting at that altitude could reach the target settlement was then obtained from the cumulative frequency graph *(left)*.

Stage 3*. Estimating the minimum time for emergency response.* Maximum rates of aa flow advance were estimated from models for constant and decelerating flow advance (Kilburn, 2004). The minimum time before inundation was determined from the measured distances and calculated advance rates.

Stage 4*. Preparation of hazard maps and emergency guidelines.* Settlement-specific hazard maps were created by zoning catchment areas into six bands, defined by the probability of an aa flow reaching the settlement from that band (0%, 1-20%, 20-40% and so on until 81-100%). Each band was colour-coded from clear to red, in order of increasing probability of inundation





References. Chester, D.K., Duncan, A.M., Guest, J.E.; Kilburn, C.R.J., 1985, *Mount Etna: The anatomy of a Volcano*, Chapman and Hall Ltd, London pp404; Guest, J.E., Murray, J.B., 1979, An analysis of hazard from Mount Etna Volcano, *Journal of the Geological Society of London*, Vol 136, 347-354; Harris, A.J.L, Favalli, M., Wright, R., Garbeil, H., 2011, *Natural Hazards*, Vol 58, 1001-1027; Kilburn, C.R.J, 2004, Fracturing as a quantitative indicator of lava flow dynamics, *Journal of Volcanology and Geothermal Research*, Vol 132,209-224; Pareschi, M.T., Cavarra, L., Favalli, M., Innocenti, F., Mazzarini, F., Pasquarè, G., 1999, Digital Atlas of Mount Etna volcano, *Acta Vulcanologica*, Vol 11, 311-314; Walker, G.P.L., 1974, Volcanic hazards and the prediction of volcanic eruptions, *Geological Society of London, Miscellaneous Paper* 3, 23 - 41.

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