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Numerical hazard zonation for pyroclastic density current scenarios at Faial and Terceira islands (Azores)

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Pyroclastic density currents are hot mixtures of volcanic particles and gas that flow at high speed along the topography. They are the most hazardous and destructive volcanic phenomena, responsible for thousands of fatalities over the last centuries. It is therefore essential to assessment the areas susceptible of being affected and the impact on people and infrastructures.

The areas potentially affected by pyroclastic density currents can be estimated using the energy cone model. This simple model correlates the height of the drop (H) and the runout distance (L), using a type of friction parameter - the Heim coefficient (μ). The angle of inclination of the energy cone is defined by arctan (H/L). Here we have used a GIS-integrated energy cone model to estimate the potential extent of pyroclastic density currents in Faial and Terceira islands (Azores) for different eruptive scenarios. The simulations were performed using a H/L range between 0.2 and 0.4 and assuming column collapse heights of 500, 750 and 1000 m above the centre of the caldera ($\sim$ 600 m a.s.l.). A digital elevation model of the islands with a 10 m grid spacing was used in the simulations.

The hazard maps produced show the dispersal areas of the pyroclastic density currents for each eruptive scenario. Combining these maps allowed us to plot hazard zones for each volcano, reflecting the different conditions in which pyroclastic density currents can develop. In Faial the most susceptible area is the northwest flank of the central volcano. However most of the island may also be affected by pyroclastic density currents during large eruptive events. While in Terceira the north part of the island is the more susceptible of being affected in all scenarios analysed. It should be considered that the extent of the pyroclastic density currents calculated with this model represents minimum dispersal areas, due to its conservative nature.

The areas affected by pyroclastic density currents in the simulations where also compared with the mapped distribution of the ignimbrites produced during the last caldera forming events in Faial and Terceira: the C11 eruption ($\sim$ 1000 years ago) and the Lajes-Angra ignimbrite ($\sim$ 23 000 years ago), respectively. The calculated areas revealed similarities in the pattern of dispersal although the runout distance was smaller. Field data shows that the pyroclastic density currents produced during these eruptions were able to concentrate and flow along topographic depression (e.g. river-valleys), reaching larger distances than those estimated by the energy cone. Nevertheless, a GIS-integrated energy cone model is a simple and easy method to evaluate potential hazardous areas and produce hazard maps with low computer resources.