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Assessing the impact of explosive eruptions at Fogo volcano (São Miguel Island, Azores)

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The assessment of volcanic hazards in oceanic islands with active volcanoes is vital for land management and emergency planning. The volcanic history of São Miguel shows that it is the most active island of the Azores, with the highest eruptive frequency of subplinian and plinian events, counting at least 33 explosive eruptions in the last 5000 years. Fogo volcano, located in the central part of São Miguel, though with the lowest eruptive frequency of the three active central volcanoes on the island, was the only that produced a plinian eruption in the last 5000 years.

In order to evaluate the hazards related to explosive eruptions at Fogo volcano, two eruptive scenarios were considered: the most probable, a VEI 4 subplinian eruption, and the worst-case, a VEI 5 plinian eruption. To assess the areas susceptible to be affected by tephra fallout and PDCs, and the potential impact on people and infrastructures, we performed simulations using the GIS-based VORIS 2.0.1 tool. Tephra fallout simulations relied on a semi-analytical advection-diffusion model and PDCs simulations were carried out with an energy cone model.

Eruptive parameters from the Fogo A eruption (plinian), total volume of 3,2 km3 and plume height of 27 km, and the Fogo 1563 eruption (subplinian), total volume of 0,99 km3 and plume height of 18 km were used to simulate the considered tephra fallout scenarios. Particle sizes for all simulations were in the range from -4 to 4 phi. For the two scenarios we used the Azores wind patterns of the typical summer and winter conditions. Input parameters for the simulation of the maximum potential extent of PDCs were collapse equivalent heights of 300 and 500 m (for VEI 4 and VEI 5 scenarios, respectively) and a constant inclination angle of 6°.

Although in a future eruption the real winds conditions will determine where the ejected tephra will be deposited, these simulations show that during summer months the prevailing winds blowing to the southeast of the caldera, will make Vila Franca do Campo the most affected municipality, with tephra thicknesses of 1-2 m (VEI 4) and 2-3 m (VEI 5) in Ribeira das Tainhas and Ponta Garça villages. During winter months, higher wind speeds spread tephra further to the east, affecting mainly Furnas village (Povoação municipality) with thicknesses of 1-2 m (VEI 4) and up to 3 m (VEI 5). In the case of PDCs, the municipalities located around Fogo volcano, Lagoa, Vila Franca do Campo and Ribeira Grande will be the most affected, with PDCs reaching maximum run-out distances of more than 9 km (VEI 4) and more than 11 km (VEI 5) from the summit. Any future explosive eruption at Fogo volcano will have significant repercussions in the economy of São Miguel Island, affecting several sectors such as, Tourism, Agriculture and Sea, which are crucial for the economic development and generation of employment in the Azores archipelago.