Tephra fallout susceptibility assessment for the most probable sub-Plinian scenario at Fogo Volcano (São Miguel Island, Azores)

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Explosive eruptions are understood as complex natural phenomena capable of causing significant socioeconomic and climatic impact. During Plinian or sub-Plinian eruptions tephra is ejected into the atmosphere and dispersed by the wind, sometimes threatening human lives and infrastructures.

Fogo Volcano (São Miguel Island) is one of the most hazardous volcanoes in the Azores archipelago, with a recent history of Plinian and sub-Plinian eruptions. The 1563 intra-caldera sub-Plinian eruption of Fogo volcano was the last one and produced a pumice and ash deposit which is divided in two main members (Lower and Upper) and eight units.

A sub-Plinian eruption with similar characteristics to those of the Fogo 1563 eruption is considered as the most probable scenario of a future explosive eruption of Fogo Volcano. To assess the susceptibility of tephra fallout at Fogo Volcano, eruptive parameters were determined from the coarser and most widespread pumice layer L2, interpreted as a single pulse, and from the total deposit of the Fogo 1563 eruption.

Obtained eruptive source parameters from the L2 layer are: total volume of 0.128 km3, plume height of 19 km and particle sizes from -4.5 to 5 phi; while from the total deposit the eruptive parameters are: total volume of 0.421 km3, plume height of 19 km and particle sizes from -5.5 to 5 phi. In both cases, the density of large, medium and small particles is 800, 1200 and 2500 kg/m3, respectively.

Tephra fallout simulations were performed with a semi-analytical advection-diffusion model using the GIS-based VORIS 2.0.1 tool. Four eruptive scenarios were considered for the simulations using the eruptive source parameters of the L2 layer and the total deposit and also the Azores wind patterns of the typical summer and winter conditions.

Overall the results of the simulations using data from the L2 layer and from the total deposit produced similar tephra fallout susceptibility maps. In the case of the L2 layer results suggest that Furnas village is the most affected inhabited area during summer and winter months, with deposit thicknesses up to 0.75 m. In the case of the total deposit, Furnas village is also the most affected area during summer months with thicknesses up to 2 m, while in winter months Furnas village, Nossa Senhora dos Remédios and Povoação are the most affected inhabited areas with deposit thicknesses up to 2 m.

Although in a future explosive eruption at Fogo Volcano the dispersion of the tephra will depend mostly on the wind direction and intensity at the time of the eruption, it is important to consider that production of susceptibility maps contributes to an improvement of the response capability and risk mitigation during volcanic crisis.