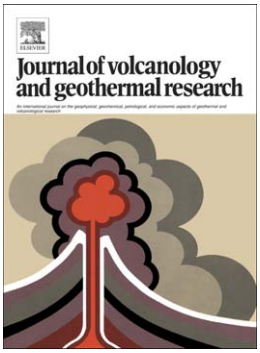

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Sensitivity test and ensemble hazard assessment for tephra fallout at Campi Flegrei, Italy

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Abstract

We present the results of a statistical study on tephra dispersal in the case of a reactivation of the Campi Flegrei volcano. To represent the spectrum of possible eruptive sizes, four classes of eruptions were considered. Excluding the lava emission, three classes are explosive (Small, Medium, and Large) and can produce a significant quantity of volcanic ash. Hazard assessments were made through simulations of atmospheric dispersion of ash and lapilli, considering the full variability of winds and eruptive vents. The results are presented in form of conditional hazard curves given the occurrence of specific eruptive sizes, representative members of each size class, and then combined to quantify the conditional hazard given an eruption of any size. The main focus of this analysis was to constrain the epistemic uncertainty (i.e. associated with the level of scientific knowledge of phenomena), in order to provide unbiased hazard estimations. The epistemic uncertainty on the estimation of hazard curves was quantified, making use of scientifically acceptable alternatives to be aggregated in the final results. The choice of such alternative models was made after a comprehensive sensitivity analysis which considered different weather databases, alternative modelling of submarine eruptive vents and tephra total grain-size distributions (TGSD) with a different relative mass fraction of fine ash, and the effect of ash aggregation. The results showed that the dominant uncertainty is related to the combined effect of the uncertainty with regard to the fraction of fine particles with respect to the total mass and on how ash aggregation is modelled. The latter is particularly relevant in the case of magma-water interactions during explosive eruptive phases, when a large fraction of fine ash can form accretionary lapilli that might contribute significantly in increasing the tephra load in the proximal areas. The variability induced by the use of different meteorological databases and the selected approach to modelling offshore eruptions were relatively insignificant. The uncertainty arising from the alternative implementations, which would have been neglected in standard (Bayesian) quantifications, were finally quantified by ensemble modelling, and represented by hazard and probability maps produced at different confidence levels.

Keywords: PVHA, tephra fallout, Campi Flegrei, sensitivity, ash aggregation