New methods of probabilistic hazard assessment of tephra dispersal: application to the Neapolitan area

Antonio Costa[1], Arnau Folch[2], Giovanni Macedonio[3], Laura Sandri[1], Jacopo Selva[1]

[1]Istituto Nazionale di Goefisica e Vulcanologia, Sezione di Bologna, Italy, [2]Barcelona Supercomputing Center, Spain, [3]Istituto Nazionale di Goefisica e Vulcanologia, Sezione di Napoli, Italy

E-mail: antonio.costa@bo.ingv.it

The intrinsic uncertainty and variability associated to the size of next eruption strongly affects short to long term tephra hazard assessment. Often, emergency plans are established accounting for the effects of one or a few selected reference scenarios. Probabilistic hazard assessments for tephra dispersal need the definition of eruptive scenarios with associated probabilities, a meteorological dataset covering a representative time period and a tephra dispersal model. Probabilistic assessment results from weighting a statistical number of simulations considering different volcanological and meteorological conditions. Volcanological inputs such as erupted mass, eruption column height, eruption duration, bulk granulometry, fraction of aggregates typically encompass a wide range of values. Because such a variability, it is clear that the eruptive scenario cannot be adequately defined using single values for the volcanological inputs. Here we account for this variability using a range for each eruptive parameter and assuming a uniform or beta Probability Density Function between the extreme values of the range. Once a PDF is defined, meteorological and volcanological inputs are chosen by using a stratified sampling method that consists of dividing the population into mutually exclusive, exhaustive and homogeneous sub–groups before sampling. The ECMWF reanalysis dataset are used for exploring different possible meteorological conditions. This procedure allows avoiding the bias introduced by selecting a single reference setting and thus neglecting most of the intrinsic sources of eruptive variability. Results from one or more dispersal models are then integrated through a Bayesian tool to quantify epistemic uncertainties. Finally, this Bayesian tephra dispersal hazard assessment allows us to produce probabilistic hazard curves for strategic structures and of standard hazard maps in analogy with the seismic case, representing the information primarily used in risk mitigation actions. As examples, here we explore this issue by analyzing long term volcanic hazard for tephra fall at Vesuvius and Campi Flegrei, Italy. We integrate the simulations by two tephra dispersal models, the analytical HAZMAP and the numerical FALL3D models respectively, into BET_VH.
The results obtained clearly show that volcanic hazard based on all possible eruptive settings is significantly different from the analysis based on a single reference setting, as used in volcanic hazard common practice. We highlight the differences with a previously published study in which three different scenarios were again considered, but each scenario had fixed volcanological inputs. As examples, we also show the resulting probabilistic hazard curves for a few strategic points in Naples, and a standard hazard map displaying, at every point, the maximum tephra load with a probability equal to 10% expected to be exceeded in 50 years.