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Volcanic hazard assessment for El Misti volcano (South Peru) based on the BET_VH (Bayesian Event Tree for Volcanic Hazard) software (work in process)

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El Misti is a 5822-m-high stratovolcano in the Central Andean Volcanic Zone, South Peru. It is known for eruptions ranging in size from Vulcanian (e.g. 1440 – 1470 AD) to sub-Plinian (e.g. ∼2030 BP) and Plinian (e.g. ∼14,000 yr BP, ∼25,000 yr BP, ∼34,000 yr BP), which produced a series of hazardous volcanic phenomena (tephra falls, ballistics, PDCs – flows and surges, debris flows, and debris avalanches). These volcanic processes affected extended areas, including the areas of the present day city of Arequipa (∼1,000,000 people), the town of Chiguata, and their surroundings. Given the high exposure of the city, we have developed a volcanic hazard assessment based on past eruptions of El Misti and modern models (numerical simulations from computer models and probabilistic models). We consider three possible eruptive sizes of explosive nature: 1) small – Vulcanian / Phreatomagmatic (∼VEI 2); 2) medium – Sub-Plinian (∼VEI 3 - 4); 3) large – Plinian (VEI 4+). The purpose of this study is to quantitatively determine volcanic hazard in the city of Arequipa, i.e. the probability of different points around the volcano or in the city being reached by one or more of the hazardous phenomena (ash fall, ballistics, PDCs, debris flows and debris avalanches) related to the three eruptive sizes. This is accomplished by computing the basic ingredients of a probabilistic volcanic hazard assessment: (i) probability of an eruption, (ii) the relative probability of the three different sizes given an eruption, (iii) the probability of occurrence of the above mentioned hazardous volcanic phenomena, together with (iv) the probability of such phenomena reaching a given distance, given an eruption of a specific size. By using the recently developed e-tool BET_VH – Bayesian Event Tree for Volcanic Hazard, we implement points (i), (ii), (iii) and (iv) in an event tree. The probability at each node of the tree is computed by taking into account as many pieces of information as possible, in order to reduce the epistemic uncertainty. For example, in order to assess the extent of a given hazardous phenomenon, we show how past data taken from stratigraphic records and results of simulations from numerical models (LaharZ, Titan2D, VolcFlow, Tephrando) can be used in a Bayesian scheme in order to obtain an estimate based on both these sources of information. We also take into account local parameters that might influence the volcanic processes. For example, variations between wet and dry seasons may dictate the impact area of a specific phenomenon (e.g. higher likelihood of debris flows during the rainy season, debris flows caused by PDCs melting the seasonal snow cover, and the distribution of tephra fallout according to prevailing seasonal winds).

Keywords: El Misti, Arequipa, Bayesian Event Tree, volcanic hazard, probabilistic assessment.