Probabilistic Hazard Mapping: A flexible Approach for Crisis Management

Eliza S Calder[1], Bruce E Pitman[2], Sarah E Ogburn[2], Robert L Wolpert[3], Jim O Berger[3], Susie MJ Bayarri[3], Elaine T Spiller[4]

[1]University of Edinburgh, UK, [2]University at Buffalo, USA, [3]Duke University, USA, [4]Marquette University, USA

E-mail: ecalder@buffalo.edu

We present a fully probabilistic analysis of the impact by pyroclastic density currents from the Soufriere Hills Volcano, Montserrat as simulated by TITAN2D. The methodology presented is new and specifically devised to address the complications associated with continuous assessment and reassessment of the status of an eruption as well as the use, and testing of, variable probability models as the understanding of the physical system is improved. For the Belham River Valley, a strategically crucial drainage system in Montserrat, we undertake a high spatial-density of site-specific probability calculations for inundation by pyroclastic flows, and thereby construct contour maps of probabilistic hazard. We present a methodology that uses flow simulations to characterize the probability of inundation from pyroclastic density currents, but requires a relatively small number of simulations and importantly, divorces those simulations from any probabilistic models of initial conditions. The key to this methodology is the realization that a particular set of initial conditions will result in flow inundation (or not) at a given map point regardless of how likely that set of initial conditions is. Our strategy therefore separates initial condition space into regions that lead to inundation and regions that do not. With that knowledge in hand, we effectively turn the probability calculation into a post-processing step to be computed without the need to undertake additional flow simulations. Furthermore, this allows for accommodation of changing eruption scenarios, or our understanding of the eruption, without coupling those to a new set of initial condition simulations. We demonstrate this by testing the method for several probability models which are constructed based on different activity levels of the volcano as well as over short (1-month) to long (10-year) periods. Utilized in this manner, the methodology provides a level of flexibility and computational efficiency, which is uniquely placed to respond and improve real-world hazard assessments.