Geophysical Research Abstracts
Vol. 17, EGU2015-4194, 2015
EGU General Assembly 2015

Assessing the long-term probabilistic volcanic hazard for tephra fallout in Reykjavik, Iceland: a preliminary multi-source analysis

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Icelandic volcanism is largely dominated by basaltic magma. Nevertheless the presence of glaciers over many Icelandic volcanic systems results in frequent phreatomagmatic eruptions and associated tephra production, making explosive eruptions the most common type of volcanic activity. Jökulhlaups are commonly considered as major volcanic hazard in Iceland for their high frequency and potentially very devastating local impact. Tephra fallout is also frequent and can impact larger areas. It is driven by the wind direction that can change with both altitude and season, making impossible to predict a priori where the tephra will be deposited during the next eruptions. Most of the volcanic activity in Iceland occurs in the central eastern part, over 100 km to the east of the main population centre around the capital Reykjavík. Therefore, the hazard from tephra fallout in Reykjavík is expected to be smaller than for communities settled near the main volcanic systems. However, within the framework of quantitative hazard and risk analyses, less frequent and/or less intense phenomena should not be neglected, since their risk evaluation depends on the effects suffered by the selected target. This is particularly true if the target is highly vulnerable, as large urban areas or important infrastructures.

In this work we present the preliminary analysis aiming to perform a Probabilistic Volcanic Hazard Assessment (PVHA) for tephra fallout focused on the target area which includes the municipality of Reykjavík and the Keflavík international airport. This approach reverts the more common perspective where the hazard analysis is focused on the source (the volcanic system) and it follows a multi-source approach: indeed, the idea is to quantify, homogeneously, the hazard due to the main hazardous volcanoes that could pose a tephra fallout threat for the municipality of Reykjavík and the Keflavík airport. PVHA for each volcanic system is calculated independently and the results from all the PVHAs can be combined at the end. This will allow to: 1) possibly add the contribution of new volcanic systems, 2) compare and hierarchically rank the tephra fallout risk among both all the considered volcanoes and, possibly, other kinds of risk, and 3) quantitatively assess the overall tephra fallout hazard over the target area.

As practical application, we selected a first subset consisting of the five most hazardous volcanic systems for tephra fallout that could affect the selected target area. These are the ones with the highest number of eruptions in the last 1100 years (Katla, Hekla, Grímsvötn) and the ones located closest to the target area (Reykjanes and Snæfellsjökull). PVHA is computed using the PyBetVH tool (an improvement of the Bayesian Event Tree for Volcanic Hazard -BET_VH- model) and tephra dispersal is modelled by means of VOL-CALPUFF numerical code. Katla volcanic system is used as pilot case study because of its eruptive history and behaviour are well known and documented. We found that some considerations and results derived from the study of Katla could be general and applied to the other considered volcanoes and, more in general, to other Icelandic volcanic systems.

The work was financially supported by the European Science Foundation (ESF), in the framework of the Research Networking Programme MeMoVolc.