Engineering Risk Analysis Group
Prof. Dr Daniel Straub

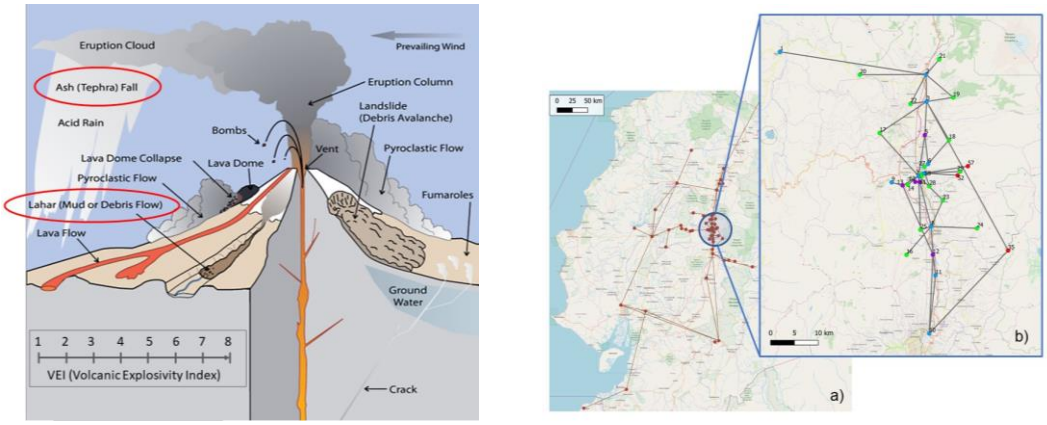
Master's Thesis - Environmental Engineering

Multi-hazard volcano analysis and its cascading effects in power networks in Ecuador

Sebastian Averdunk, October 2019

Background

It is generally known that natural hazards can cause serious disruption in functioning societies and their infrastructure networks (Clarke and Obrien, 2016). Often endangered areas are exposed to not just one but multiple hazards. One example is the province Cotopaxi, named after its volcano in Ecuador, which was threatened during past eruptions by multiple volcanic hazards such as lahar, a mudflow on volcanic terrain, and ashfall. While these hazards are analysed in the literature separately a combined approach considering both hazards was not yet undertaken (Wardman, 2013, Dagá et al., 2017). This study introduces a method to analyse the impact of multiple volcanic hazards on the electric power system in Ecuador.



Left: Schematic representation of multiple volcanic hazards
Right: Topological representation of the analyzed power network

Methodology

A network-based simulation calculates the impact of these hazards as well as incorporate the damage propagation through the network. The failure probability of nodes is determined with the concept of fragility functions, for four eruption scenarios with different magnitudes which were classified according to the Volcanic Explosivity Index. The consequences are expressed by two performance measures: The system's connectivity loss and the population without power service.

Results

The results show that while ashfall during small eruptions causes no power blackouts, large eruptions can have extreme effects depending on the wind direction. Despite the lahar hazard is the dominant one in most cases, there are some events (strong north-east wind) where ash leads to extreme consequences. Especially severe volcano outbursts make the consideration of both hazards, as well as their damage propagation important.

In cooperation with Landslides Research Group (TU Munich), Instituto Geofísico EPN in Ecuador

Supervised by M.Sc. Hugo Rosero, Prof. Dr. Daniel Straub