Abstract for the AVCOR workshop, 2013, Gisenyi (Rwanda)

Calibration of a GIS-based combined thermo-rheological and probabilistic lava flow model for Nyamulagira volcano

Kervyn M., Feltz A., Poppe S., Smets B., Mossoux S.

Department of Geography, Earth System Science, Vrije Universiteit Brussel

Lava flows represent one of the main volcanic hazards on Earth. Although rarely threatening human lives, they are associated with significant damages to human infrastructures and ecosystems. As they emplace over hours to days after eruption onset, rapid simulation of lava propagation is of uttermost importance for effective hazard evaluation and real-time risk management.

Here we present a GIS toolbox that aims at simulating the spatial propagation of lava flows. The model combines an advanced probabilistic approach based on the VORIS model (Felpeto et al., 2001) and a thermo-rheological constraint for the lava flow length based on the FLOWGO model (Harris et al., 2001).

The GIS toolbox is coded in Python and runs in ArcGIS, but is compatible to other GIS platforms. It simulates the propagation of lava flows from a point or linear source selected interactively on a Digital Elevation Model. Multiple flow paths are simulated iteratively, allowing the lava to flow downward, with a probability inversely proportional to the height difference between the source and the surrounding pixels. The lava is allowed to overcome topographic obstacles of contrasted heights where the lava is flowing on a slope or accumulating in a depression.

The length of the simulation can be defined as a fixed value, as a probability density function based on a Gaussian distribution, or it can be controlled by the initial eruption rate and the thermo-rheological parameters controlling the cooling of an open-channel lava flow. The main inputs of this model version are the eruption rate, the channel geometry, the lava viscosity and the phenocryst content.

This toolbox is here tested and parameterized for 4 different lava flows (1980, 1986, 2004, 2006) of Nyamulagira volcano, using a quality parameter. Nyamulagira volcano is one of the most active volcanoes in Africa, with lava-dominated eruptions every 2 to 4 years. Sensitivity analyses are carried out on the 90 m SRTM DEM. Simulation results are stable for 5000 iterations or more. The initial VORIS model simulated complicated flow paths, leading to shorter effective flows than the input length. This issue is overcome by reducing the capacity of flow to overcome obstacles on sloping ground and by attributing a higher probability to the steepest descent paths. The thermo-rheological calibration of flow lengths proved

successful in simulating different lava flows with a single set of input parameters. The date of acquisition of the DEM and its sensitivity to vegetation cover are shown to control most of the errors in the simulated lava flows.

The toolbox offers the advantage to be coded in a freeware and can therefore be adapted to the need of the user. It can run with decimal values and adapts to DEMs of different spatial resolution. The parameterization for Nyamulagira lava flows demonstrates that it can be used in near-real time for simulation of future lava flows, once the localization of the eruption is known. This toolbox will also be calibrated and tested in the near future to simulate lava flow hazards from Nyiragongo volcano threatening Goma city.

Felpeto et al. (2001), Assessment and modelling of lava flow hazard on Lanzarote (Canary islands), *Nat. Hazards*, *23*, 247-257.

Harris and Rowland (2001), FLOWGO: a kinematic thermo-rheological model for lava flowing in a channel, *Bull. Volcanol.*, *63*, 20-44.