LAHAR SERVICE

Numerical Simulation of Lahar Hazards

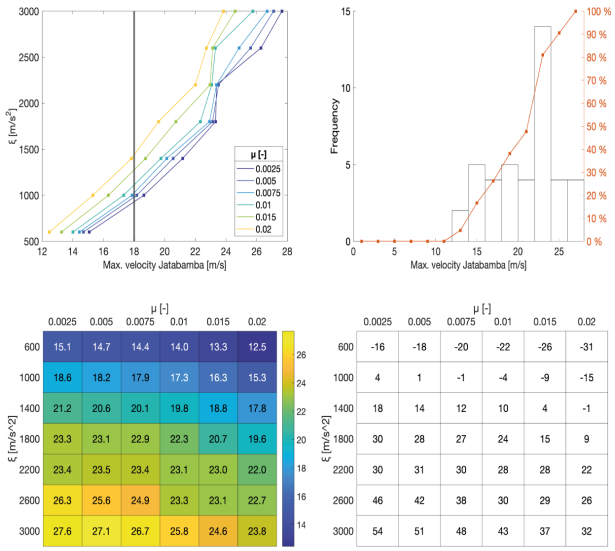
Lahars rank among the most disastrous volcanic natural hazards. Their destructive potential arises from their sudden onset and outstanding flow characteristics featured with high sediment carrying capacity, speeds exceeding tens of km/h, discharges up to about 50,000 m^3/s, and runout distances of tens to even hundreds of kilometers. In the RIESGOS project, the pilot region for volcanic hazards is located around **Cotopaxi volcano**, Ecuador. The active, glacier-capped Cotopaxi volcano is among the most dangerous volcanoes worldwide, because it can potentially produce massive syneruptive lahars.

Lahar deposits at the foot of Cotopaxi volcano. Photo: Johannes Leinauer, 2019.

In RIESGOS, we develop a generic model approach across different scales of high-magnitude lahars and show how it can be used to **anticipate future syneruptive lahars**.

NUMERICAL APPROACH

The numerical simulations use the **single-phase RAMMS model** (Christen et al., 2010) with an implemented entrainment algorithm, covering the entire lahar path from the steep volcano flank to an extent of tens of km from the source. The model requires careful **calibration of the two governing friction parameters of the Voellmy-Salm rheology**. Therefore, we back-calculate the last major Cotopaxi lahar of 1877 and objectively constrain best-fit input parameters based on 14 historic records on flow height, flow velocity, peak discharge, travel time and inundation limits.



Example of the calibration process: which parameter combination best represents the 1877-lahar velocity at Jatabamba?

A realistic parametrization of flow behavior also involves estimating the **erosion capacity of lahars**, which is achieved by a straightforward estimation of substrate erodibility. In this way, the model can estimate the volume growth of the lahar on the steep volcano flanks and during downstream

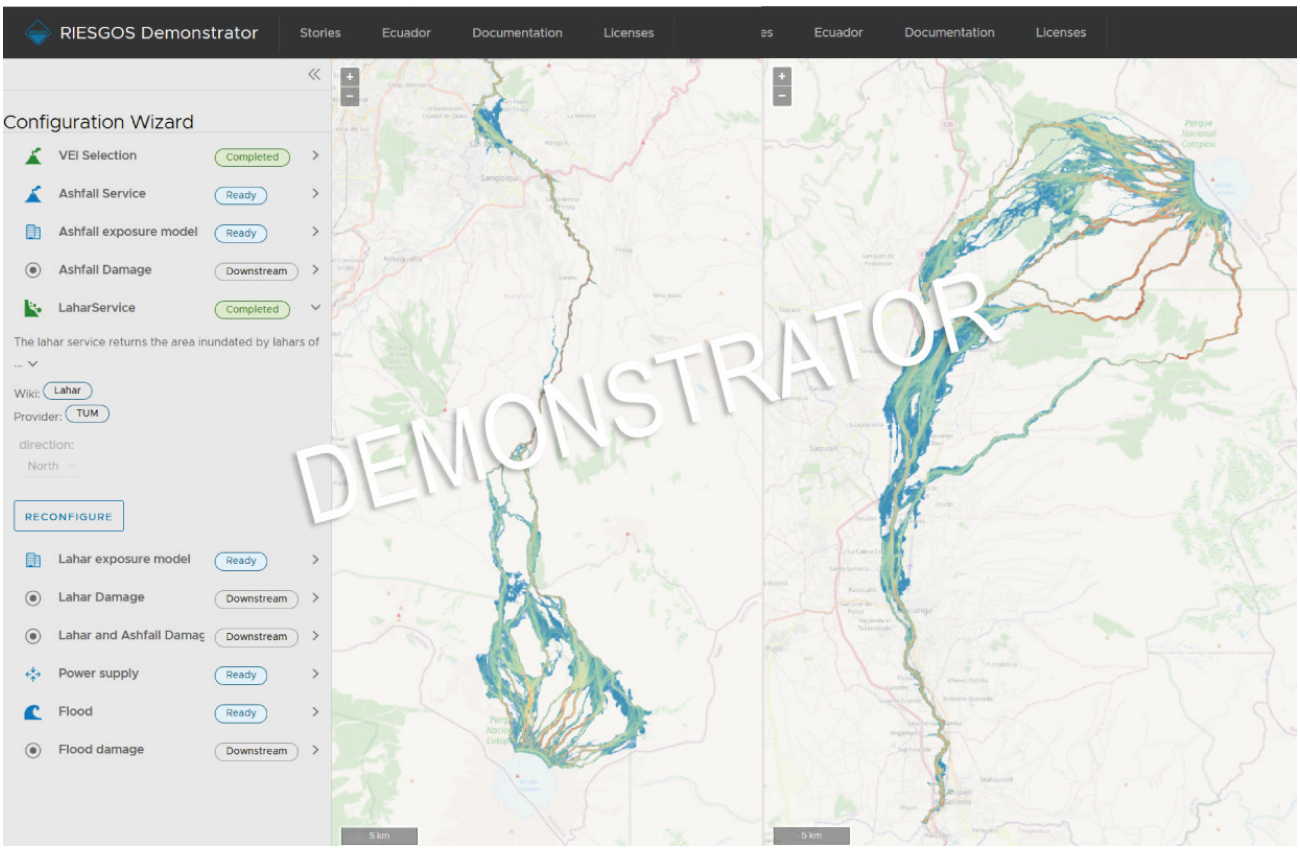
propagation. The calibrated model is applied to potential future eruption scenarios at Cotopaxi and accordingly scaled lahars.

DATA PRODUCTS

The RIESGOS demonstrator explores the hazards of future syneruptive lahars generated during **four potential eruption scenarios** (VEI 1-2, VEI 2-3, VEI 3-4, VEI > 4), as defined by IG-EPN Ecuador. For each scenario, the following products of the lahar service are visualized in the demonstrator:

- Estimated **max. flow height**
- Estimated **max. flow velocity**
- Estimated **max. pressure**
- Estimated **max. erosion depth**
- Estimated **travel time**

The rasterized results have a resolution of 10 m and are displayed either for the northern or southern drainage of Cotopaxi. In the future, the demonstrator can also include existing lahar models of earlier studies to enable comparison of simulation results.



Screenshots of the RIESGOS demonstrator, displaying maximum heights of syneruptive lahars generated during a potential future VEI 3-4 eruption in the northern (left) and southern drainage (right) of Cotopaxi.

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More information about the project:
www.riesgos.de

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