Size-frequency distribution of landslide-dammed lakes from a simulation approach

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Introduction:

The scaling of events in geomorphology relates the magnitude of an event to its frequency. The size-frequency distributions of landslides have been found to follow a power-law scaling (Tebbens, 2020). However, the scaling of lakes formed by the deposition of landslides in the river bed received less attention (Fan et al., 2020). In this study, we simulate landslide occurrence, their runouts and the resulting lakes in 8 mountain ranges.

Methodology:

We simulate landslide-dammed lakes across 8 mountain ranges from topographical datasets, then plot their size-frequency distribution to assess the variability of scalings found.

Research questions:

Do landslide-dammed lakes also follow a power-law?
What is the influence of topography in their size-frequency distribution?

Landslide release area determination based on slope thresholds (Hergarten, 2012) reproducing landslide size-frequency distributions.

Input data:
World-wide available topographic dataset (SRTM, 1 arc-second resolution)

Landslide runout simulation (Hergarten et al., 2015)

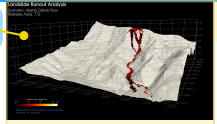
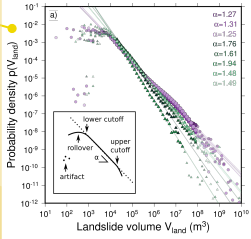


Fig. 3: Landslide runout analysis with Gerris (Popinet, 2003; Hergarten et al., 2015).

Lake filling, landslide-dammed lake scaling

Fig. 2: Landslide scaling of the simulated landslides in the 8 mountain ranges. The size-frequency distribution of landslides follow a power-law (Tebbens, 2020).



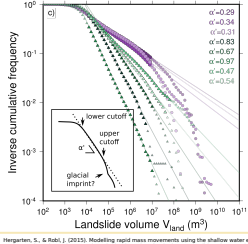
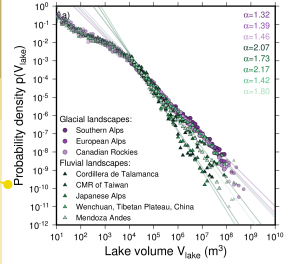
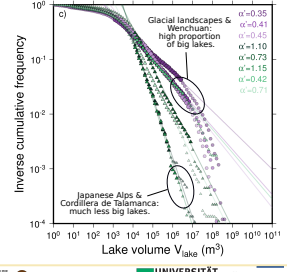


Fig. 4: Landslide-dammed lake scaling of the simulated events in the 8 mountain ranges.





Conclusions:

- Landslide-dammed lakes also follow a power-law scaling, although not directly predicted by the scaling of the landslides.

- Cumulative density plots are especially appropriate to highlight the influence of glacial imprint on landslide scaling.

- Fluvial landscapes present results following more closely the power-law scaling.

However, since lake volume is influenced by valley shape, and can be inferred from drainage area as well as landslide size (Argentin et al., 2020), its scaling cannot be directly explained by glacial imprint and landslide scaling.

Todo:

- Validation against existing datasets (e.g. Fan et al., 2020)
- Analysis of the link between scaling coefficient and topographic characteristics

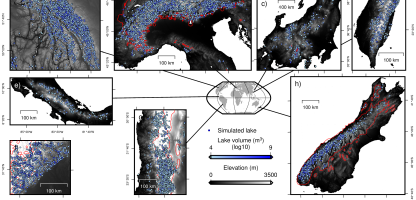


Fig. 1: Location of the simulated landslide-dammed lakes in the 8 mountain ranges investigated: a) Canadian Rockies, b) European Alps, c) Japanese Alps, d) Central Mountain Range of Taiwan, e) Talamanca Cordilleira, f) Wenchuan region, China, g) Mendoza Andes, h) Southern Alps of New Zealand

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