# Parameters driving debris flow dynamics


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### Introduction

Debris flows are rapid and hazardous mass movements consisting of water and soil debris in high concentration (Fig. 1). The dynamics of a debris flow are the key to hazard assessment. The most important dynamic parameters are velocity, flow depth and the Froude number. The Froude number combines velocity and flow depth and is a simple way to scale a debris flow.

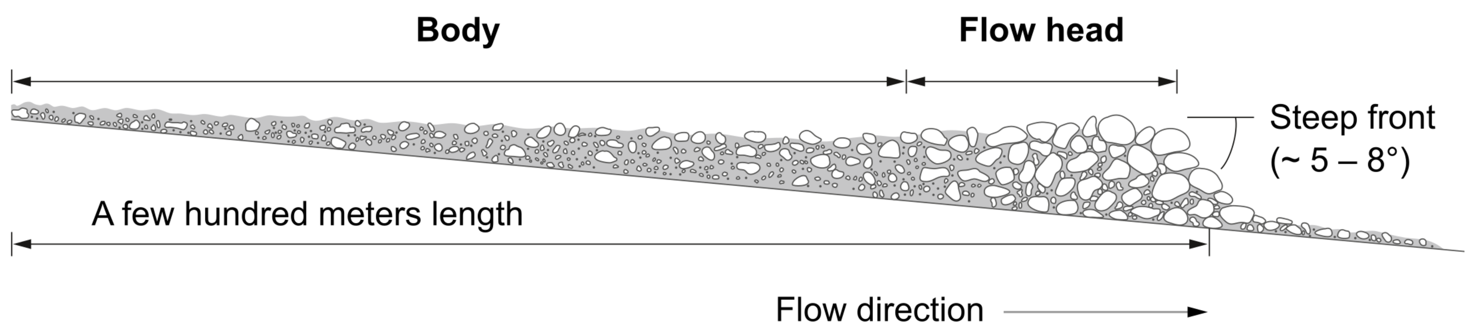


**Figure 1:** General architecture of a debris flow modified after Costa (1984) and Schlunegger & Garefalakis (2023).

### Aim

The aim of this study is to investigate, based on the Illgraben system, which key parameters have an influence on debris flow dynamics and are thus essential for hazard assessment.

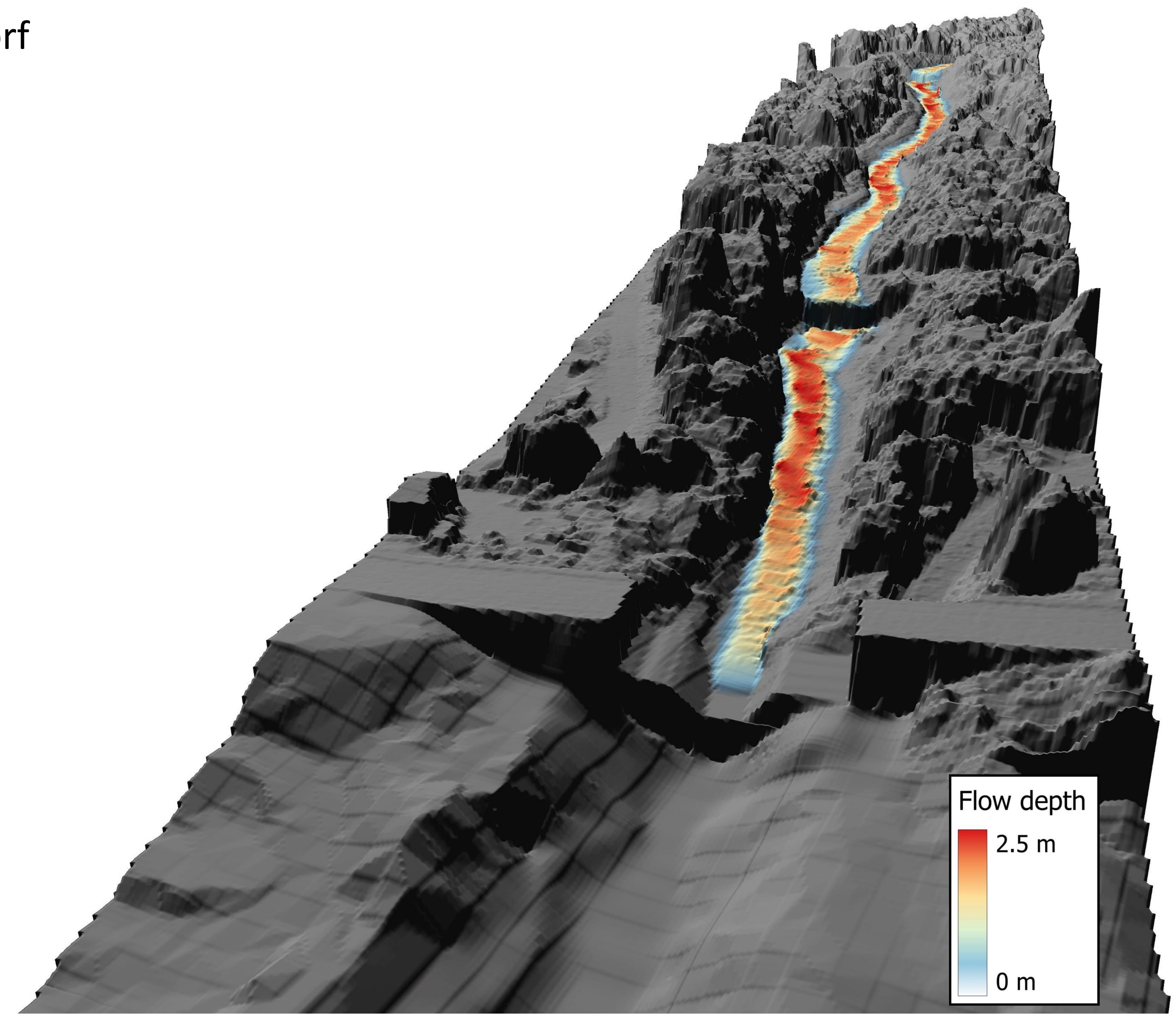


**Figure 2:** Simulation of a debris flow event in the Illgraben using RAMMS::DEBRISFLOW.

### Study site

The Illgraben is located in the Valais, south of Leuk. It is an exceptionally active catchment, generating 3-5 debris flows per year (McArdell et al., 2007). Due to this high activity, a debris flow monitoring station was installed by the WSL. This station records parameters such as velocity, flow depth, volume, maximum discharge and density for each debris flow.

### Methods

- Samples of debris flow deposits to investigate the influence of grain size distribution on the dynamics.
- Debris flow simulation with the program RAMMS (Fig. 2) to analyze the friction conditions and their relationship to debris flow dynamics.
- Search for correlations between different measurements of the monitoring station.

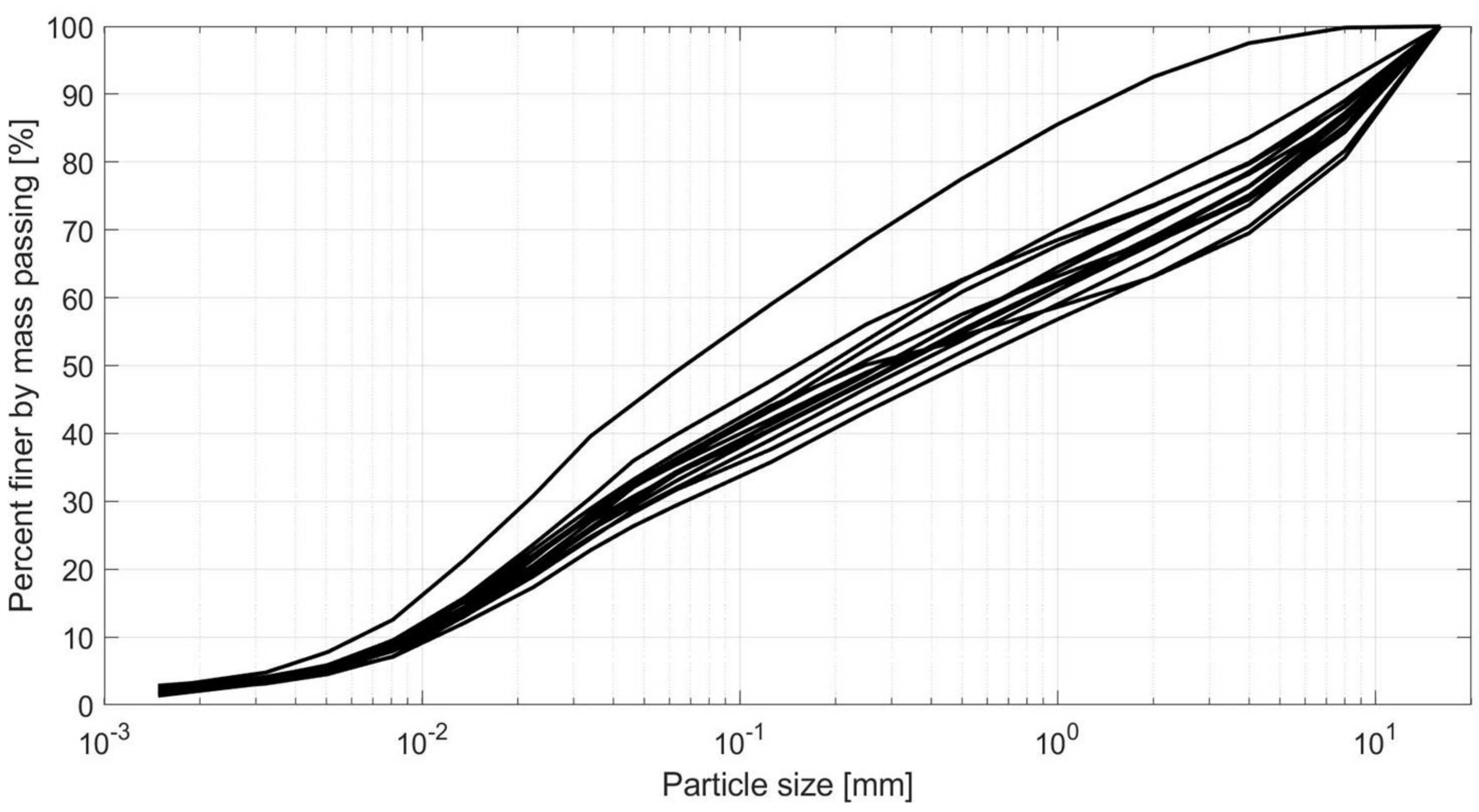


**Figure 3:** Grainsize distributions of the debris flow deposits. The samples are from the years 2019, 2021 and 2022.

### Results

- Uniform grain size distribution (Fig. 3) with no correlation to flow dynamics.
- Froude number proves to be a simple but very useful indicator for the dynamics of a debris flow.
- Strong relationship between friction conditions and Froude number in a RAMMS simulation.
- Significant correlation between total volume of a debris flow and its Froude number (Fig. 4).
- No correlation between water content of a debris flow and its Froude number (Fig. 4).

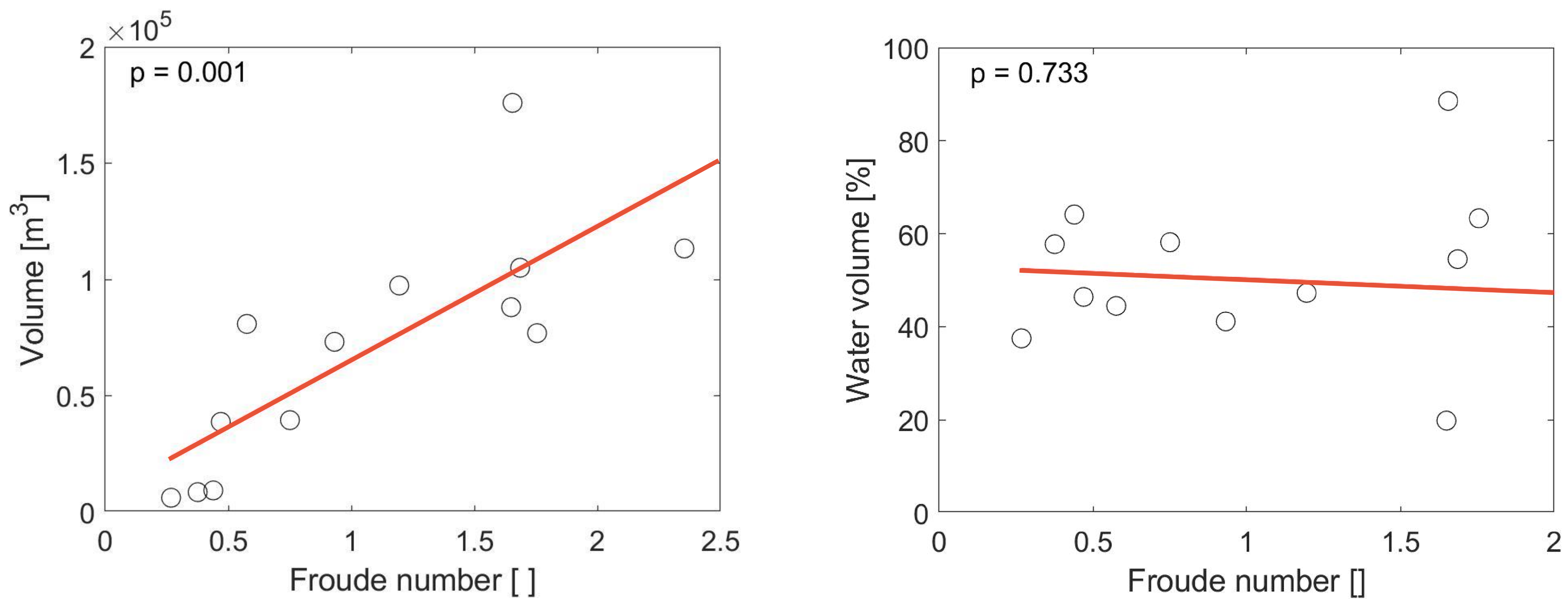


**Figure 4:** Correlation plots with a first order polynomial least square fitted trendline (red) and a statistical p-value.

### Conclusion

- Debris flow dynamics do not depend on the grain size distribution.
- Friction conditions in a RAMMS simulation can be defined based on the estimated Froude number in order to obtain a realistic simulation.
- A debris flow can be assessed based on a volume estimate.


**Acknowledgement**

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**References**


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