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Optimal design of snow avalanche passive defense structure using extreme value run-out models

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In order to protect elements at risk (humans, roads, houses, etc.) against snow avalanche hazard, civil engineering structures can be used such as dams or mounds. Generally, the design of such defense structures is based on the definition of a reference hazard used to define the potential loading applied. These approaches remain insufficient for their optimal design. The minimization of expected total costs is an interesting alternative that generalizes cost-benefit approaches to a continuous decision variable. Hazard magnitude must though be evaluated with care, and extreme value theory is a natural framework to work within.
In this study, we expand previous work devoted to the optimal design of the height of an avalanche dam by risk minimization. The magnitude of an avalanche is assumed to be represented by its run-out distance, the most critical value. A simple Peak Over Threshold model is used to represent the number and the magnitude of run-outs exceeding the dam, but the exponential distribution is replaced by the Generalised Pareto Distribution more consistent with the extreme value theory. Total costs are evaluated as the sum of construction costs and damages to buildings of various value and position.
An application on a real case study illustrates the approach. Statistical and decisional considerations are proposed to quantify the risk. For instance, a baseline risk function is considered and its influence on the decisional variable is shown. Optimal design results, obtained under both Classical and Bayesian paradigms, are compared and discussed.