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Materosion - Modelling sediment cascade towards prediction of solid mass wasting in steep alpine catchments

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The Materosion model, conceived between IGAR and CREALP, aims at better assessing the sediment output of torrential streams over a 100-year timespan. The study area is centered on the village of Zinal, in the upper Anniviers Valley (canton Valais, Switzerland). This village is exposed to several active torrents and snow avalanches propagation zones, requiring massive protection measures (levees and dykes). These retention structures need regular maintaining and dredging. Since the village is situated upstream the valley, the extracted volumes of sediment must be managed locally for practical and economical reasons.

The Materosion model derives from the concept of a sediment cascade. Considered torrents are divided in homogeneous reaches (slope, width, direction, etc), that receive, contain and transmit sediment from and to other reaches. Slope processes such as landslides, rockfalls, soil creep and rock glaciers contribute to the system. Those contributions are calibrated using regional studies (regional sediment budget), detailed site study and TLS of active zones for short term erosion rates. The model is then coupled with a stochastic precipitation input, controlling the frequency and magnitude of debris flows and bedload transport events, routing the sediments downstream.

The final output gives a mean trend of sediment production downstream each catchment over a number of different simulations (> 10'000), as well as the distribution of events, and the variance induced by all the event scenarios deriving from the meteorological model. The model is adaptable to different catchment types, sizes and processes involved. The results are in agreement with historical measurements in small control catchments (yearly mean production of 1100 m3 over 100 years (variance of 500 m3) with stable climatic conditions, compared to recorded mean volume of 1000 m3 over 20 years), adding to the latter the whole site distribution of events as well as temporal repartition.