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# Global budget of relief destruction

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As proposed by Jaeckli (1957), all surface erosion processes should be taken into account in order to define the budget of a watershed. One way to compare all these slope processes, which are mainly gravitational (even dissolved matter is flowing down), is to quantify the potential energy loss associated to each one of these processes. All gravitational processes, including debris-flows, rockfalls and rock avalanches, landslides, dissolved and bed loads, solifluction,. should be then considered.

Using the data related to the Upper Rhone River Basin (URB) in the Swiss Alps, it is possible to compare the potential energy loss related to the slope processes with the present potential energy loss estimated from the sediment yield in the Rhone River. The URB has a surface of approximately 5,200 km$^2$, with an average altitude of 1770 m above its outlet. The solid erosion rate, estimated from the suspended load in the Rhone River, is about 0.19 mm/a, which is the same order of magnitude as for other catchments over the world Anhert (1998).. The erosion rate due to dissolution, which is estimated from the dissolved load in the river, is about 0.09 mm/a. Assuming that the potential energy loss is distributed over the entire surface of the basin, the energy loss due to the solid transport is about 8,700 J/(a.m$^2$) (Solid + dissolved = 12,700 [J/(a.m$^2$)]) (Schlunegger and Hinderer, 2003). Now, considering the rockfall frequency (which follows a power law dependant on the volume of the event (Dussauge et al., 2003), the mean landslide (excluding rockfalls and debris-flow) velocity and thickness based on observed velocities, and the mean debris flow activity, we obtain a total potential energy loss, for all three processes, of 5,400 J/(a.m$^2$), that corresponds to an equivalent denudation rate of 0.12 mm/a. This calculation shows

that the orders of magnitude of both energy loss and erosion rates are the same for the slope activity and the fluvial solid transport. In fact, most of the suspended load comes from the bottom of the valley of the drainage basin. This leads to the conclusion that the potential energy loss due to the solid transport is largely overestimated. Moreover, the suspended load comes mostly from glacial deposits. Thus we conclude that presently most of the destruction of the URB is produced by slope activity and dissolution, and only partly by river erosion.

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