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Landscape response to rare flood events: a feedback cycle in channel-hillslope coupling

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Fluvial channels and the surrounding landscapes are in a permanent feedback relation, exchanging mass and energy. Only rarely we get the opportunity to observe the processes at work and study the underlying cause and effect relations. This is especially difficult, since processes can be highly non-linear, and the response to a trigger may occur after a lag time such that their correspondence is not immediately obvious.

In the Erlenbach, a mountain stream in the Swiss Prealps, we study the mechanistic relations between in-channel hydrology, channel morphology, external climatic forcing and the surrounding sediment sources to identify relevant controls of sediment input and their characteristic scales. Here, we present time-lapse observations of a suspended slow-moving landslide complex with a direct connection to the channel. The channel-hillslope system was in a stable system state for several months. Only after a flood event, in which a channel step was eroded at the base of the hillslope, the hillslope was destabilized through debuttressing. As a consequence, the landslide was reactivated and entered a sustained phase of integral motion. The response phase ended when the landslide material reached the channel and formed a new channel step, re-buttressing the hillslope.

The observations reveal that, at least in the Erlenbach, sediment input from the hillslopes is not a uniform process controlled by precipitation only. Instead, a perturbation of the system in form of the erosion of an alluvial channel step was necessary to initiate the feedback cycle. The observation illustrates the importance of a thorough identification of the process mechanics to understand the sediment dynamics and the formation of landscapes on long time-scales.