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Modelling geomorphic responses to human perturbations: Application to the Kander river, Switzerland

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Before 1714 the Kander river (Switzerland) flowed into the Aare river causing massive flooding and for this reason the Kander river was deviated (Kander correction) to lake Thun. The Kander correction was a pioneering hydrological project and induced a major human change to the landscape, but had unintended hydrological and geomorphic impacts that cascaded upstream and downstream. For example doubling the catchment area of Lake Thun, which gave rise to major flood problems, cessation of direct sediment delivery to the Aare, and sediment flux to lake Thun forming the Kander delta. More importantly the Kander correction shortened the Kander river and substantially increased the slope and bed shear of the Kander upstream from the correction. Consequently impacts of the correction cascaded upstream as a migrating knickpoint and eroded the river channel at unprecedented rates.

Today we may have at our disposal the theoretical and empirical foundations to foresee the consequences of human intervention into natural systems. One method to investigate such geomorphic changes are numerical models that estimate the evolution of rivers by simulating the movement of water and sediment. Although much progress has been made in the development of these geomorphic models, few models have been tested in circumstances with rare perturbations and extreme forcings. As such, it remains uncertain if geomorphic models are useful and stable in extreme situations that include large movements of sediment and water. Here, in this study, we use historic maps and documents to develop a detailed geomorphic model of the Kander river starting in the year 1714. We use this model to simulate the extreme geomorphic events that preceded the deviation of the Kander river into Lake Thun and simulate changes to the river until conditions become relatively stable. We test our model by replicating long term impacts to the river that include 1) rates of incision within the correction, 2) knickpoint migration, and 3) delta formation in Lake Thun. In doing this we build confidence in the model and gain understanding of how the river system responded to anthropogenic perturbations.