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Response of an experimental micro-scale river to a vertical offset of its bed

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Understanding the dynamics and estimating the timescale governing the response of a river to an external perturbation is an important task as some features such as terraces or knickpoints are often used as markers to determine upflift rates or to date earthquakes and climatic changes. Here we focus on the question of the lifetime of a vertical offset generated in the bed of a river by a seism.

This problem is adressed experimentally by investigating the response of a micro-scale river to a vertical offset of its bed. The experimental setup is a small inclinable flume of cross section $5 \times 5\ cm^2$ and length 1m. Water is injected in the flume inlet with a flow rate ranging between 0.1 and 2 liters per minute and flows above an erodible bed of glass beads of size between 50 and 100 μm. The relationship between bedload and water flow rate is calibrated. Although the flow is laminar, our experimental river follows a transport law similar to the Peter-Meyer-Muller law which governs sediment transport in natural turbulent rivers.

A gate located at the downstream end of the flume can be suddenly dropped down thus creating an offset of the river bed. The response to this perturbation is characterized by measuring the bed elevation at regular time interval using the deviation of several laser sheets. The offset is rapidly erased and the river transits toward a new equilibrium state through propagation of an erosion wave. Sediment mass conservation together with the transport law and shallow-water equations allow us to write the equation describing the evolution of the bed elevation. Numerical solutions of this equation show a good agreement with the experimental observations. The results are extrapolated to the case of natural rivers allowing us to estimate the timescales necessary for a river to fully erase the trace of a vertical offset of its bed.