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Analysis of the spatiotemporal planform dynamics of braided rivers: a novel laboratory investigation

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Braided rivers are highly dynamic, labile environments which experience significant morphological changes even during moderate flow events.
Recent remote sensing techniques enable to monitor the river morphology with great detail. However, capturing the rapid morphological changes of a large river with sufficient temporal and spatial resolution is still very challenging. As a consequence, quantitative analysis of the braided channel dynamics is often limited to local processes (e.g. a single bifurcation or confluence) and short time periods (e.g. a single flood).
This work aims at providing quantitative, statistical description of the channel network dynamics in a braided network at larger spatial and temporal scales, namely the reach scale and the multiple flood scale.
This can be achieved using a new technique based on time lapse imagery that we recently developed at the University of Trento. This technique provides high frequency, two dimensional maps of the bed load transport in a large laboratory model, thus allowing to capture the spatiotemporal variability of the transport processes with unprecedented detail.
We performed a set of laboratory experiments in a 23 m long, 3 m wide flume, sand bed load flume, where self-formed braided networks can be reproduced. We run several experiments with different discharges and channel widths, lasting for a long time (from 20 to 65 hours) to enable a robust statistical description of the equilibrium morphodynamics.
High-resolution pictures were taken at 1 min interval from two SLR cameras, then rectified and merged in order to cover a 7 m long reach. We processed a large number of images to obtain maps of bed load transport, and we developed an algorithm to automatically identifies active (i.e. transporting) channels, bifurcations and confluences. The statistical analysis we performed includes two dimensional correlations, spatial and temporal scales, channel migration rate, avulsion frequency, bank erosion rate. This provides a complete, quantitative description of how the braided channel pattern evolves in time depending on the relevant controls, primarily water discharge and available width.
Such results provide information about the fundamental mechanisms governing the braided dynamics and about "how" and "how much" the river is likely to change during a flood, which is relevant for the calibration of numerical morphodynamic models and for river management purposes.