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Influence of a submerged vegetation patch on river hydraulics and morphodynamics

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Vegetation is a common feature in natural rivers. It creates a drag that reduces the flow velocity and it is also known to modify the turbulence structure of the flow. Sediment transport which is driven by near bed shear stress and turbulence is therefore also affected by the presence of vegetation, as well as the morphodynamic evolution of the riverbed.

In order to quantify the effect of vegetation on flow, sediment transport and morphodynamics, we performed a flume experiment with a patch of flexible, submerged vegetation. The flume is 12-meter long, and the central 6-meter long portion of the bed is covered with plants made of plastic blades. The sediment bed is made of sand (150 microns) which is transported both as bedload and suspension.

For the flow, we found that velocity was reduced in the canopy, and that turbulence was generated at the top of the canopy. Calculating a Manning's friction coefficient also yielded higher values than on a bare sand bed.

For the sediment transport, we found that the sediment flux in the vegetation was reduced. As the experiment proceeded, a morphodynamic adjustment of the sand bed was observed with deposition at the entrance of the patch that led to an increase of the bed slope in the patch. Finally, an equilibrium stage was reached, where the sediment flux was restored and the bed slope in the vegetation patch was stabilized at a higher value than at the beginning.

To explain these observations, we partition the total bed stress and show that the skin friction, which is the portion of the bed stress that is efficient for sediment transport, is reduced in the plant patch. This induces a reduction of the sediment transport in the patch and a morphodynamic adjustment of the bed in order to accommodate the incoming sediment flux.