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Caroline Le Bouteiller[1], Jeremy G. Venditti[2], Dave McLean[3]
[1] IRSTEA, UR ETNA, Saint-Martin d'Hères, France (caroline.le-bouteiller@irstea.fr)
[2] Simon Fraser University, Burnaby BC, Canada
[3] Northwest Hydraulic Consultants Ltd., North Vancouver BC, Canada

Abstract:

Vegetation is a common feature in coastal and riverine flows. It interacts both with the water flow and with the sediment fluxes, therefore affecting the morphodynamics of the system. Here we focus on the case of submerged and flexible vegetation, such as eelgrass that grows on the tidal flats of Southwestern Canada.

Using flume experiments, we studied how such vegetation may affect first the water flow, then the sediment fluxes. For the hydrodynamics, we found that the friction law was modified by the vegetation. Moreover, as the plant bending changes with the water velocity, the friction law itself depends on the water velocity. For the morphodynamics, we found that the skin friction and the sediment flux were reduced in the plants, because most of the shear stress was contributed by the plant drags. In a constant sediment input environment, the morphodynamic response was an increase of the bed slope in the plants. We partitioned the total shear stress between the skin friction, the form drag generated by the bedforms and the form drag generated by the plants, and we found that the ratio of the skin friction to the total shear stress depends on the vegetation density but does not depend on the water velocity.

Based on these experimental results, we proposed new methods to take the effect of vegetation into account in a 2D hydrodynamic model such as Telemac2D-Sisyphe. In Telemac2D, we incorporated a modified Manning's friction law where the Manning's coefficient is a function of the local velocity. The higher the velocity, the more the plant bends, and the less friction it generates on the flow. In Sisyphe, we defined a specific skin friction correction that accounts for a reduction of the skin friction in the vegetated areas only. The correction is a function of the local vegetation density.

We tested the model by running simulations of the flume experiments and we found that it reproduced well the main morphodynamic response of the bed. Future work involves testing the model at larger scales both in tidal and riverine hydrodynamic conditions.