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Sediment resuspension in simulated and real vegetated beds by waves and turbulence in wetlands

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A set of laboratory experiments were conducted to study the effect of submerged aquatic vegetation in sediment resuspension under a) progressive waves and b) turbulence in an attempt to quantify the buffer effect of vegetated beds under external forcings, in wetlands. Three vegetation models, rigid, flexible and real plants of Ruppia maritima and four canopy densities (Solid Plant Fractions, SPF in the range of 1-10%) were used. In the progressive waves experiment six wave frequencies (in the range F=0.6-1.6 Hz) were used to propagate waves in a flume while in the turbulence experiment three turbulent conditions originated from a top oscillating grid were used. The sediment bed properties corresponded to a salt marsh wetland with a bimodal particle size distribution with two particle populations (population 1: particle diameters in the range of 2.5 to 6.0 μm, and population 2: particle diameters in the range of 6.0 to 100 μm).
In the progressive wave experiment, for the rigid canopy model, in comparison to the unimpeded experiment, an increase in TKE inside the canopy for smaller frequencies (F=0.6-1.2 Hz) was observed, together with stem Reynolds numbers Rep above 250. As a result, sediment resuspension for both sediment populations was higher than that of the unimpeded experiment. However, at higher frequencies (F=1.4 and 1.6Hz) and high canopy densities (SPF=5%, 7.5% and 10%), the TKE inside the canopy decreased, coinciding with stem Reynolds number Rep below 250. As a result, sediment resuspension for larger canopy densities and larger frequencies was reduced.
For the flexible vegetation model, in comparison with the unimpeded experiment, a reduction in the TKE inside the canopy was found. Resuspended sediment concentrations were found to decrease as flexible canopy densities increased. For the flexible vegetation the stem Reynolds number was Rep<250 and no production of TKE was observed. The real case of a canopy of Ruppia m. behaved similarly to the flexible model canopy.
In the turbulence experiment, the denser the canopies were the greater the reduction in TKE was. The concentration of resuspended sediment from the sediment bottom was an exponential function of the TKE for all canopy densities and simulated canopies. In the high canopy densities, there was a greater resuspension in the rigid canopies than in the flexible canopies. In addition, the greater the sediment concentration in the bed, the higher the concentration of the resuspended sediment.
Assuming that plant survival relies heavily on a stable substrate, this suggests that in both wave or turbulent domains, sparse, rigid vegetation may be as equally resilient as sparse, flexible vegetation, but dense, flexible vegetation may be more resilient than dense, rigid vegetation. Therefore this study has determined how a vegetated bed in a wetland may respond to forcing conditions as such waves and turbulence.