Effects of aquatic vegetation on hydrodynamics and biogeochemical processes : from ecosystem engineering to feedbacks for plants

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Abstract

Submerged aquatic plants are ecosystem engineers that are able to modify their habitat. In streams, patches of aquatic plants are porous objects through which flow can partly pass, but with a reduced velocity, shear stress and turbulence. As a result, the potential of resuspension and erosion is reduced within plant patches, where fine sediment tends to accumulate, whereas flow acceleration next to the patch contributes to particle resuspension and erosion. Our objectives were to investigate the effects of patch size on plant-flow-sediment interactions in lotic ecosystems and the possible feedbacks for the plant themselves resulting from these modifications of the habitat. We performed in situ measurements of hydrodynamics, sediment characteristics, nutrient concentrations in interstitial water and plant growth along natural plant patches. Our results demonstrate that a minimum patch size was needed to induce in-patch streamwise velocity reduction and the accumulation of fine sediment. Streamwise velocity and the sediment grain size decreased with patch length, following a linear and exponential relationship, respectively. Our results also demonstrate an increased organic matter content of the in-patch sediment as well as increased concentrations of orthophosphate and ammonium and a reduced nitrate concentration in interstitial water in patches compared to bare sediment. All these changes in biogeochemical characteristics were dependent both on patch length and on position within patches and resulted in feedbacks for plant growth that may determine vegetation dynamics in flowing ecosystems. The

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modification of some important physical characteristics of the habitat (flow, sediment deposition...) induced by plants may play an important role in ecosystem functioning through the changes in the nutrient cycling of nutrients occurring within plant patches.