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Implementing plant growth of flexible aquatic vegetation into a hydrodynamic model (TELEMAC2D)

Implementing plant growth of flexible aquatic vegetation into a hydrodynamic model (TELEMAC2D)

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Abstract:

In lowland rivers, mutual interactions between aquatic vegetation and water flow are expected to impact morphology. The presence of aquatic vegetation increases the hydraulic resistance encountered by water flow. On a local scale this results in flow deceleration within vegetation patches and in flow acceleration adjacent to vegetation patches. Reduced flow velocities within vegetation patches are beneficial for plant growth and therefore referred to as a positive feedback. While increased velocities adjacent to the vegetation patches are able to hamper plant growth, break off or uproot plants constituting a negative feedback. These two phenomena are in literature referred to as scale-dependent feedbacks (positive and negative feedbacks dependent on the spatial scale considered, i.e. in the patch or at its edges), which are further described as the mechanisms influencing heterogeneous spatial habitat structure.

A depth-averaged hydrodynamic model (TELEMAC2D) coupled with a plant model is used to investigate the importance of scale-dependent feedbacks in structuring lowland river habitats. We simulate the feedback between spatio-temporal growth of aquatic vegetation and its impact on the associated flow field. The dynamic plant growth model simulates changes in biomass of the plants. The biomass is represented as a tracer in the hydrodynamic model. The plant model itself consists of vegetation establishment-, mortality-, logistic increase of biomass- and lateral spatial expansion processes. The influence of vegetation is incorporated by schematizing vegetation as cylinders which exert a drag force to the flow, following the approach of Baptist et al. (2007). Since vegetation is flexible, the magnitude of the drag force is a function of vegetation reconfiguration and therefore dependent on the stream velocity itself.

Our preliminary results stress the importance of scale-dependent feedbacks on spatial habitat structure. We focus on three species with contrasting plant traits which due to differences in scale-dependent feedback strength lead to different spatial configurations. A dense species (*Callitriche obtusangula*) causing high hydraulic resistance instigating a strong scale-dependent feedback which results in delineated patches alternated with bare soil. An intermediate dense species (*Sparganium emersum*) forms long vegetated areas and a low density species (*Potamogeton natans)* with low hydraulic resistance, limited interaction with the water flow occupies the complete river bed. Our results underline, through a comparison between our model results and observed vegetation

patterns in lowland rivers, the importance of species-specific plant traits on spatial habitat structure.

References:

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