Technische Universität Braunschweig

Master thesis

Analysis and Numerical Simulation for a new Shallow Water Model with Vegetation

Course of study: Mathematics or Computational Sciences in Engineering

Problem

River flows are efficiently simulated using the shallow water equations. In the most simple version, the evolution equations for water height h and average velocity u, read

$$\partial_t h + \partial_x (hu) = 0, \quad \partial_t (hu) + \partial_x \left(hu^2 + \frac{1}{2} g h^2 \right) = -gh\partial_x b.$$

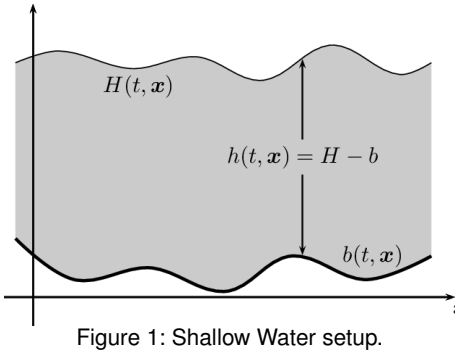

Figure 1: Shallow Water setup.

Recently, more advanced models have been developed that take into account more physical velocity profiles, for example slower velocities at the bottom of the river due to friction.
In this project, we want to study the effect of vegetation on the water flow. This requires more detailed knowledge about the velocity profile and its interaction with the vegetation. Most commonly, vegetation is modeled by an additional friction term in the model. This friction term then reduces the velocity only in the regions of vegetation. Different scenarios include, e.g., submerged or floating vegetation.

Goal

This project's goal is to use newly developed models to analyze and simulate more accurate river flow with vegetation. The detailed goal depends on the interests of the student and can vary between an analytical investigation of the model, a numerical simulation, or the extension of existing software tools for this model.

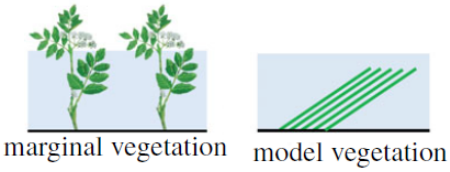

Figure 2: Vegetation in water.

Preliminary work

The model has been proposed in 2019 and was followed by 1D simulations, stability properties, steady-states analysis, and the extension to 2D. The inclusion of vegetation is still missing.

Tasks

The theoretical, applied or computational work can include (in part)

- Addition of a vegetation model to the extended shallow water equations
- Analysis of the coupled model
- Inclusion of a vegetation growth model
- Comparison of the model with experimental data or other models

The final tasks will be discussed with the supervisors. Please feel free to get in contact.

Supervision

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