Universität Stuttgart

IWS Department of Hydraulic Engineering and Water Resources Management
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M.Sc. Topic

Three-dimensional (3d) simulation of turbulence in open channel flows and nature-based solutions

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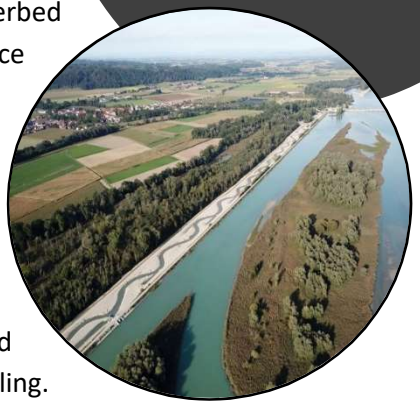

Background

Efforts to restore rivers have aim to improve the habitat quality of aquatic ecosystems, but can be challenging because of riverbed clogging. In gravel-dominated rivers, fine sediment can cause clogging by infiltrating the pore space of the coarse sediment matrix. Riverbed clogging reduces the hydrodynamic exchange between surface water and the hyporheic zone, which deters habitat conditions, for example, by reducing the availability of oxygen for fish eggs in the riverbed. The placement of large wood (LW) pieces—a type of nature-based solution (NbS) —was found a promising tool to trigger de-clogging of the riverbed by increasing hydrodynamic flow field variability, that is, turbulence. However, turbulence in open channel flows is challenging to measure and model, even with sophisticated three-dimensional (3d) CFD modeling.

This thesis capitalizes on an existing two-dimensional (2d) numerical model of a morphodynamic fishpass. The existing model accounts for multiple modes of sediment transport and will be extended in this thesis into the third dimension in space. For this purpose, measurement data is available, such as flow velocity, a digital elevation model (DEM,) structure dimensions, and many more. A sensitivity analysis of model input parameters (e.g., roughness height, turbulent viscosity, etc.) will serve identify the variance of the model output compared to measured data.

Thesis Overview

1. Familiarize with TELEMAC 3D and its options for turbulence modeling.
2. Familiarize with the existing model and data.
3. Refine the numerical mesh around LW pieces.
4. Set up the 3d simulation and run a sensitivity analysis of relevant parameters.
5. Run the numerical model with different turbulence models.
6. Describe the observations in the model output regarding flow patterns.

Required Skills: Basic understanding of numerical modeling of rivers and passion for hydraulics.

Desirable Skills:

1. Basic skills in Python programming
2. Command of GIS tools (such as QGIS)

Apply now!

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The thesis can be written in German or English

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