Mixed-size sediment morphodynamics

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Challenge

Rivers carry sediment of different sizes. Modelling this characteristic is essential for properly predicting the effect of interventions (e.g., sediment nourishments). The current modelling approach sometimes catastrophically fails when accounting for mixed-size sediment, as the model is mathematically ill-posed. Currently, river managers do not have a reliable tool for predicting river morphodynamic changes accounting for mixed-size sediment.

Innovative components

We have analyzed the conditions under which the current model becomes useless in practice. We have developed a tool to predict when will this happen in numerical simulations. We have conducted a set of laboratory experiments to gain insight into the physical reasons that cause failure of the current model. Using the results of the analysis and the laboratory data, we have developed a strategy that prevents the current model from failing. We have also developed a new model that describes the physical processes observed in the experiment that are not included in the current model.

For whom and where?

Our results are of special interest for modellers. In particular, for people dealing with morphodynamic changes including mixed-size sediment. Our results are applicable at both laboratory and field scale without restriction. The problem of ill-posedness is independent of the numerical solver. For this reason, the results apply to all modellers independently of the software they use (e.g., Delft3D, FM, Telemac, Basement,…).

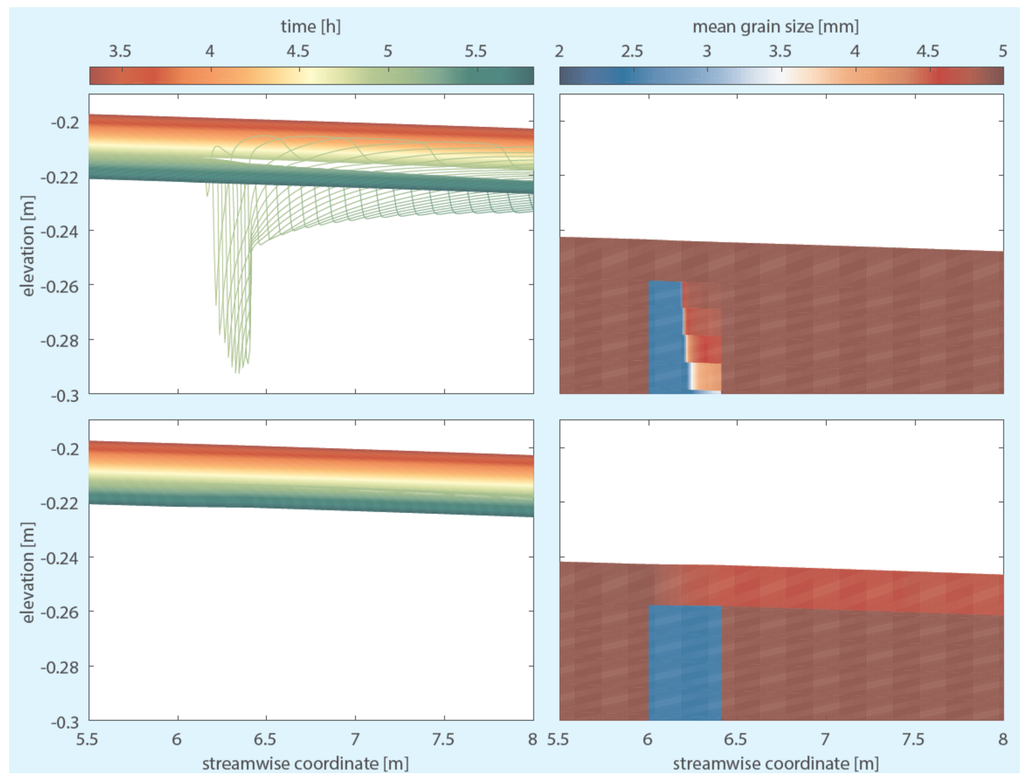
Status for day-to-day practice

- A tool to analyze well-posedness of numerical simulations is available.
- A research numerical model describing river morphodynamics with mixed-size sediment is available that includes the current modelling approach as well as the strategy to regularize the current model when this becomes ill-posed and our new model.

Next steps

While we have analyzed the problem of ill-posedness under one and two-dimensional conditions, our solutions have focused on one-dimensional conditions only. We are currently extending our work to two-dimensional conditions.

Laboratory experiments. We used two sediment size fractions: fine (blue) and coarse (red). Degradational conditions were imposed, causing the entrainment of fine sediment. The current model cannot predict this situation.



The current model (top) fails when modelling the experiments. A large spurious oscillations develops that mixes the substrate sediment in an unrealistic manner. Our strategy to regularize the current model (bottom) is stable and captures the behavior averaged with time reasonably well.

Interested?

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Explore more in https://kbase.ncr-web.org/rivercare/projects/project-d1/ project description

D1 Project

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