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Please forward to appropriate candidates

TOPIC: Sediment-flow-interactions in pores of gravel river beds

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Fine sediment infiltration, interstitial flow processes, experimental work, PIV/PTV

Introduction and background

The long history in research regarding fine sediment infiltration and accumulation into gravel river beds has shown the importance to improve the understanding of the involved fundamental physical processes (surface/subsurface processes). Both the complex interactions from numerous disciplines (hydrology, hydraulics, morphology, sediment transport) and overlapping scales make it difficult to unravel the involved processes or to predict those using mathematical/numerical modelling tools. In addition, interactions between near-bed turbulences, interstitial flows and progressive pore-filling with fine material are so far unexplored but are fundamental to understand the dynamic behaviour of sediment infiltration and accumulation.
This work focuses on interstitial processes to better describe the interactions between progressive occlusion of pores due to infiltrating fine sediments and the interstitial flow field. The interstitial flow close to the sediment surface is usually a result of the advective flow in an out of the gravel bed caused by topographically induced pressure variances and turbulences within the pores of the gravel bed. Thus, the Darcian theory, which is often used to describe hyporheic flow is not applicable in these zones. Using innovative measuring techniques such as particle image velocimetry and particle tracking velocimetry (PIV/PTV) allow for measurements with high spatio-temporal resolution to record the change of the interstitial flow field in the pores continuously and to determine the hydraulic forces, which are exposed to infiltrating particles.

Hence, information on amount and direction of interstitial transport processes can be derived, which significantly increases the available knowledge related to fine sediment infiltration processes.

Methods to be used

The doctoral student will first review both key and recent literature to become familiar with the state-of-research in this scientific field. In addition, the PhD-student need to get familiar with the proposed measuring techniques (particle image velocimetry, particle tracking velocimetry) to be able to prepare, install, test and use them. Based on the literature review, the student will develop an experimental setup and conduct different series of experiments to identify sediment-flow-interactions in pores of gravel river beds. Extensive post-processing, including the use of statistical methods, will be required to develop functional relationships between involved parameters and to compile newly gained knowledge from the laboratory experiments.

Research goals

The main objective of this work is to investigate the interactions between interstitial flow (hydraulic forces) and the infiltration of fine sediments. This includes a detailed analysis of the turbulent flow conditions in surface-near pores of gravel river beds (non-Darcian flow) and the potential (horizontal) transport of infiltrated fine sediment particles. This work contributes to a better understanding of the interstitial/hyporheic processes during fine sediment infiltration and accumulation in gravel river beds.

References (incomplete)

Beschta, R., Jackson, W.L., 1979. The intrusion of fine sediments into a stable gravel bed. Journal of the Fisheries Research Board of Canada 36, 204–210.

Blois, G., Sambrook Smith, G.H., Best, J.L., Hardy, R.J., Lead, J.R., 2012. Quantifying the dynamics of flow within a permeable bed using time-resolved endoscopic particle imaging velocimetry (EPIV). Experiments in Fluids 53, 51–76. doi:10.1007/s00348-011-1198-8

Seydell, I., Ibisch, R., Zanke, U.C., 2009. Intrusion of suspended sediments into gravel riverbeds: influence of bed topography studied by means of field and laboratory experiments. Advances in Limnology 61, 67–85.

Research environment

The doctoral student will conduct the experiments in the hydraulic laboratory at IWS with access to state-of-the-art measuring equipment and support from the laboratory staff. In addition, the student will be embedded in an interdisciplinary working group of post-docs and other doctoral students dealing with different hydromorphological aspects of rivers.

Prerequisites

Background in flow mechanics, statistics and sediment transport is required, at least some idea in experimental work, measurement equipment and techniques.

Contact for questions

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