

EGU21-256

<https://doi.org/10.5194/egusphere-egu21-256>

EGU General Assembly 2021

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HIPPO – In situ device to monitor the remobilization process of fine sediments

Tim Kerlin, Mark Musall, Peter Oberle, and Franz Nestmann

Karlsruhe Institute of Technology, Institute for Water and River Basin Management, Department for Hydraulic and Rural Engineering, Germany (tim.kerlin@kit.edu)

Within the joint project Integrated Water Governance Support System (iWaGSS) funded by the German Federal Ministry for Education and Research (BMBF, reference number: 02WGR1424C) the Institute of Water and River Basin Management (IWG) of the Karlsruhe Institute of Technology (KIT) developed a benthic flume. The benthic flume HIPPO (Hydro-morphological Investigation of riverbed Particle Performance On-site) is an adjustable in situ device to reliably determine the start of erosion of fine sediments.

In advance 3D-CFD simulations have been carried out to optimize the components and the setup of the measurement system. The final product is primarily a benthic flume, which has a downwardly opened sampling area at the bottom and is placed on the river or reservoir bed. This underwater flow channel can be adapted to the local conditions with further components and is connected via a tube system to a measurement boat or raft. On the boat a pump creates a steady flow velocity in the system. The velocity in the benthic flume is gradually increased at fixed time intervals and is monitored using a built-in flow velocity meter (Acoustic Doppler Velocimeter). In addition the entire erosion process is recorded visually with video cameras. Also the turbidity of the water flowing through the system is continuously measured by a turbidity probe installed behind the pump. The amount of flow induced by the pump is controlled by a valve close to the end of the system. With the pump currently installed flow velocities of up to $v = 0.8$ m/s at the sampling area can be achieved, which is sufficient for the determination of the critical flow rate for erosion of most types of clay, silty and fine sandy sediments. During the process of erosion also the remobilization of fluid mud can be monitored. The critical flow velocity for the start of sediment transport is determined on the basis of the turbidity of the pumped water and data from the flow velocity probe and is verified using the camera system.

In addition to the critical threshold flow velocities, the critical bed shear stress is often required as input or evaluation variables for morphodynamic numerical models. The conversion can be made, for example, using the quadratic velocity approach originally used in pipe hydraulics. The determination of the required resistance coefficient λ is based on the Moody Chart. However, it should be considered that this procedure entails some uncertainties with regard to the measurement system presented here. Still for cohesive sediments, the natural values measured in this way represent a significant added value compared to common estimates based on only

partially known bed parameters, since factors such as vegetative cover, consolidation or even a developed biofilm can influence the timing of erosion. Especially against this background, possible effects of the change of hydraulics by the measuring system (geometry, velocity profile) seem to be small compared to the uncertainties of contemporary morphodynamic analyses.