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# High spatio- and temporal resolution measurements of cohesive sediment erosion

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Knowledge regarding critical shear stresses and erosion rates of cohesive sediments are fundamental to establish sustainable sediment management strategies in rivers and reservoirs. However, the measurement of the incipient motion of cohesive sediments is complex due to the interacting physical, chemical and biological parameters leading to different spatial and temporal erosion behavior. Consequently, no analytical theory is yet available for cohesive sediments. Thus, experimental methods are required to obtain knowledge regarding their erosion behavior. Open flumes, closed tunnels or annular flumes are used in-situ as well as in laboratories to gain this information. At the Institute for Modelling Hydraulic and Environmental Systems (University of Stuttgart) the so called SETEG-flume is used to measure critical shear stresses and erosion rates of cohesive/non-cohesive sediment mixtures. In the rectangular SETEG-flume the discharge is continuously increased (pressurized flow) until incipient motion is observed. To derive erosion rates the bed evolution over time is monitored.

In this article, improved methods for high spatio- and temporal resolution measurements and their application on natural cohesive sediments will be presented. By using a photogrammetric method combined with an image-processing tool, erosion rates with volumes smaller than 10 $mm^3$ can be measured. For this purpose, the SETEG-flume is equipped with a CCD video camera (10 Hz) and a laser, which projects a random pattern of light points (24,000) on the sediment surface (D = 100-140 mm). After an erosion experiment, a dense optical flow algorithm of OpenCV library is used to analyze the displacement of each projected light point for consecutive time-steps, which allows for the determination of topographical changes over time. These eroded volumes allow in a further step the calculation of erosion rates for affiliated time steps.

Within this study, sediment cores from a reservoir were used to investigate the erosion behavior of natural cohesive sediments with the above mentioned novel methods. Experiments were conducted for different sediment surfaces and for different flow rates to study the temporal and spatial resolution of erosion rates under different acting forces. The results regarding the temporal resolution show the expected high erosion rates at the beginning and the decreasing tendency with elapsed time. The analysis of the spatial resolution shows clearly that the erosion process is not distributed homogenously over the whole surface but varies over many orders of magnitude. Moreover, the spatio-temporal resolution of the new instrumentation allows for observing the erosion of single aggregates. Hence, the novel photogrammetric method facilitates highly-detailed investigations to gain new knowledge on the phenomenon of erosion of cohesive sediments.