International Journal of Sediment Research 33 (2018) 1–2

Contents lists available at ScienceDirect

International Journal of Sediment Research

journal homepage: www.elsevier.com/locate/ijsrc

Introduction to the special issue of the 13th International Symposium on River Sedimentation, Stuttgart, Germany: Experimental and measuring/monitoring research related to sediment issues

The papers in this issue stem from the 13th International Symposium on River Sedimentation held in September 2016 at the University of Stuttgart, Germany. The Symposiums on River Sedimentation aim to provide a platform for scientists and engineers for fruitful and in-depth knowledge exchange. The objectives are to develop sustainable revitalization and management strategies that address the ongoing negative effects of anthropogenic activities, whilst improving river systems toward a healthy ecological status. The fundamental research and understanding of interactive processes between water and sediments is as important as the sharing and exchange of knowledge in applied projects. The accepted contributions of 185 full papers covered the broad spectrum of river sediment related issues that were organized in six topics and five special sessions (Wieprecht et al., 2016).

This special issue includes eight selected contributions to the symposium related to experimental and measuring/monitoring research which have undergone an additional peer-review process for publication in this issue. Although each of the following eight articles stands solidly on its own merits, we have made an effort to impose a rough thematic structure and logical flow in their ordering.

The issue begins with two contributions addressing the monitoring of suspended load fluxes. The first paper is entitled “In-situ investigation on real-time suspended sediment measuring techniques: turbidimetry, acoustic attenuation, laser diffraction (LISST) and vibrating tube densimetry” and is authored by Felix et al. (2017). The measured suspended sediment concentrations of the mentioned devices were all tested in the waterway of a hydropower plant in the Swiss Alps and compared to gravimetrical analyses as reference. Based on their results, the authors recommend a combination of LISST and vibrating tube densimetry, because the measured suspended sediment concentrations with these devices were not or less biased by variations of the particle size distribution compared to the other tested devices. In this combination, most data are provided by the LISST, and the vibrating tube densimetry serves mainly for the measurement of higher sediment concentrations. Acoustic instruments and/or turbidimeters may be used as less costly alternatives. However, higher uncertainties have to be expected for these instruments in environments where particle properties vary over time.

The second paper related to suspended load measurements is contributed by Haun and Lizano (2017). A combination of two indirect methods to measure suspended sediment concentrations (SSC) is presented. The paper on “Sensitivity analysis of sediment fluxes derived by laser diffraction and acoustic backscatter within a reservoir” fuses the acoustic backscatter signal (ABS), data obtained from an ADCP, with data from a LISST-SL. By doing so, the authors show that a high spatial distribution can be achieved for studying sediment fluxes. It is noted that although the approach is an exciting new way to tackle the assessment of sediment fluxes over the depth of a reservoir. For deep reservoirs with large blanking zones, case-by-case evaluations have to be undertaken to ensure accurate results.

In addition to suspended load measurements, the monitoring of bed load transport rates is addressed by two contributions. The paper “Near-bankfull floods in an Alpine stream: Effects on the sediment mobility and bedload magnitude" is authored by Rainato et al. (2017). Rainato et al. (2017) monitored the sediment mobility and bedload magnitude of three high-frequency flood events in Rio Cordon, Italy using a fixed monitoring station (sediment trap) for the determination of bedload and tracers (Passive Integrated Transponders, PIT) to allow for continuous tracing. The authors found a clear difference regarding the number of tracers mobilized and their mean travel distance. The near-bankfull events showed an average travel distance of one order of magnitude higher compared to the below-bankfull event. In addition, the latter was only able to transport sediments with $d < 128$ mm. Although the two near-bankfull events had a similar peak flow and particle travel distance, the bedload magnitude differed by a factor of 24. Based on these findings, the authors concluded that the results demonstrated that near-bankfull events can mobilize large amounts of material for long distances, and that floods of apparently similar magnitude may lead to different sediment dynamics, depending on the type and amount of sediment supply.

The paper entitled "Application of an impact plate-bedload transport measuring system for high-speed flows", authored by Koshiba et al. (2017), presents a device for the measurement of bedload transport rates in flows with high sediment fluxes. The design of the device is based on both the Swiss plate geophone and the Japanese pipe microphone, and it consists basically of a bottom mounted steel plate to which an acceleration sensor and microphone are attached. These two sensors are used to detect particle impacts on the plate which in turn can be used to determine the bedload transport rates. Besides a detailed description of the device, the paper presents the calibration and results showing the capability of the device to determine impacts of particles with a diameter larger than 2 mm.

The next three contributions investigated sediment erosion processes from different perspectives. The first two papers address

https://doi.org/10.1016/j.ijsrc.2018.02.002

the erosion of sediment replenishments to compensate for sediment deficits using sandy and gravel material while the third paper investigates the erosion stability of widely graded particle size distribution for tidal currents.

Arai et al. (2017) performed an “Experimental investigation on cohesionless sandy bank failure resulting from water level rising”. They conducted four bank failure experiments in a soil tank using two types of cohesionless uniform sands and two bank heights. The matric suction and water content as well as the bank geometry and bank failure velocity were recorded during the experiments. Based on their experiments, the authors concluded that the erosion was caused by the complete loss of apparent cohesion given the pore filling during increasing water levels, which subsequently caused rotational slide and cantilever toppling. In addition, they observed for smaller particles and the same bank height, the formation of more severe overhanging geometries before collapsing and traced this back to the stronger apparent cohesion and tensile strength of the smaller particles. Moreover, their findings demonstrated the need to incorporate a non-linear relation of tensile strength to saturation for stability analysis of cantilever toppling failure.

Sediment replenishment with artificial gravel deposits represents another option to compensate for sediment deficits in rivers. Therefore, the authors Friedl et al. (2017) performed laboratory experiments to study “The erosion pattern of artificial gravel deposits” by varying governing parameters such as deposit geometry, bulk density, grain size distribution and hydraulic load and quantifying their influence on the mean erosion rate. The authors found that the mean erosion rate increases with deposit height and width and decreasing grain size, while the bulk density showed no significant impact on mean erosion rates. Furthermore, the authors developed an excess shear stress relation to describe and predict the temporal evolution of the mean erosion rate using parameters describing the approaching flow, the deposit geometry and the sediment mixture.

Schendel et al. (2017) investigated the “Influence of reversing currents on the erosion stability and bed degradation of widely graded grain material”. They used a recirculating flume with reserving currents to simulate tidal flow conditions. They found a bidirectional displacement of particles because previously shielded sediment areas become exposed as the flow direction reverses. In addition, the eroded sediment fractions were finer in the initially applied flow direction compared to in the subsequently applied reverse direction, indicating an increase of erosion stability, which was confirmed by comparing the results with the particle size distribution of the bed load under unidirectional flow conditions. The authors concluded that widely graded grain mixtures have a promising potential for bed and scour protection in applications involving estuarine and coastal conditions, but also stated that further tests need to be performed to ensure the repeatability of the results, particularly regarding the inhomogeneous material properties and the bed structure.

The last contribution in this special issue shows the advances made by using new technologies such as Unmanned Aerial Vehicles (UAVs). “On the Way to Airborne Gravelometry based on 3D Spatial Data derived from Images” is a contribution by Detert et al. (2017). With the help of UAV technology it is now possible to survey whole river stretches at the grain-scale, with the paper specifically studying grain size characteristics of gravel bed rivers. A structure from motion (SfM) based approach is introduced for the image processing, and data is compared to laser recordings and manual sampling. This is a new exciting avenue of research, as it allows studying whole reach scale elevation data with low-cost videos.

A full and complete overview of ongoing research in the field of experimental methods related to sediment issues is beyond this special issue. However, we hope that this special issue provides useful insights to further advance our understanding of riverine sedimentary processes.

The editors would like to thank the authors for contributing their papers as well as the reviewers for their commitment and efforts in maintaining the high standard of these publications. Finally, we thank the journal for its willingness to publish the contributions.

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