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Spatio-temporal flow structures and morphological changes in a meander bend during a spring flood: a unique ADCP mini-boat approach

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To date, measuring flow structure of rivers has been time consuming and mostly based on a cross-sectional survey approach. Therefore temporal and spatial scales of earlier studies on flow dynamics have been rather limited. The development of acoustic measurement techniques has improved knowledge of flow structure and their dynamics. Especially Acoustic Doppler Current Profiler (ADCP) has regenerated field of flow studies. ADCP is used in most cases for discharge measurements and cross-sectional flow structure measurements. However, flow measurements covering the whole meander bend are still uncommon. Our measurement approach enables to acquire spatially well-covered and accurate 3D flow data for the whole reach.

We studied the changes in near-bed flow structure and bed morphology in a sandy meander bend. Flow measurements were undertaken during nine days field work period in the rising state of a spring flood. During the field investigation the water level rose 1.3 meters with discharge increasing from 35 to 66 m^3/s.

3D flow structures and the associated bed morphologies were studied using ADCP coupled with high accuracy VRS-GNSS. Both ADCP and VRS-GNSS were placed on remote controlled mini-boat in order to measure the meander bend effectively. This combination enables spatially accurate measurement of flow structure and bed morphology. Plotting frequency of both devices was 1 Hz, which allowed dense measurements of flow structure and bed morphology. Average density of flow measurements was 1.2 pts/m^2.

The day-to-day changes in flow structure and bed morphology were studied and compared. Spatial and temporal changes in near-bed flow velocity and direction were investigated and compared with depth-averaged flow velocity and direction. Subsequently, morphological changes were detected and compared to daily changes in flow velocity, direction, depth and other flow characteristics. In total, changes from nine days of measurements were analysed daily during the rising state of the flood. Flow velocities varied from 0.5 to 1.3 m/s in the upstream part and 0.6 to 1.0 m/s in the downstream part of the meander bend.

Highly accurate spatial and dense temporal scale measurements of flow structure and bed morphology can be undertaken only by using a remote controlled platform that is capable of navigating in river channel with high position flow measurement accuracy. Our remote controlled mini-boat in combination with a state-of-the-art VRS-GNSS and ADCP system opens a new perspective on studying fluvial dynamics on a very detailed spatio-temporal scale.