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Precise mapping of annual river bed changes based on airborne laser bathymetry

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Airborne Laser Bathymtery (ALB) is a method for capturing relatively shallow water bodies from the air using a pulsed green laser (wavelength=532nm). While this technique was first used for mapping coastal waters only, recent progress in sensor technology has opened the field to apply ALB to running inland waters. Especially for alpine rivers the precise mapping of the channel topography is a challenging task as the flow velocities are often high and the area is difficult and/or dangerous to access by boat or by feet. Traditional mapping techniques like tachymetry or echo sounding fail in such situations while ALB provides, both, high spot position accuracy in the cm range and high spatial resolution in the dm range. Furthermore, state-of-the-art ALB systems allow simultaneous mapping of the river bed and the riparian area and, therefore, represent a comprehensive and efficient technology for mapping the entire floodplain area. The maximum penetration depth depends on, both, water turbidity and bottom reflectivity. Consequently, ALB provides the highest accuracy and resolution over bright gravel rivers with relatively clear water.

We demonstrate the capability of ALB for precise mapping of river bed changes based on three flight campaigns in April, May and October 2013 at the River Pielach (Lower Austria) carried out with Riegl's VQ-820-G topo-bathymetric laser scanner. Operated at a flight height of 600m above ground with a pulse repetition rate of 510kHz (effective measurement rate 200kHz) this yielded a mean point spacing within the river bed of 20cm (i.e. point density: 25 points/m2). The positioning accuracy of the river bed points is approx. 2-5cm and depends on the overall ranging precision (20mm), the quality of the water surface model (derived from the ALB point cloud), and the signal intensity (decreasing with water depth). All in all, the obtained point cloud allowed the derivation of a dense grid model of the channel topography (0.25m cell size) for all three epochs constituting an excellent basis for, both, the visual and quantitative estimation of the changes over the year.

It turned out that even between the April and May flight remarkable differences could be detected although there was no major precipitation event in-between and the flow conditions were entirely below mean flow. In contrast to the moderate changes between April and May, the flood event in June 2013 (HQ1) resulted in a radical change of the river bed topography documented by the October flight. Since the study site (Neubacher Au) is a Natura2000 conservation area, space for a meandering flow is allowed. Entire gravel bars have been removed and new bars were deposited down-stream. Furthermore, the river axis was locally shifted by more than 1m during the flood event.

The results demonstrate the high potential of laser bathymetry for precise mapping of river bed changes. This opens new perspectives for the validation of sediment transport models models and a much better understanding of the river morphology (e.g. formation and changes of sand and gravel banks). The traditional approach in sediment transport modelling based on a limited number of cross sections can be completed respectively replaced by a more comprehensive and more reliable concept on the basis of spatial distributed river bed data. Valuable calibration data in a new quality will be available.