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Influence of a bubble screen on open-channel bend morphodynamics under live-bed conditions

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Open-channel bends are characterized by interactions between the streamwise flow, the curvature-induced secondary flow, the bed morphology and the sediment transport, resulting in the development of a typical bar-pool bed morphology. This typical morphology can involve problems in the river: the bend scour at the outer bank may endanger the stability of structures whereas the bar at the inner bank may reduce the navigable width due to insufficient flow depth.
An air-bubble screen, created by a porous tube, is installed in a sharply curved laboratory flume near the outer bank with the aim of reducing outer bank scour. The bubble screen generates a bubble-induced secondary flow which is expected to redistribute the flow patterns and consequently influence the morphological development of the bend. A reference experiment performed without the bubble screen is compared to an experiment performed with the bubble screen, under live-bed conditions.
The efficiency of the bubble-screen technique to modify the morphological development of the bend is not uniform all around the bend. Three different zones are determined: A first zone in the upstream part of the bend where the strong outward transverse mass flux prevents the occurrence of the bubble-induced secondary flow cell, a second zone in the middle part of the bend where the bubble-induced secondary flow emerges, amplifies in downstream direction and starts redistributing the streamwise velocity, and a third zone in the downstream part of the bend where the redistributed velocities yield substantial morphological redistribution.
The distribution of transverse velocities at the water surface is found to be a good indicator on the efficiency of the bubble screen as the latter is directly related to the bubble-induced transverse flow at the water surface.
In addition to demonstrate the potential of the bubble screen technique to reduce erosion, these experiments show that performing experiments under live-bed conditions is relevant to take into account all processes involved in the morphological development of a bend.