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Hydrodynamics and morphodynamics of a mobile bed confluence under equilibrium conditions for different values of the flow discharge ratio

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Under steady water and sediment feeding in laboratory conditions, sediment fluxes tend to reach a steady state and bed morphology tends to equilibrium. This laboratory study states two objectives: i) to provide a detailed three-dimensional characterization of the flow field at a movable bed confluence and ii) to contribute to the characterization of the effect of the flow discharge ratio (Qr = Qt/Qm, Qt – tributary flow discharge and Qm – main channel flow discharge) on the flow field. While the junction angle between the main channel and the tributary as well as the sediment discharge ratio were kept constant, two scenarios corresponding to two different flow discharge ratios with dominant main channel flow discharge (Qm > Qt) were analyzed. Prior to the flow velocity measurements, both channels were fed with water and sand mixtures and tests were run until the equilibrium condition was reached, i.e. until the moment where the difference between the total supplied sand discharge and the total outgoing sand discharge was smaller than ± 5%. During the experiments, bed topography was systematically recorded. Then, the flow was stopped, the water was slowly drained and the bed was carefully fixed with a cement and vernix coat and allowed to dry to guarantee that it remained stable from there on, while the clear water (free of sand) discharges were fed again to the fixed bed converging channels. A 3D side looking Acoustic Doppler Velocimeter (ADV), installed on a remotely controlled and precisely positioned (± 0.1 mm) robotic arm, was used to measure the instantaneous velocities at a very dense mesh. Once the velocities measured and recorded, the water surface levels were surveyed. For the case with more dominant tributary flow (Qr = 0.17), as expected, the scour hole formed at the tributary mouth is much deeper and larger and extends towards the outer bank of the post-confluence channel, as well as upstream the junction corner. The avalanche slopes are, consequently, steeper. On the other hand, for the case with a weaker tributary flow (Qr = 0.08), no erosion is observed immediately upstream the junction. Moreover, the bank-attached sediment bar downstream the junction is considerably more developed in longitudinal and vertical directions. In both scenarios, a strong horizontal vortical structure was observed immediately downstream the junction. More detailed analysis of the origin and the characteristics of these and other flow patterns is still under investigation.

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