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Field Evidence of The Influence of Low Momentum Ratio on Confluence Hydrodynamics and Mixing

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River confluences are zones where two or more rivers join and form a single channel downstream of their junction. Because of their essential role in dendritic drainage networks as a control on stream hydrodynamics, sediment flux and ecology, the last three decades have seen significant attention given to their hydrodynamics and morphodynamics. In general, the latter are controlled by the momentum ratio (Mr) between the two incoming channels, confluence angle and bed morphology. Most studies to date have focused on confluences with Mr values close to one. Much less attention has been given to confluences with Mr values much less than one, that is where the tributary has a flow momentum much less than the main stream, and there are almost no field studies of such confluences.

Here, three upper Rhône river confluences in Switzerland, which are characterized by low momentum ratio and a varied rate of poorly sorted sediment transport, have been monitored using spatial distributed acoustic Doppler current profiling (aDcp) measurements. Experimental results have suggested that in such confluences, if the rate of sediment transported from the tributary into the main channel is high enough, formation of bed discordance and a two layer flow downstream of the junction, should be evident. In this case mixing will take place more rapidly downstream of the junction because of the formation of secondary circulation. On the other hand, if the tributary sediment delivery rate is low and the tributary mouth bar is absent, the formation of a pronounced scour hole downstream of the junction apex and within the hydrodynamic zone is more probable. Secondary circulation is less intense and mixing will take place farther downstream of the junction. These results are in conflict with existing conceptual models that do not explain fully the flow behaviour in confluences with low momentum ratio.

Key words: river confluences, momentum ratio (Mr), junction angle, bed discordance, sediment transport, acoustic Doppler current profiler (aDcp), mixing, secondary circulation, tributary mouth bar, conceptual models.