DISCUSSION / DISCUSSION

Discussion of “Three-dimensional numerical study of flow structure in channel confluences”¹

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The Discussers would like to congratulate the Authors for their interesting work concerning the flow characteristics in channel confluences, performed by means of three-dimensional numerical simulations considering rectangular cross-sections with smooth bed. The model is validated with reasonable agreement with experimental data. The investigation of several geometries (angles and channels widths) and hydraulic conditions (discharge ratios and Froude Numbers) contributes to increase the knowledge on the hydrodynamics in channel confluences.

Although the flow characteristics in channels confluences are well documented in literature (main references are cited by the Authors), the presence of sediment transport and its influence on the morphodynamic features in confluence zones are still not completely understood. The few existing laboratory studies regarding confluence morphology (Mosley 1976; Ashmore and Parker 1983; Best 1988) and the field investigation of flow and morphological features of bed concordant (Roy and Bergeron 1990; Rhoads and Kenworthy 1995; Rhoads and Sukhodolov 2008; Rhoads et al. 2009) and bed discordant (Biron et al. 1993; Leclair and Roy 1997; Boyer et al. 2006) confluences show that the hydrodynamics of confluence zones are highly responsive to the changes in the morphology. One of the most important examples, which has been the subject of a large scientific debate, concerns the presence, number, and intensity of the secondary flow cells driven by the confluence (Fujita and Komura 1989; Rhoads and Kenworthy 1995; Leclair and Roy 1997; Best et al. 2010). The model describes five main morphological features, associated to six main flow features. The important difference between the flow depths in the tributary and the main channel leads to the formation of a pronounced bed discordance (M1). The presence of a large sediment bar downstream of the confluence (M2) is neither related to flow recirculation nor to secondary flow cells, which are both absent in the present case. Instead, the shape of the sediment bar is the result of sediment continuity requirements, e.g., the reduction of the flow area required to increase velocities and the sediment transport capacity. The absence of a marked scour hole (M5) is another important morphological feature of alpine confluences. Near-surface flow coming from the main channel (F1) is deviated towards the outer bank by the tributary flow (F3) in the confluence zone, whereas the near-bed flow originating from the main channel (F2) goes straight to the sediment bar. The two-layer flow prevents the formation of the flow recirculation downstream of the confluence. Moreover, it does not lead to the formation of secondary flow cells. The sediment transfer between the tributary and the post-confluence channel mainly occurs near the downstream corner of the confluence due to the formation of a stagnation zone (F4) at the upstream confluence corner that causes an asymmetric distribution of the sediment transport and its influence on the morphodynamic features in confluence zones are still not completely understood. 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flow and sediment transport. A shear layer ($F5$) forms where flows originating from the tributary and the main channel collide. It is characterized by high turbulence intensity and its outer limit coincides closely with the toe of the sediment bar. In the downstream confluence corner, spiral vortices ($F6$) lift fine material into suspension. Fine materials are then transported near the inner bank ($M4$) while the coarse ones are transported on the face of the deposition bar ($M3$).
References


