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Basin-scale temporal evolution of the discharge ratios at confluences: The case of the Upper-Rhône watershed

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Confluences are key elements of dendritic drainage networks. They are known to have a very specific bed morphology. Field and experimental studies have shown that the river bed presents has erosion and deposition patterns linked to the specific fluid circulation that occur in the junction zone. Previous studies have emphasized that one of the main drivers of the morphology of the river bed is the symmetry ratio between the two incoming channels. The symmetry ratio is generally expressed as the ratio between the two drainage areas, reflecting the relative size and then the averaged discharge of the tributary to those of the main stem. However, previous studies have also shown that the bed morphology of confluences vary with time, especially with the variation of the discharge ratio (i.e. the ratio Qr=Qt/Qm, where t refers to the tributary, and m to the main stem). Variation of the discharge ratio is natural in any river basin because the response time of different basins is a function of basin size and shape, but also because the hydrological processes dominant in different basins may vary. For instance, the response of Alpine sub-basins to temperature and precipitation will depend upon the distribution of elevations in each basin, and so cause differences in discharge ratio through time.

A distributed (250 x 250 m) hourly-based hydrological model of the Upper-Rhône basin (Fatichi et al., 2015) is used to determine the temporal variability of the discharge ratio at a large number confluences spread within the catchment. The discharge ratio is computed at each time-step and the occurrence of different ranges of ratio are investigated in the light of factors such as the the confluence position within the catchment and the characteristics of the two confluence sub-catchments.

The results show that confluences located upper in the catchment tend to have a wider range of discharge ratios than those located further downstream, reflecting the ‘scaling effect’ of the drainage network, introduced first by Horton (1945). The ratio may also reverse sometimes (i.e. the tributary has a higher discharge than the main stem). As the morphology of a confluence is not always in equilibrium with the delivered flow, it follows that associations between discharge ratio and confluence morphology may be more complicated than suggested by flume experiments.

References:

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