



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

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Confluences are known to have a very specific bed morphology. Field and experimental studies have shown that the river bed 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 $Q_r=Q_t/Q_m$, where t refers to the tributary, and m to the main stem). Further the angular momentum ratio (i.e. considering the geometry of the confluent channels) may better explain confluences morphology. Variation of the discharge ratio, and then of the angular momentum 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. In this paper we aim to assess how in time and space the discharge ratio of junctions evolves. To do this, a distributed (250x250 m) hourly-based hydrological model of the Upper-Rhône (south-western Swiss Alps) basin (Fatichi et al., 2015) is used to determine the temporal variability of the discharge ratio at a large number of confluences spread within the catchment. Geometrical characteristics (e.g. junction angles, confluent channels slopes) of the confluent channels are collected through geodatabases and digitization from aerial imagery together with complementary field measurements. The discharge ratio is then computed at each time-step on a subset of nearly one hundred confluences. The angular momentum ratio is then computed thanks to geometrical properties of the junctions. The occurrence of different ranges of ratios are investigated in the light of factors such as 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).

Conclusions

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

Fatichi, S., Rimkus, S., Burlando, P., Bordoy, R., Molnar, P., (2015). High-resolution distributed analysis of climate and anthropogenic changes on the hydrology of an Alpine catchment. *J. Hydrol.* 525: 362–382.