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Hydrograph transposition to ungauged basin accounting for spatio-temporal rainfall variability

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Lack of measurements is one of the main issues in hydrological modelling. However, neighbours and nested gauged catchment are precious sources of information to understand the catchment behaviours within one region. Extracting the maximum of information from those points of measurements, that could be then transposed to ungauged catchment, is still a great challenge.

We propose a methodology to transpose hydrological information from gauged catchments to ungauged ones, in order to simulate streamflow hydrographs. It uses geomorphology-based hydrological modelling, which is particularly well adapted to ungauged basins thanks to its robustness, generality and flexibility.

We develop a geomorphology-based model on the gauged catchment which has been built in order to capture the main behaviour of the basin. Its transfer function considers the different dynamics of the catchment through the combination of velocities and width functions. Moreover, the explicit structure of the model enables to easily create a map of isochrone areas describing the time to the outlet. Therefore, spatially distributed rainfall can then be split into those isochrone areas, permitting the transfer function to deal with spatio-temporal variability of rainfall. Once the model calibrated, using a particle swarm optimisation algorithm, its transfer function is inversed to assess the net rainfall time series. In this way, we obtained a standardized variable which is used to estimate discharge in ungauged basin. Therefore, net rainfall time series is transposed and convoluted on the ungauged catchment using its own transfer function. Spatio-temporal rainfall variability between basins is considered through a correction of this net rainfall time series. This correction is based on differences between mean gross rainfall observation among those two catchments.

This methodology is applied on pairs of basins among 6 gauged basins (from 5km^2 to 316km^2) located in Brittany, France. For the benefit of the exercise, within each pair of basins, one is considered as “gauged” and the other one as “ungauged”. Different spatial configurations of pairs of basins are compared. Results demonstrates the benefit of a well defined transfer function, as well as the importance of considering rainfall variability. Finally, through the assessment of transposition efficiency, this framework is presented as an original way to describe and understand hydrological similarities in catchment behavior.