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A framework for hydrological modeling of ungauged and poorly-gauged catchments coupling hydrological signatures and channel network morphometric properties.

Catchments in many parts of the world are either ungauged or poorly gauged, and the dominant processes governing their streamflow response are still poorly understood. This presentation aims to present a framework for hydrological modeling on ungauged basins. The methodology has three steps: i) characterization of the hydrological processes; ii) identification of the main characteristics of the channel network which enter into the understanding of the transfer function; iii) development of an adapted hydrological modeling approach coupling the results of the two first steps.

First, an original soft water level sensor is proposed to characterize rainfall and stream flows (Crabit et al., Sensors, 2011). This sensor works as a capacitor coupled with a capacitance to frequency converter and measures water level at an adjustable time step acquisition. This device was used to compare the runoff of 11 small catchments with ephemeral streams with the given uncertainty at both the event and the annual scale (Crabit et al., Hydrological Processes, 2011). The analysis of runoff coefficients provides essential insight into catchment response, particularly if both range of catchments and a range of events are compared. The results indicate significant variability between the catchment's responses. This variability allows for classification in spite of all the uncertainty associated with runoff estimation. This study highlights the potential of using a network of poorly gauged catchments. From almost no catchment understanding the proposed methodology allows to compare poorly gauged catchments and highlights similarity/dissimilarity between catchment responses.

Second, we define new morphometric descriptors on the basis of hub's properties and the graph theory in order to compare channel networks, to identify the main morphometric factors explaining the width function transfer function, and to answer the following questions: are there any similar channel networks referred as 'twins'? and what channel network resembles most to an other given channel network? (Moussa et al., Water Resources Research, 2008, 2011). Applications were conducted on 788 ungauged basins. Two ways of classifications are proposed: the first one according a supervised procedure based on 8 types and a second one according a nested hierarchy considering the main hub as the key factor of the classification.

Finally, an adapted conceptual global hydrological model is developed for each catchment by coupling: i) a production function on the basis of the hydrological signatures identified in the first step; ii) a transfer function on the basis of the morphometric characteristics of the channel network identified in the second step. The new models were applied and validated on gauged catchments, and then applications were extended on ungauged ones.