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Have we fully exploited the topographic information in hydrological modelling?

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Involving topographic information in hydrological model is not a new story. Topography in most cases controls catchment boundary, influences local micrometeorology, determines water movement and drainage. Since topography underlies the water head gradient, it is not a surprise that hydrological modellers noticed the impact of topography at early stage of developing models. Various models apply different methods, considering topography information, to describe water movement, to distinguish hydrological similarity and/or connectivity, and to simulate the spatial heterogeneity of solar radiation and evaporation, and snow and ice melting etc. But, have we fully exploited the topographic information in hydrological modelling?

In this study, we report a novel and simple topography-driven runoff generation parameterization – the HAND-based Storage Capacity curve (HSC) – representing the spatial distribution of heterogeneous storage capacities in unsaturated root zone, without calibration of the shape parameter (β) in many conceptual models. The HSC uses a topographic index (HAND, Height Above the Nearest Drainage) to identify hydrological similarity and the extent of contributing areas in catchment scale. The assumption of the HSC module is supported by a global synthesis of ecological observations. Tested by over 300 catchments in the UK and the US, with diverse climate, soil, vegetation and geological characteristics, the HSC performs better comparing with HBV and TOPMODEL, particularly in the catchments with gentle topography, less forest cover and arid climate. The HSC as a runoff generation module has great potential be used in any conceptual rainfall-runoff models in ungauged basins.

Although various hydrological models, including HSC, were developed based on topographic information, the beautiful fractal patterns of geomorphology may inform modelers more about how water interacts with landscapes, causing the nonlinearity of rainfall-runoff processes. Further breakthrough discoveries in rainfall-runoff research are expecting to emerge from these or other unexplored interconnections between topography and hydrological processes.