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Reducing the number of calibration parameters in Rainfall-Runoff models.

The use of over-parameterized hydrological models limits the insight into hydrological processes at work. Thus, little help from such models can be expected for detecting hydrological similarity and a possible regionalisation of parameters which is needed to make predictions in ungauged basins. In this study we have developed a rainfall–runoff model in which the sub-surface water accounting and flow dynamics are parameterized from maps and runoff data. Only one parameter is left for calibration. Inspired by earlier work on the link between geomorphology and hydrological response, the dynamics of runoff for small catchments are here derived from the distribution of distances from points in the catchments to the nearest stream in a catchment. The river network and the shape of catchment provide a unique distribution function for each catchment and can be determined from a GIS. The distribution of distances, which for many catchments in Norway closely follows an exponential distribution, will, when a velocity of (sub-surface) flow is introduced, provide a distribution of travel times, or a unit hydrograph (UH). If we have different layers in the sub-surface with different sub-surface flow velocities, we have different UHs and runoff is derived from the super-positioning of the different UHs. This study shows how different sub-surface velocities can be estimated from runoff records. Recession events are sampled and the different events are assumed to represent a superpositioned UH for different levels of sub-surface saturation. The different levels of saturation are then assumed to indicate which layers are active in generating runoff. The observed superpositioned UH for a level of saturation is thus considered to be the weighted sum of UHs of the active layers, and the layer-specific UHs can then be estimated if the first layer-specific UH is assumed to be equal to the slowest observed (superpositioned) UH. For eight catchments the estimated sub-surface velocity profiles show a variation on the order of 10^-5 m/s. The new model has been calibrated for eight Norwegian catchments and provides similar results in precision and detail as the Swedish conceptual HBV model used operationally for flood forecasting in Norway.