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Modelling discharge dynamics from information derived from maps

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In a programme to develop improved hydrological models in Norway, we reduce the number of parameters that requires tuning and instead introduce algorithms that are parameterised from observable catchment characteristics. A reduced number of tuning parameters, and hence reduced parameter- and model uncertainty, makes the transfer of information from gauged to ungauged catchments by applying hydrological similarity, more realistic. Inspired by earlier work on the link between geomorphology and hydrological response the dynamics of discharge is derived from the distribution of distances 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 constitutes a detailed description of the drainage density, where the location of the stream relative to the catchment is taken into account. From conservative tracer experiments and the timescale of response, we assume that water entering the stream is the result of a pressure-wave propagating trough the hill slopes. Within a fixed time interval, water is propagated a certain distance through the catchment and defines a fractional area. The fractional area is estimated as an area enveloping the river network, whose width, perpendicular to the river network, is determined for the time interval of interest by the celerity (wave-velocity). For constant celerity, the time steps define adjacent areas that, for sufficient number of time intervals, cover the entire catchment. For different horizontal layers and celerities, the total discharge is the sum of discharge from each layer for each time step. The proposed model for dynamics of discharge is implemented in the Swedish HBV model. The new model, named DDD (distance distribution dynamics), performs similarly as the HBV model for larger catchments (>100 km^2) and better for smaller catchments. DDD requires less tuning parameters than the HBV model since a number of the parameters required for describing the dynamics are estimated from maps.