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Catchment classification and model parameter transfer with a view to regionalisation

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Physiographic and climatic catchment characteristics are responsible for catchment response behaviour, whereas hydrological model parameters describe catchment properties in such a way to transform input data (here: precipitation, evaporation) to runoff, hence describing the response behaviour of a catchment. In this respect, model parameters can thus be seen as catchment descriptors. A third catchment descriptor is runoff behaviour, depicted by indices derived from event runoff coefficients and Flow Duration Curves. In an ongoing research project founded by the Deutsche Forschungsgemeinschaft (DFG), we investigate the interdependencies of these three catchment descriptors for catchment classification with a view to regionalisation.

The study area comprises about 80 meso-scale catchments in western Germany. These catchments are classified by Self Organising Maps (SOM) based on a) runoff behaviour and b) physical and climatic properties. The two classifications show an overlap of about 80% for all catchments and indicate a direct connection between the two descriptors for a majority of the catchments. Next, all catchments are calibrated with a simple and parsimonious conceptual model, stemming from the Superflex model framework.

In this study we test the interdependencies between the classification and the calibrated model parameters by parameter transfer within and between the classes established by SOM. The model simulates total discharge, given observed precipitation and pre-estimated potential evaporation. Simulations with a few catchments show encouraging results: all simulations with the calibrated model show a good fit, which is indicated by Nash Sutcliff coefficients of about 0.8. Most of the simulations of runoff time series for catchments with parameter sets belonging to their own class display good performances too, while simulated runoff with model parameter sets from other classes display significant lower performance. This indicates that there is a strong connection between runoff behaviour, catchment properties and model parameter sets within the classes.

The next step is the classification of the catchments based on calibrated model parameters with SOM. If the parameter sets show significant relation to the previous classification, model parameters may be used as an easy accessible start for catchment description. Physiographic and climatic properties can now be related directly to model parameters, corroborating a quantitative approach to basin classification. Furthermore, one representative parameter set for each class of catchments can describe the runoff behaviour for a whole class.

The description of runoff behaviour by calibrated model parameters of a conceptual model in relation to classes of physically and climatically similar catchments can facilitates catchment description, classification and regionalisation and provides insight into the processes and functioning of catchments. The use of calibrated model parameters for classification instead of time-consuming description of the runoff behaviour with event runoff coefficients offers an attractive alternative for regionalisation.