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Exploring the link between spatial hydrologic variability and catchment similarity for the purpose of regionalisation

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Catchments are complex systems, with a large number of strongly interdependent variables operating at many space and time scales. This makes it difficult to discover the processes in a particular catchment in greater detail as a prerequisite for runoff modelling. Instead of studying a particular catchment in much detail, we can explore spatial patterns of the runoff response to learn about the most important runoff generating processes in a study area. This can be done by linking the spatial variability of runoff signatures with that of climate and catchment characteristics through statistical techniques. The gained additional knowledge about catchment functioning can then be the departure for improved regionalisation models, which enable more reliable estimates at ungauged basins than models which do not take process information into account.

This contribution explores the link between representations of hydrological variability and catchment similarity measures for the purpose of regionalisation. Guided by case studies of an Austrian and a German study area, we show how spatial patterns of the various runoff signatures, from droughts to floods, together with representations of climate and catchment characteristics can be jointly used to infer catchment functioning in terms of most important runoff generating processes. It is further shown how the information about similarly and differently functioning catchments can be employed to improve statistical regionalisation models. Results indicate that for seasonal climates, low flow processes are strongly linked with seasonality patterns. Grouping catchments according to seasonality can therefore significantly improve the predictive performance of regionalisation. The German study showed that shape and magnitude of the annual flood distributions are linked (i) to different catchment/climate characteristics (ii) in different (linear/non-linear) ways. This suggested a combined model of Top-kriging (linear model for flood magnitude) with the Index Flood method (non-linear model for flood shape) as suitable regionalisation method. A cross-validation analysis showed that the combined model performed indeed better than alternative statistical models which did not take process information into account. We conclude that the spatial patterns of runoff signatures, together with those of climate and catchment characteristics, contain a wealth of information, which can be profitably used for runoff predictions in ungauged basins.