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Non-linearity and uncertainty in an attribute-based regionalisation of catchment model parameters

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Linking model parameters to catchment attributes like slope, soil, geology etc. is a frequently used technique to derive parameter estimates for ungauged basins. Most studies reported in literature rely on linear regression techniques to establish the regionalisation scheme although it is well-known that the underlying assumption, the linearity of the relationship between catchment attributes and model parameters, is often violated. This study evaluates the potential benefits and drawbacks of including non-linearity in the parameter regionalisation schemes. To this end, regionalisation schemes based on linear regression analysis and ANNs are compared for regionalising the most sensitive parameters of the semi-distributed hydrological model SWAT (Soil and Water Assessment Tool) for the Flemish part of the Scheldt river basin. The uncertainty on both regionalisation procedures is assessed with a non-parametric bootstrap method. The most suitable technique for regionalisation depends on the goal of the study. Linear regression is the most commonly used tool, but ANNs may provide a useful alternative in some cases, in particular if the non-linear relationship between parameters and catchment attributes can be physically understood. On the other hand, one should be careful with the use of non-linearities that have little physical meaning. Parameter optima are rather fuzzy and different parameter optima might exist, so that the detected non-linear trend might be due to the parameter optimisation process. In a linear as well as a non-linear approach, the parameter regionalisation scheme introduces a considerable degree of uncertainty. This uncertainty, quantified with a non-parametric bootstrap method, lies between 15% and 30% for all parameters and regionalisation techniques. The uncertainty on the stream flow simulated with these regionalised parameters is about 20%.