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Towards methodical modelling: Differences between the structure and output dynamics of multiple conceptual models

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Conceptual hydrologic models consist of a certain arrangement of spatial and temporal dynamics consisting of stores, fluxes and transformation functions, depending on the modeller's choices and intended use. They have the advantages of being computationally efficient, being relatively easy model structures to reconfigure and having relatively low input data demands. This makes them well-suited for large-scale and large-sample hydrology, where appropriately representing the dominant hydrologic functions of a catchment is a main concern. Given these requirements, the number of parameters in the model cannot be too high, to avoid equifinality and identifiability issues. This limits the number and level of complexity of dominant hydrologic processes the model can represent. Specific purposes and places thus require a specific model and this has led to an abundance of conceptual hydrologic models. No structured overview of these models exists and there is no clear method to select appropriate model structures for different catchments.

This study is a first step towards creating an overview of the elements that make up conceptual models, which may later assist a modeller in finding an appropriate model structure for a given catchment. To this end, this study brings together over 30 past and present conceptual models. The reviewed model structures are simply different configurations of three basic model elements (stores, fluxes and transformation functions), depending on the hydrologic processes the models are intended to represent. Differences also exist in the inner workings of the stores, fluxes and transformations, i.e. the mathematical formulations that describe each model element's intended behaviour. We investigate the hypothesis that different model structures can produce similar behavioural simulations. This can clarify the overview of model elements by grouping elements which are similar, which can improve model structure selection.