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Legacy, not adequacy, drives the selection of conceptual hydrological models: how did we get there?

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Ideally, the selection of a hydrological model should be based on its adequacy for the research question (such as the landscape of the region, the temporal and spatial scale, and the purpose of the study, for instance flood modelling or water resources management). However, experience suggests that the main selection criterion for conceptual hydrological models is usually not adequacy, but legacy (hydrologists use the model they have most experience with).

To gain quantitative insights into the model selection process, we used text-mining to search the abstracts of 1043 hydrological modelling studies published between 1991 and 2017. Those abstracts were selected because they mention one of the seven conceptual models this study focuses on. We extracted the affiliation of the authors and, when available, the country of application of the model and keywords describing the context of the study. Clear geographical biases exist. For instance, VIC and SACRAMENTO are predominantly used in the USA, while HBV dominates in Scandinavia and in other parts of Europe. These regional preferences are so strong, that we could correctly predict which model was used in the large majority of the cases using solely the affiliation of the first author. In contrast, our text-mining analysis provided no evidence that models are selected because of their adequacy for the research question. We extracted keywords describing the landscape, the purpose, the spatial and temporal scale of hundreds of modelling studies, but could not show that a specific model was prefered for any specific task or environment.

We propose that development of conceptual models over the last decades has led to the predominance of model legacy over model adequacy for several reasons: i) resources invested into and experience gained with a model make hydrologists tied to this model, ii) automated parameter optimisation techniques give conceptual models great (perceived) realism and flexibility, iii) there is lack of clear guidance on how to select a model structure so that it reflects the structure of the landscape, iv) the code of standard conceptual models often lacks modularity, which makes model development expensive and reinforces i). We question whether the dominant tendency of investing resources in the parallel (and usually uncoordinated) development of hydrological models is the best way forward for hydrologic science, and we reflect on the potential benefits of a community hydrological model.