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Reply on RC1

Jan Seibert and Sten Bergström

Author comment on "A retrospective on hydrological catchment modelling based on half a century with the HBV model" by Jan Seibert and Sten Bergström, Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-542-AC2>, 2022

Thanks for these valuable comments on our manuscript. The reviewer is right that we, in this manuscript for the special issue on History in Hydrology, took a somewhat inward look by focusing on the history of the HBV model. A full review of the history of catchment modelling would be beyond the scope of this manuscript, but we will try to be a bit more self-reflecting in the revised version.

Beyond we shortly discuss how we will address the points raised in the reviewers list:

- Yes, the term hydrological modeling is broader than we use it here. Your suggestion was to change this to rainfall-runoff modelling. As snow is an important part in many HBV studies, this should be precipitation-runoff modelling, or perhaps even precipitation-temperature-runoff modelling – but then there is also potential evapotranspiration as input. Therefore, we will instead change this to 'catchment modelling'.
- Yes, we agree that for other types of hydrological models other issues than those discussed here from the aspect of (conceptual) catchment models will be important. We will clarify the more narrow focus of the discussion in our manuscript (see also point 1).
- Good point, we will not repeat the full (interesting) discussion between these papers, but agree that we should refer to this discussion.
- Yes, we realize that our use of the term hydrological modelling might cause confusion as we are focusing on catchment (runoff) models here (and not all the other types of hydrological models)
- Thanks
- Agreed, we will change the heading to 'Early catchment models'
- We here wanted to express that the differences between a simple model and a model based on equations such as Darcy might not be so large if the latter is applied using elements or parameterizations that do not capture the real-world heterogeneities. We will clarify this section.
- Good point; we will consider implementing these thoughts in the revised version.
- We agree and will clarify these important details of Breuer et al. (2009) in the revised version.
- We agree that many hydrologists working with modelling would say that all kinds of catchment models need some form of calibration. However, we also still meet the

notion that more complex models with 'measurable' parameters would not require calibration or at least not as much calibration (thus, using other terms such as tuning) by colleagues working with these, in their eyes superior, models. We appreciate the nuanced discussion in Hrachowitz & Clark (2017) and also the reviewer statement that the view on the need for calibration has changed over the years. We will include the H&C reference and would, if the reviewer does not object, also add a pers.com. reference to include the changing-ideas-on-calibration point.

- The (international) success of the HBV model is in our opinion much related to the 3 P-s (parsimony, performance, persistence) as mentioned in the introduction and above in section 3. The parsimony made the model code easy to understand (and re-program), the HBV model often performed well especially in comparison studies, and it certainly helped that the model was intensely used by SMHI and the hydrological services of Norway and Finland, and became a standard tool for the Nordic hydropower industry (opposite to a single researcher or research group as was the case for other models). We will add these thoughts in section 3.3.
- We agree that new sources of data (including spatial patterns derived from remote sensing) might open new opportunities, but as we write there is a challenging balance between more available data and more model complexity to make these data directly usable for model evaluation. We argue that this applies to any type of catchment model but also see some promising studies such as the one by Stisen et al.. We will modify the text to clarify that we see multi-criteria calibration as a suitable way forward although this approach is challenging in practice. Actually, we have used multi-criteria calibration also in applications of the HBV-model (e.g., Seibert, 2000; Bergström et al. 2002).

Bergström S, Lindström G, Pettersson A. 2002. Multi-variable parameter estimation to increase confidence in hydrological modelling. Hydrological Processes 16: 413–421.

Seibert, J., 2000. Multi-criteria calibration of a conceptual rainfall-runoff model using a genetic algorithm. Hydrology and Earth System Sciences, 4(2): 215-224.

Again, thanks for these valuable comments and interesting thoughts that will help us clarify the manuscript.

Best regards,

Jan and Sten