Hydrology and Earth System Sciences Discussions

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Comment on hess-2022-175

Anonymous Referee #1

Referee comment on "Calibration of groundwater seepage against the spatial distribution of the stream network to assess catchment-scale hydraulic properties" by Ronan Abhervé et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-175-RC1, 2022

General comment:

In the submitted manuscript, Abhervé et al present a study that deals with the estimation of hydraulic conductivity at the catchments scale. Solving the groundwater flow equation for R/K (R: long term recharge, K: catchment-scale hydraulic conductivity), the authors try to find most realistic values of K for 24 catchments in north-western France with different geologies, for which they compare simulated stream network extent with independently derived stream network maps. As a measure of similarity, they use the difference of the averaged over- and under-estimated stream network lengths. The results show that estimated K values cluster by the geologies of the 24 catchments with increasing estimated Ks towards more permeable rock types (Limestone). Sensitivity analysis shows that the resolution of the available DEM for estimating K is much less important than the stream map product to calculate most suitable K estimate.

Overall, the topic of the study and the produced results are of great value for the hydrological community and beyond since K estimates are usually available on much smaller scales (points to contributing areas of wells during pumping tests). The presented approach would provide K estimates at a scale most useful to be transferred into prediction models. However, I see two major weaknesses that need to be addressed until this work can be considered for publication:

- There is a lack of reference to proceeding studies and methods to estimate K both in the introduction and the (very short) discussion. Although the authors estimate K at the catchments scale, they should provide more information about existing approaches to

estimate K (e.g. well cores, pumping tests, model calibration) and for which scale they are applicable. There should also be more information on previous work trying to up-scale this information for large-scale modelling. Hartmann and Moosdorf are mentioned but no information about their upscaling approach and the range of K values they obtained. Also, there is some recent work on earth-tides and their usability for K estimation on larger scales. There is also need for mentioning typical ranges of K for different lithologies found by different studies or provided by established text books (e.g., Freeze & Cherry).

- There is a lack comparison to K values obtained by different approaches and studies. The authors relate their results to the works of Stoll and Weiler (2010) and Lou et al. (2010), who used very similar methods. But I would expect more comparison and discussion to independently derived K values, ideally for some of the test sites but at least to typical ranges provided in text books (e.g. Freeze & Cherry) or the values provided from up-scaled map like the one of Hartmann and Moosdorf (note that there are more recent versions of the global permeability map available). Generally, the values found here seem to be quite similar compared to the differences of several orders of magnitude for different geologies mentioned in Freeze & Cherry or even in Stoll and Weiler (2010).

For those reasons, and for the more specific comments in the following, I recommend major revisions.

Specific comments:

- The introductions provides the motivation of the study and moves quickly to methodological aspects (LL 46 and following). Please move methodological parts to the methods section and provide a more detailed review of the state of the art of K estimation ide3ntifying the research gap addressed by this study.
- Equation (1) describes anisotropic conditions (different Ks in the directions of x, y and z), while K estimates of this study assume isotropic conditions (no specification of K direction). Please simplify Eq (1) or clarify why the more complex version of the equation is shown here. Also, shouldn't W have the unit [L T^{-1}] and not [T^{-1}] as indicated in L 114?
- I am not sure if the performance metric J, as specified in Eq (2) will give you the best estimation of K of a given catchment. Since real geological systems are always heterogeneous and anisotropic, a best estimate of a catchment's K might give you a small over-estimation and a larger under-estimation of stream lengths, while J would find its optimum when both lengths are the same. Why did you not choose a metric that minimizes both over- and underestimation?
- Subsection 3.1 provide new methods Eqs (3-5), which should be moved to the methods section.

- The Discussion section is much too short and it should be separated from the conclusions. Please discuss here your assumptions and resulting uncertainty, compare to more other studies (not just Stoll & Weiler and Lou et al.), and explain under which conditions and how the approach can be applied at other catchments and the limits of transferability.