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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Is the groundwater reservoir linear? A mathematical analysis of two limiting cases" *by* G. H. de Rooij

Anonymous Referee #1

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This paper investigates the behavior of the storage discharge relationship of the groundwater reservoir of a watershed based on different assumptions on the configuration of the aquifer. The mathematical analysis is based on the analytical solution of the groundwater flow equations, and it is contrasted with the results of previous work based on the interpretation of the observed input-output relationships of different catchments. The analysis leads to the conclusion that the storage-discharge relation will in general be nonlinear and non-unique, suggesting that the representation of the groundwater reservoir as a lumped linear storage in conceptual rainfall runoff models may be unrealistic.

This paper is a nice follow up to an ongoing debate in hydrology, which contrasts experimental findings and theoretical background. The paper is clear and well written,

although the understanding of the equations requires a strong background in groundwater hydrology.

My main critiques are as follows:

1. The Author concentrates on a set of hypotheses about groundwater flow dynamics, which does not cover the full set of possibilities, and which may not represent the most common situation in natural catchments. Experimental investigations show that the groundwater table may look very different from the illustrations given in the paper (and on textbooks in general). In many cases, groundwater flow may be challelized through macropores, the groundwater table may be discontinuous, water may reach the stream through a system of ponding from a bedrock depression to the other, etc. I would not be able to say which of these situations is the norm and which one is the exception, but it is definitely important that the author places his set of hypotheses in the right context, confronting it with literature on experimental evidence, and giving it the right 'weight'. If in this light the conclusions of the paper appear too strong, they should be smoothed out.

2. The author mentions that the storage discharge relationship may be non-unique. It would be interesting to investigate somewhat more into detail how this non-uniqueness would affect the representation of the storage discharge relationship through a unique function, such as a power law. To what extent is this approximation acceptable? Would a representation through a stochastic function more appropriate in lumped modeling?

3. Adding some more material to the paper, would also address my last concern, which is the relative contribution of this paper to de Rooij 2013 and other previous work of the Author. Many of the equations used in the paper are already present in de Rooij 2013. Here they are restated under a different light, which some additions of course. But I think it would be important that this paper brings some more novel material

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