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Discussions

Interactive comment on "Opinion paper: Linking Darcy's equation to the linear reservoir" *by* Hubert H. G. Savenije

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The opinion paper by H.H.G. Savenije addresses one of the fundamental questions in subsurface hydrology – how can we upscale equations and parameter values from the laboratory scale to larger scales? I enjoyed reading this rather short and well-written paper, although (or perhaps because) the title pulled my thoughts into a completely different direction before starting to read.

Fortunately, W.R. Berghuijs and M. Cuthbert already did an excellent job in reviewing the paper as part of the interactive discussion, so that there is not much left for me to be done. In both comments, the consideration of the linear storage as a paradigm for the system scale plays a central part, and I am also not sure whether the linear storage

is a good thematic anchor for the very interesting part presented in Sect. 3.

As pointed out by M. Cuthbert, each diffusive system of finite size turns into an exponential decay that looks like a linear storage as soon as its diffusive length scale becomes much larger than the system size. So each system of Darcy-type storages coupled by a fast preferential flow system should look like a linear storage at the long time scale where the coefficient of recession is governed by the largest Darcy-type element. I would suspect that the fast preferential flow system plays a minor part at the long time scale. This behavior was, e.g. exemplified by a fractal pattern of Darcy-type blocks where the fractal dimension of the block size distribution determines the power-law exponent of the short-term recession curve, while the size of the largest blocks is responsible for the long-term recession coefficient (Hergarten and Birk, 2007). Sorry for citing my own work here, there is probably much more literature in this direction.

Taking this into account I wonder whether the exponential decay of a linear reservoir is really our target. So far I believed that the behavior at shorter times carries much more information about the internal structure of the system. So I am aware that it is an opinion paper and not a review paper, but I am a bit afraid that evidence for any phenomenon or process-based idea could be focused too much on a single property.

For me, drawing attention on the formation of preferential flow patterns and the consequences for the resulting system characteristics is the most important contribution of this paper. But while reading this very interesting section I was a bit confused. Is the concept of a "self-organized" distribution of porosity or permeability according to minimum energy dissipation proposed by Hergarten et al. (2014) not already very close to what you are thinking of? It is, of course, only a theoretical concept; evidence is rather weak so far (Hergarten et al., 2016), and the question how to upscale it finally is still open.

But anyway, both the minimum energy expenditure of Rodriguez-Iturbe and Rinaldo and the concept of minimum energy dissipation in subsurface flow predict a strong de-

pendency of resistance on discharge. The preferred flow paths must have the lowest resistance. So the conjecture of a constant resistance made in Sect. 3 clearly contradicts to the theoretical concepts of minimum energy dissipation and perhaps even to the concept of preferential flow. As far as I can see, this also affects the arguments pointing in direction of a linear reservoir.

In summary, I still find this opinion paper a valuable contribution to the discussion, and looking at the comments by W.R. Berghuijs and M. Cuthbert I think it already has done a good job. Nevertheless, I think the points discussed above should be addressed a more thoroughly in a revised version.

References:

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Again sorry for citing only own work.

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