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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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I thank dr. Hergarten for his thought-provoking review. I am familiar with his work and, indeed, it would have been appropriate to refer to it. I shall do so in the final document. I do agree that the recession is dominated by the slowest part of the drainage system. Hence, in my conceptual figure 2, it is the drainage towards the preferential, fractal-like, structure that determines the time scale during recession. This is precisely what the article assumes: It is the Darcian flow in the top layers of the phreatic aquifer towards the dendritic preferential network that determines the time scale of the recession. Of course also the top layer may have some form of preferential flow, but this can be parametrized by Darcy's law and is substantially slower than the flow through the dendritic network. As Hergarten et al. (2014) mention, the origin of the dendritic network

may be due to both predesign and solution of the substrate by the (aggressive) rainwater. I concur with Hergarten that the self-organisation of the flow pattern is most likely caused by solution of the substrate. As a result, the resistance within the drainage network is negligible compared to the resistance towards entering the network.

My article assumes that the flow towards the network is Darcian (even if partly preferential) and that it is predominantly vertical. This applies to a situation where there is no shallow impermeable boundary underlying the hillslope. If such a boundary were there, then the flow lines would be forced into a more horizontal direction, which would lead to non-linear behaviour. However, my paper is intended for catchments that do drain as a linear reservoir. Subsequently, the linear recession can be explained by assuming a phreatic aquifer draining to a dendritic subterranean network with homogeneously distributed resistance to entering this network.

Like in the papers by Hergarten et al., there is a dependence of the discharge on resistance, but the resistance r_g is not the resistance within the dendritic network, but rather the resistance in the top layer of the phreatic aquifer that separates the water table from the dendritic network. We don't know how thick this layer is, but we assume that the resistance to entering the drainage network is constant in space. I don't see how this is in contradiction with the concept of minimum energy dissipation. The minimum energy dissipation applies to the dendritic network, much like the networks described by Hergarten et al. (2014), but not to the layer that separates the water table from entering the dendritic network.

Since the rate at which the dendritic network expands by solution of minerals is very slow, probably not observable at human time scales, we may assume the drainage network to be static and r_g to be constant. But at geological timescales, the resistance r_g is likely to reduce over time.

So in summary, I am grateful for the comments raised by Dr Hergarten and I shall incorporate his suggestions in the revised paper.

Reference:

Hergarten, S., G. Winkler S. Birk (2014). Transferring the concept of minimum energy dissipation from river networks to subsurface flow patterns. Hydrol. Earth Syst. Sci., 18: 4277-4288, doi 10.5194/hess-18-4277-2014

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