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Are subsurface drainage networks responsible for power law recession behaviour, and under which circumstances?

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Flow recession curves from steep catchments can often be described by a power law or even linear reservoir approximation. Such behaviour cannot be modelled with Darcy's law. The main reason for this is that in such environments the assumption of pure matrix flow is violated. This is likely caused by subsurface preferential flow networks. Although, such networks have been observed at the very small scale, it is hard to observe complete networks. This makes it difficult, or even impossible to empirically derive how such networks look like.

Last year at the EGU, it has been hypothesized that these networks extend mainly horizontally under the hillslope, such that the (vertical) flowpath towards the network is equal everywhere in the catchment [Savenije 2017]. At the same time the resistance from the veins of the network towards the outlet of the catchment is assumed to be equal for all the different veins as well.

In this work I am investigating if and how these networks should look like to be responsible for the power law recession curve. I hypothesize that only network configurations that minimize energy dissipation within the network would make this possible, while purely random networks will not exhibit a power law recession curve.

This hypothesis is tested by simulations of flow through a 2D pipe network. Different pipe network configurations are tested as well as the effect of a sloping network. This will give insight if, and under which prerequisites such networks causes power law recession behaviour.