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Dynamics of a laboratory aquifer

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Hillslopes bring rainfall water to the drainage network by surface runoff and groundwater flow. To identify the contribution of groundwater to river discharge, we need to characterize flow regimes in unconfined aquifers. Here we investigate the dynamics of free-surface Darcy flows in a two-dimensional laboratory model. Although very simple, this experimental setup produces realistic hydrographs showing a series of regimes: quick increase of the discharge after the beginning of rainfall, sharp decrease after rainfall ends, and finally drought flow.

Brutsaert and Nieber (1977) have explained the asymptotic behavior of the drought flow exiting an unconfined aquifer. Using similar methods, we examine the earlier regimes, and compare our experimental results to various sets of hypotheses, including the Dupuit-Boussinesq (or shallow-water) approximation. Finally, we discuss how such analysis could apply to a field hydrograph.