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Influence of quick groundwater recharge on base flow in karstic catchments

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Flow from karst springs is important for the groundwater flow and its recharge which, in turn can determine the pattern of base flow. This behaviour can be well observed in the Ammer catchment, located in southwestern Germany. It covers an area of approximately 130.5 km^2 with several karst springs contributing most of the groundwater flow to the Ammer River. Its discharge shows a very special behaviour with a sharp increase every winter. It is supposed that the groundwater storage layer of this catchment can store large volumes of water because of karstification of the aquifers. Recharge from the subsurface storage to the groundwater storage when subsurface storage reaches a threshold makes groundwater storage increase rapidly, which is also reflected in a quickly rising base flow. We set up a semi-distributed hydrologic model to reproduce this behaviour and gain additional insights on the underlying processes of these discharge dynamics. The model is composed out of three main components: soil moisture, subsurface storage and groundwater storage. Besides percolation from subsurface storage to groundwater storage, quick recharge was introduced into this model for interpreting the sharp rise of base flow. This model was used for five years of simulation (from 2003 to 2007). Results indicate that: (a) percolation is an every day process whereas quick recharge only occurs over few days within a year, mostly from December to April and also in June when precipitation is very large; (b) the annual average recharge from percolation and quick recharge account for 18% and 82% of the total groundwater recharge, respectively, but the quick recharge rate is seven times higher than the percolation rate; and (c) for a single event of sharp increase in base flow quick recharge contributes 70%-78% to groundwater recharge, but in case of a single event of gradual increase of the base flow quick recharge contributes only 30%.