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Drought propagation through the terrestrial part of the hydrological cycle – How to move forward?

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Pro-active water management requires seasonal drought forecasting to prevent or alleviate the impacts of severe droughts on the environment (e.g. water quality, food, and nature) and the economy (e.g. health, crop production, waterborne transport, hydropower, availability of cooling water, and recreation). A prerequisite for adequate drought forecasting is thorough knowledge of the space-time development of hydrological drought (groundwater and streamflow), incl. underlying processes (e.g. Tallaksen and Van Lanen, 2004). Up to now most drought research has focused either on precipitation or on low-flows, and only to a limited extent on groundwater droughts. Furthermore, mainly statistical methods have been used, while studies using physically-based hydrological modelling of droughts are scarce. The problem with statistical methods is that many subjective choices are needed to get a good fit with observations and expectations. Additionally, they are highly black box, and have limited predictive power because the physical processes governing drought development are still poorly understood. Therefore, more knowledge is needed on the propagation of a drought signal through the terrestrial part of the hydrological cycle (i.e. precipitation $>$ soil moisture $>$ groundwater $>$ streamflow). Eltahir and Yeh (1999) and Peters et al. (2003) gave the initial impetus to research on drought propagation, but many questions are still pending. For example, it is still unclear how lag and attenuation result in dampening or amplifying of the meteorological drought signal? And how catchment characteristics influence drought propagation? Peters et al. (2003) used linear reservoirs in a theoretical study on drought propagation, but further development of

their theory is needed to make it valuable for drought forecasting. The main aim of the current study is to develop a generic method to characterise the propagation of drought through the terrestrial part of the hydrological cycle based on the hydroclimatology and catchment control (e.g. soils, hydrogeology). The proposed methodology will be tested in four catchments in Europe and focuses on understanding processes: (1) by investigating natural storage capacity of the catchments, (2) by using hydrological modeling and some statistical methods, (3) by intercomparing the different catchments and methods, and (4) by trying to link the catchment knowledge to regional and global scale drought development. At the current stage, discussion is needed on how to come to an comprehensive and objective method to characterise droughts that reflects their propagation? On how to include all important processes in the propagation analysis? And how to upscale and generalise drought propagation mechanisms?

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