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When is the steady state assumption valid? - Topographic controls on shallow groundwater levels in a steep, pre-alpine catchment

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Spatial and temporal variation in groundwater levels govern the spatio-temporal distribution of runoff source areas, catchment-wide hydrological connectivity and thus streamflow responses in headwater catchments. Topography is an important control on the spatial variability of groundwater levels. In this study we monitored groundwater levels at 51 sites in a 20 ha pre-alpine catchment in Switzerland for 27 months to evaluate the role of topography on median groundwater levels, the importance of local versus upslope topographic characteristics on median groundwater levels and the temporal variation in the correlation between the Topographic Wetness Index (TWI) and groundwater levels. Median groundwater levels were correlated to local and upslope topographic indices, namely the mean curvature of the upslope contributing area, TWI, the upslope contributing area, the local slope gradient and the mean TWI of the upslope contributing area. The correlation between TWI and groundwater levels decreased at the beginning of rainfall events, reflecting spatially variable groundwater responses, and increased after peak flow, indicating a state of hydrological connection closer to steady state. TWI and groundwater levels were most strongly correlated during the late snowmelt period, when groundwater levels where high and the catchment was closest to steady state and lowest during long dry periods, when large parts of the catchment were hydrologically disconnected.