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Human and natural drought impacts on groundwater fluxes of non-Amazonian South America

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The consistent impact of droughts and the progressive use of groundwater for the superficial allocation of crops has extremely increased groundwater withdrawal. The rapid economic expansion is increasing water usage and is likely to exacerbate hydrological drought. While global drought intensities are increased by 10–500\% due to human water consumption, the consequences at a regional and global scale are aggravated by changing precipitation patterns, resulting in multi-year droughts and decreased groundwater recharge.

An essential factor to better understand how human activities affect drought characteristics and development is to quantitatively distinguish natural and human components. At the same time, we see that the recovery from a severe drought is also impacted by catchment characteristics and regional climatology. In this study, we focus on the south American non-Amazon region which has frequently experienced multi-drought periods with severe impacts on surface and groundwater.

We estimate the drought impact on groundwater with the model PCR-GLOBWB2 at a 5 arcmin resolution under natural and human influence. Aggregations of the model output at a catchment level of the groundwater and subsurface partitioned run-off was performed. To determine the influence with and without lateral water flux at high resolution, the flux differences of groundwater components such as baseflow and groundwater recharge were quantified. Finally, the drought termination (DT) framework was applied to understand the recovery response of simulated surface runoff, interflow, and groundwater recharge.

The PCR-GLOBWB2 identifies regions influenced by human impact in the non-Amazon basins, supported by the drought duration, deficit, and groundwater fluxes. The differences in fluxes show an increasing groundwater withdrawal due to irrigated zones, affecting hydrological processes at a catchment and regional scale. The recovery of fluxes during these events consists of a relevant indicator for groundwater behavior due to drought and/or human consumption. We quantified the impact on groundwater resources by addressing the land-use component to understand the variability in water volumes. This study is beneficial to identify groundwater drought vulnerability in regions where observations are lacking and help to predict drought recovery periods, lateral-flux impacts, and characteristics.