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Hydroclimatic change driven by land-water-use developments:the case of transboundary Sava River Catchment, South Eastern Europe

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Growing human demands for water, food and energy have led to extensive use and modification of world water bodies, for instance by construction of dams, reservoirs and channels for hydropower purposes. In this study we use the transboundary Sava River Catchment (SRC) in South Eastern Europe, as field case for investigating long-term hydroclimatic changes and their relation to regional hydropower and associated land-water-use developments. We find sustained increase in average annual evapotranspiration, and decrease in average annual runoff and temporal runoff variability as hydropower production increased in the SRC parts with the greatest such developments during the 20th century. Purely climate-driven estimates of change in evapotranspiration and runoff cannot capture these changes, which are apparently related to the land and water use changes associated with hydropower development. Direct comparisons with corresponding results from other world regions and global estimates show consistent cross-regional results, supporting generalization of obtained specific numerical results and the used analysis approach on different scales and across different parts of the world.
With regard to specific results, the estimated average increase of actual evapotranspiration by hydropower-related/reflected land-water-use changes in SRC (sub)catchments with considerable hydropower development is 37 mm/year (for their average annual hydropower production of 217 MWh/km2). This result is for instance consistent with a corresponding estimate of evapotranspiration increase by Destouni et al (2012) of 57 mm/year (for their investigated Swedish hydropower catchments with average annual hydropower production of 322 MWh/km2).
The SRC case study, of an area of recent political and social instability with less than ideal conditions regarding environmental monitoring, represents a methodological success by showing that, even in such a complicated part of the world, relevant data series can be compiled for detecting and recognizing hydro-climatic changes and their possible land-water-use drivers. The used catchment-wise methodological approach offers opportunities for improved assessment of drivers and hydro-climatic changes across different scales, and for further development of climate and Earth system models based on this improved knowledge.