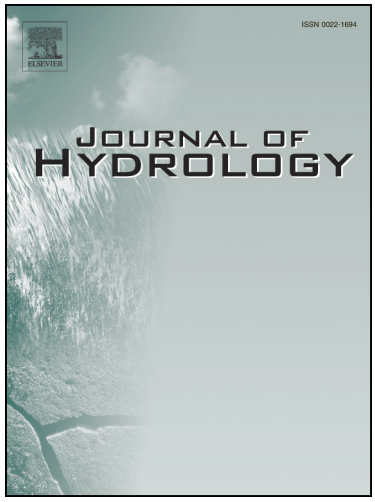

Research papers

Anthropogenic hydrological cycle disturbance at a regional scale: state-wide evapotranspiration trends (1979-2015) across Nebraska, USA

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Anthropogenic hydrological cycle disturbance at a regional scale: state-wide evapotranspiration trends (1979-2015) across Nebraska, USA

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Abstract Trends in monthly evapotranspiration (ET) rates across Nebraska, the most intensely irrigated state within the US, were calculated by the calibration-free version of the nonlinear complementary relationship of evaporation over the 1979-2015 period utilizing North American Regional Reanalysis (NARR) net radiation, 10-m wind velocity, as well as Parameter Regression Independent Slope Model (PRISM) air- and dew-point temperature data. State-averaged modeled ET rates rose by 5.5 mm decade^{-1} due to the presence of wide-spread large-scale irrigation projects in accordance with a 2.4 mm decade^{-1} increase in PRISM precipitation (P) and a simultaneous -2.8 mm decade^{-1} drop in United States Geological Survey's state-averaged annual streamflow rates, raising the state-wide ET to P ratio from 0.89 to 0.91 over the modeled time-period. ET rates over irrigated crops increased by 7 mm decade^{-1} despite a -4.4 mm decade^{-1} drop in precipitation rates. A similar increase in ET rates (6 mm decade^{-1}) required 8.1 mm decade^{-1} increase in precipitation rates across the non-irrigated Sand Hills of Nebraska. Published NARR ET rates are unable to pick up this unusual regional trend. Since an increase in precipitation rates should normally decrease the ET ratio, as predicted by the Budyko curve, this study yields evidence on how dramatically sustained large-scale irrigation can alter the regional hydrologic cycle not only through a) trivially depleting streamflow rates and/or lowering groundwater table levels; b) suppressing precipitation locally (while enhancing it a long distance downwind), but also; c) reversing the trajectory of the regional ET ratio under generally increasing trends of precipitation.

Keywords: complementary relationship of evaporation, regional hydrologic cycle, ET ratio, Budyko curve, water balance, High Plains aquifer, GRACE data