Quantitative effects of changes in agricultural irrigation on potential evaporation

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Abstract

Evaporation is the key to the basin's water cycle. Agricultural irrigation has resulted in a significant variation of regional potential evaporation (E_{pen}). The spatiotemporal variation of E_{pen} and the influencing factors in the natural, agricultural, and desert areas in different developmental stages of irrigation in the Heihe River Basin (HRB) from 1970 to 2017 are comparatively analyzed in this study. This work focused on the correction effect of irrigation on the variation of E_{pen}. The agricultural water consumption in HRB significantly varied around 1998 due to the agricultural development and water policy. Under the influence of irrigation, the annual variation of E_{pen} in the agricultural, natural, and desert areas was significantly different. From 1970 to 1998, the annual trend slope of E_{pen} in the natural area only reduced by 1 mm decade^{-1}, while that in the agricultural area significantly decreased by 39 mm decade^{-1}. After the implementation of water-saving irrigation, the E_{pen} in the natural and agricultural areas increased by 11 and 54 mm decade^{-1}, respectively, from 1998 to 2017. In contrast with the natural and agricultural areas, E_{pen} in the desert area decreased by 80 mm decade^{-1} from 1970 to 1998 and continuously decreased by 41 mm decade^{-1} from 1998 to 2017. However, the regulatory effect of irrigation on E_{pen} in the desert area started to manifest due to the expansion of the cultivated land area in the desert area from 2010 to 2017. Irrigation has a significant regulatory effect on the variation of E_{pen} in HRB. The regulatory effect is mainly reflected on the aerodynamic term (E_{aero}). The analytical results of the main meteorological factors affecting Epen in different regions indicated that the main meteorological factors influencing the variation of E_{pen} in each region are the wind speed 2 m above the surface (U_2) and the water vapor pressure difference (VPD).

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Figure captions

Fig. 1 Spatial location and characteristics of the HRB.

Fig. 2 Annual runoff at different hydrological stations and water diversion in the upstream of the agricultural area in HRB.

Fig. 3 Distribution of trend slopes per decade of E_{pen}, E_{rad}, and E_{aero} in the different stations in the HRB (1970–2017).

Fig. 4 Annual variations of the averaged E_{pen}, E_{rad}, and E_{aero} in different regions in the HRB.

Fig. 5 Relationship between the variations of potential and actual evaporation in the HRB.

Fig. 6 Fitting of the E_{pen} variation calculated by the regression and trend analytical methods in the HRB.

Table captions

Table 1. Meteorological conditions and regional characteristics of the different regions in HRB.

Table 2. Location of the meteorological stations and the percentage of cultivated land area within 4 km of the stations in HRB.

Table 3. Trend slopes per decade of E_{pen}, E_{rad}, and E_{aero} in different regions in the HRB (1970–2017).

Table 4. Trend slopes per decade of the meteorological factors in different regions in the HRB (1970–2017).

Table 5. Trend slopes per decade of E_{pen}, E_{rad}, and E_{aero} at different stations in the HRB (1970–2017).

Table 6. Contributions of the meteorological factors to the variation of E_{pen} in different regions in the HRB.