

GROUNDWATER DEPLETION IN THE NORTH CHINA PLAIN: THE AGROHYDROLOGICAL PERSPECTIVE

Tammo S. STEENHUIS (✉)¹, Xiaolin YANG²

¹ Department of Biological and Environmental Engineering, Cornell University, NY 14853, USA.

² College of Water Resources & Civil Engineering, China Agricultural University, Beijing 100083, China.

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Correspondence: tss1@cornell.edu

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SUPPLEMENTARY MATERIALS

SECTION P1 REGIONAL GROUNDWATER TABLE CHANGE FOR MULTIPLE CROPS

The regional evaporation for the j^{th} year for more than one crop can be obtained using Eq.6 by adding the evaporation of the individual crops, i , that are grown that year in a portion of the region, viz

$$E_{rj} = \sum_{i=1}^m \frac{Y_{i,j}}{Y_{maxi,j}} \frac{A_{cropi,j}}{A_{total}} E_{maxi,j} \quad (S1)$$

where for year j , E_{rj} is the regional evaporation per unit area in a cropped region with an area, A_{total} , $Y_{i,j}$ is the crop yield of crop i that is grown on an area, $A_{cropi,j}$ that has a maximum yield $Y_{maxi,j}$ and water use of the $E_{maxi,j}$. The inherent assumption is that during a fallow period, the evaporation is minimal, presuming that the field remains weed-free.

The potential groundwater change in an agricultural region for the year, j , Δh_j , can be found by substituting Eq S1 into Eq 3.

$$\Delta h_j = \mu \left[P_j + X_j - \sum_{i=1}^n \frac{Y_{i,j}}{Y_{maxi,j}} \frac{A_{cropi,j}}{A_{total}} E_{maxi,j} \right] \quad (S2)$$

where μ is the drainable porosity, P_j is the precipitation in year j and X_j is the imported water per unit area from outside the region in year j . The groundwater table declines when $\Delta h_j < 0$. Since it takes longer than a year for percolation from the root zone to reach the groundwater, the annual potential groundwater table changes have to be averaged of several years, n

$$\bar{\Delta h} = \frac{1}{n} \sum_{j=1}^n \Delta h_j \quad (S3)$$

where n is the number of years. The exact value of n depends on the groundwater depth, depth of water percolated from the root zone, and the composition of the soil profile. Further research is needed to determine the value of n . Yang et al. found that it took approximately two years to reach the groundwater during a high rainfall year^[1]. They also showed that Eq S3 could predict the groundwater table decline with measured values of maximum water use and with crops producing maximum yields

The condition for preventing groundwater depletion in an agricultural region with multiple crops is

$$\sum_{j=1}^n \sum_{i=1}^m \frac{Y_{i,j}}{Y_{max i,j}} \frac{A_{crop i,j}}{A_{total}} E_{max i,j} \leq \sum_{j=1}^n [P_j + X_j] \quad (S4)$$

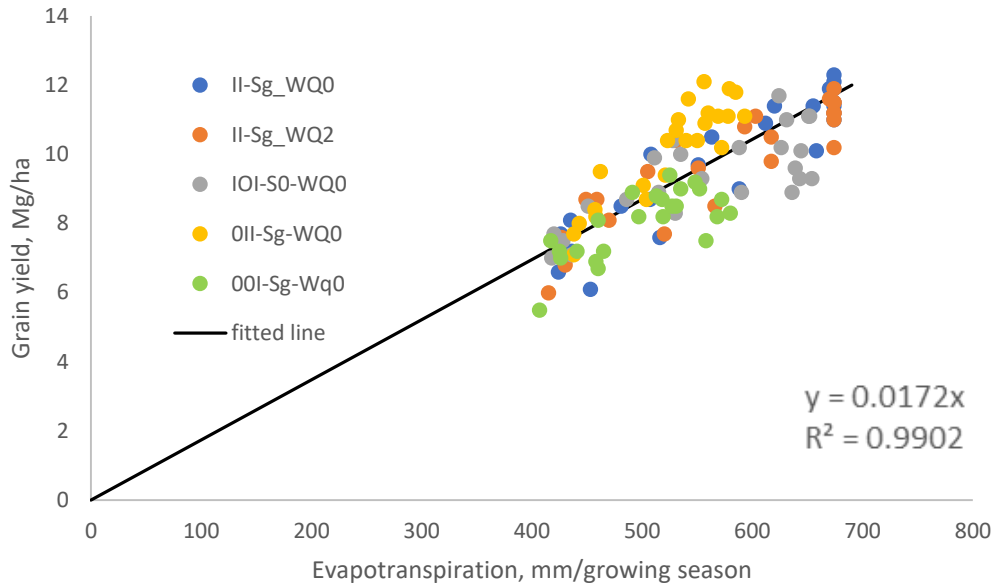


Fig. S1 Maize grain yields from several irrigation-timing and water quality treatments related to seasonal evapotranspiration in Davis, California in 1974. Maximum plant water use is 674 mm per growing season. Data are taken from Appendix C, Tables C1–C5^[2].

REFERENCES

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