1 Introduction

The North China Plain is one of China’s most important agricultural regions. It relies heavily on groundwater pumping for irrigation powered by electric energy. This region is also facing a severe problem of groundwater over-pumping. The interaction of agricultural production, groundwater resources and energy requirement was analyzed in the case study of Guantao County (456 km²). The results allow to provide recommendations for developing practical strategies for groundwater over-pumping control.

2 Guantao in North China Plain

3 Method and results

1) Reconstruct energy consumption for irrigation

\[ E_{irr} = E_{irr,p} - c \cdot GDP \]

- \( c = 0.037 \text{ kWh/RMB} \) (from the records in 2007 [1])
- Hypothesis: the inter-annual variability of \( E_{irr,p} \) is caused by the randomness in annual precipitation.

2) Test energy-water conversion factor \( \alpha \) (kWh/m³) at selected wells (Fig. 4)

- \( \alpha = E/V \)
- Pump efficiency \( \eta \) can be then calculated (30%).

3) Reconstruct historical groundwater abstraction \( V = E/\alpha \); where \( \alpha = H/\rho g/(367g) \)

- Historical \( \alpha \) was calculated using the historical lift \( H \).
- The result was verified by a water balance model (Fig. 5).

4 Application: Assessing strategies of groundwater pumping control

S0: Present situation. No water saving equipment, energy-water conversion factor \( \alpha_0 \), groundwater consumption \( V_0 \), over-pumping rate \( k \) (10%). Energy consumption for pumping \( E_0 = V_0 \cdot \alpha_0 \), electricity price \( R_0 (0.5 \text{ RMB/kWh}) \).

To close the gap of over-pumping, two strategies are compared:

S1: Subsidize water saving equipment. Sprinkler is installed; water consumption can be reduced by \( \delta \) (26%) [2]; more energy is consumed in water saving irrigation, \( \alpha_1 (0.6 \text{ kWh/m}^3) \).

S2: Reduce planting area. No water saving equipment; planting area is reduced by \( k \) (10%); crop production is also reduced by \( k \) due to the reduction of planting area. (Table 2)

S3: Increase water price to incentivize farmers to save water

Water price, \( R_0 \) should be high enough to make using water-saving equipment profitable.

\[ R_0 > R_2 \cdot \alpha_2 \cdot [(1-k) - \alpha_1]/s \]

Water price should be at least 0.48 RMB/m³, which is higher than the present water price of 0.1 RMB/m³.

4 References & Acknowledgement

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