Supplementary information

Equations of water resources system:

$$W_{total} = W_{surface} + W_{ground} - W_{repeat} \quad (1)$$

$$Q_{ava} = \rho(W_{total} - W_{eco} - W_{flood}) \quad (2)$$

$$W_{demand} = W_{ind} + W_{agr} + W_{lives} + W_{eco} \quad (3)$$

where: W_{total} is the total water resource (m^3 $year^{-1}$); $W_{surface}$ is the water resource of surface flow (m^3 $year^{-1}$); W_{ground} is the water resource of ground water (m^3 $year^{-1}$); W_{repeat} is the water resource counted twice due to the recharge of surface and ground water with each other (m^3 $year^{-1}$). ρ is the water storage capacity efficient; Q_{ava} is the available water resource quantity (m^3 $year^{-1}$); W_{total} is the total water resources (m^3 $year^{-1}$), W_{eco} is the water quantity needed for keeping the ecological balance in Channel and calculated with the ecological hydraulic radius method (m^3 $year^{-1}$) [1]; W_{flood} is the water quantity lost in the flood events and calculated as 20% of the total water resource based on the water resource calculation evaluating method (m^3 $year^{-1}$) [34]. W_{demand} is the total water demand for the society development (m^3 $year^{-1}$); Wind is the industrial water demand (m^3 $year^{-1}$); W_{agr} is the agricultural water demand (m^3 $year^{-1}$); W_{lives} is the domestic water demand (m^3 $year^{-1}$); W_{eco} is the ecological water demand used for diluting the polluted water and meeting the ecological water demanding outside the channel (m^3 $year^{-1}$).

Equations of economic system:

$$\boldsymbol{W_{ind} = Y_{ind} \cdot P_{pop} \cdot \rho_{ind}} \quad (4)$$

$$\boldsymbol{W_{agr} = Y_{agr} \cdot P_{pop} \cdot \rho_{agr}} \quad (5)$$

$$\boldsymbol{W_{lives} = P_{pop} \cdot \rho_{lives}} \quad (6)$$

$$\boldsymbol{W_{eco} = W_d + W_{outside}} \quad (7)$$

where W_{ind} is the industrial water demand (m^3 $year^{-1}$); W_{agr} is the agricultural water demand (m^3 $year^{-1}$); W_{lives} is the domestic water demand (m^3 $year^{-1}$); ϱ_{ind} is the GDP per capita; ϱ_{agr} is the farmland area per capita per year; ϱ_{lives} is the water demand per capita (m^3 $capita^{-1}$ $year^{-1}$). Y_{ind} is the water demand per 10^4 RMB per year; Y_{agr} is the water demand per ha; P_{pop} is the population. W_{eco} is the ecological water demand (m^3 $year^{-1}$); W_d is the water quantity for water dilution (m^3 $year^{-1}$); $W_{outside}$ is the water quantity for meeting the ecological safety outside the channel (m^3 $year^{-1}$).

Equations of ecological system:

$$W_d C_d = \beta Q_p C_p + (1-\beta) Q_p C_{unp} \quad (8)$$

$$Q_p = Q_{agr} + Q_{ind} + Q_{doc} \quad (9)$$

$$C_d \le C_s \quad (10)$$

$$Q_m \ge Q_p \quad (11)$$

where: C_d is the CODCr of streamflow (mg/L); Q_p is the quantity of polluted water (m^3 $year^{-1}$); C_p is the concentration of the polluted water after the treatment (mg/L); C_{unp} is the concentration of polluted water before the treatment (mg/L); β is the purification rate of sewage plants; Q_{agr} is the polluted water quantity of agricultural field (m^3 $year^{-1}$); Q_{ind} is the polluted water quantity of industry (m^3 $year^{-1}$); Q_{doc} is the polluted water quantity of domestic lives (m^3 $year^{-1}$); C_s is the targeted

concentration of polluted water (mg/L) and set to 20mg/L; Q_m is the targeted minimum quantity of sewage (m^3 $year^{-1}$) and equal to Q_P in this study.

Reference:

[1] Liu, C.M.; Men, B.H.; Song, J.X. Hydrological Radius method for Estimating the Ecological Water Demand of Channels. Progress of Natural Science 2007, 17, 42-48.