A model for optimal regulation of soil and water resources in agro-ecosystems under climate change based on climate data processing

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Objectives

As population growth and resource shortage intensify, sustainable agricultural development is facing great difficulties. The optimal allocation of agricultural water and soil resources is an effective way for sustainable agriculture, while significantly affected by climate change. However, meteorologically driven synergistic water-economic-environmental regulation of agroecosystems has been under-researched. The study developed a climate-driven multi-objective optimization model of agricultural water and soil resources to achieve the synergy of economic-environmental-water system for agroecosystems.

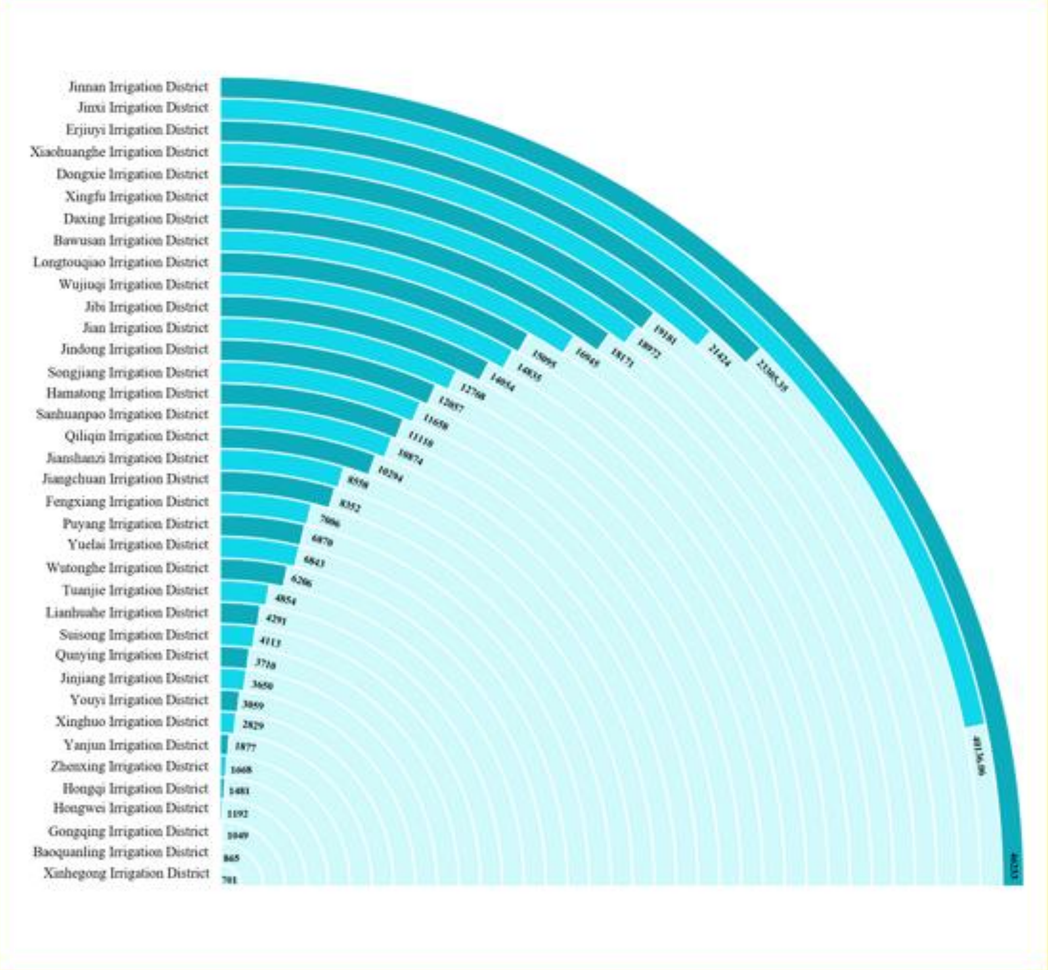

Figure 1 Irrigation district water dispatch allocation (m^3)

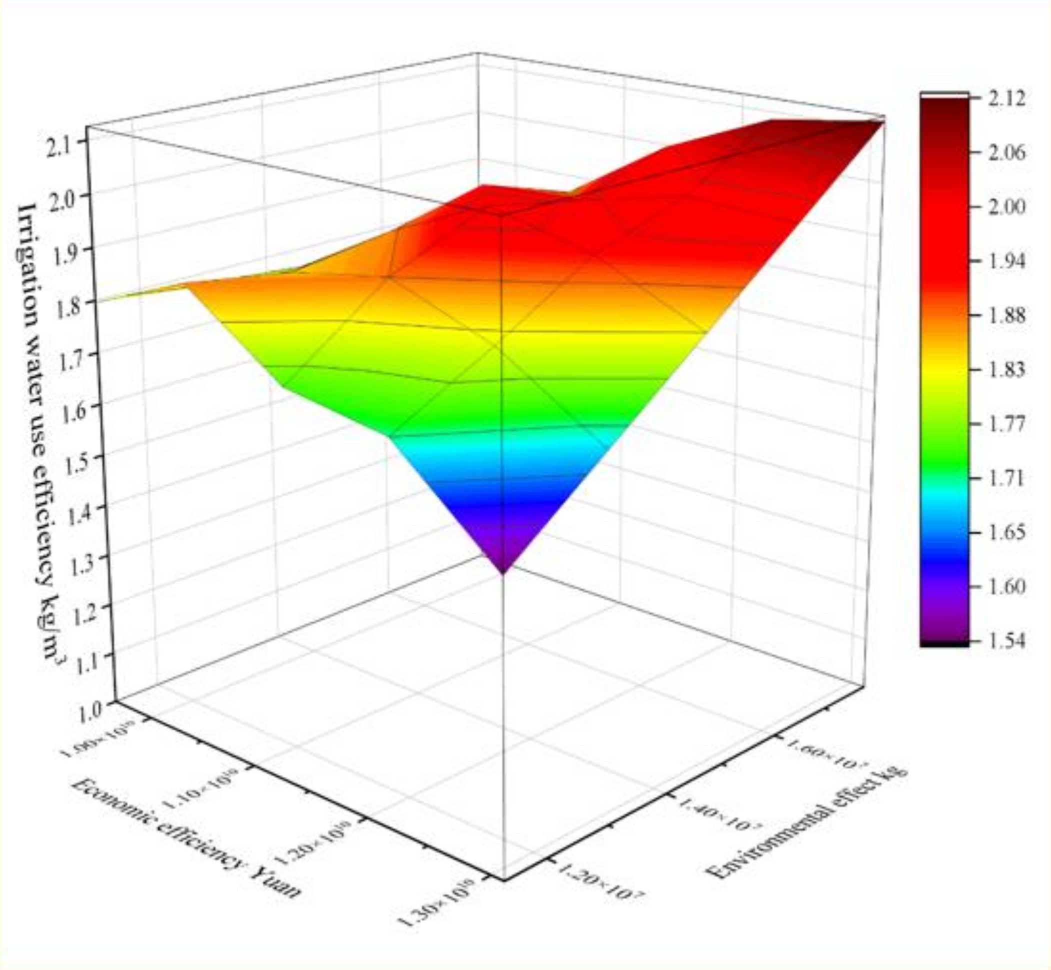

Figure 2 Graph of trade-offs between objective functions

Methods

- An economic efficiency objective function is constructed based on the crop water management model.
- The environmental effect objective function was constructed through the carbon emission model and the nonpoint pollution model.
- The objective function of water utilization efficiency was constructed by combining the crop water production and consumption model.
- Reflecting the uncertainty of hydrometeorological data management through intuitive fuzzy numbers.
- Explore the relationship network between hydrometeorological factors and runoff volume under climate change using dynamic Bayesian networks.
- A fuzzy mathematical approach with optimistic-pessimistic-mixed viewpoints is used to solve the multi-objective model results.

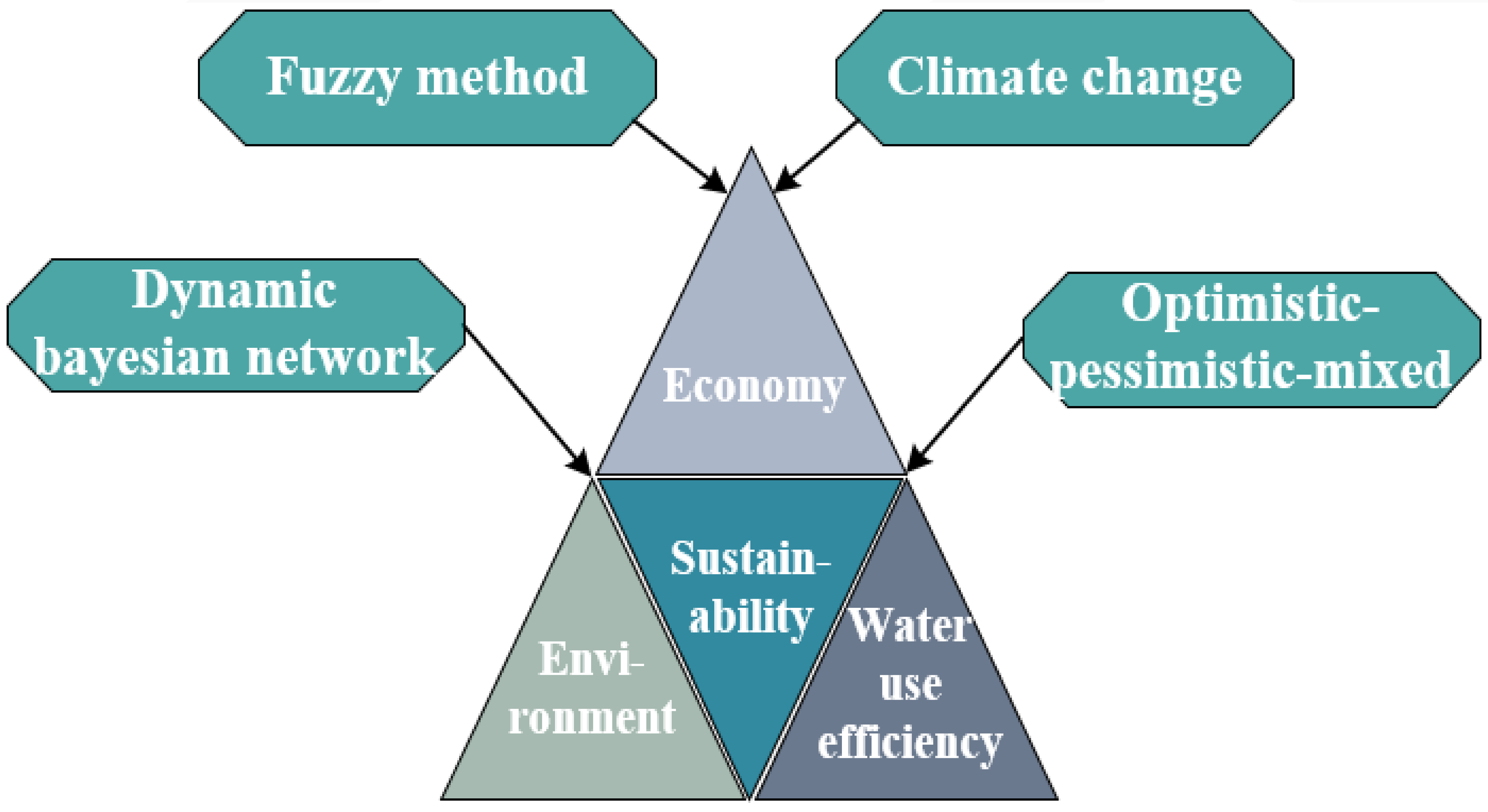

Figure 3 Conceptual diagram of the model

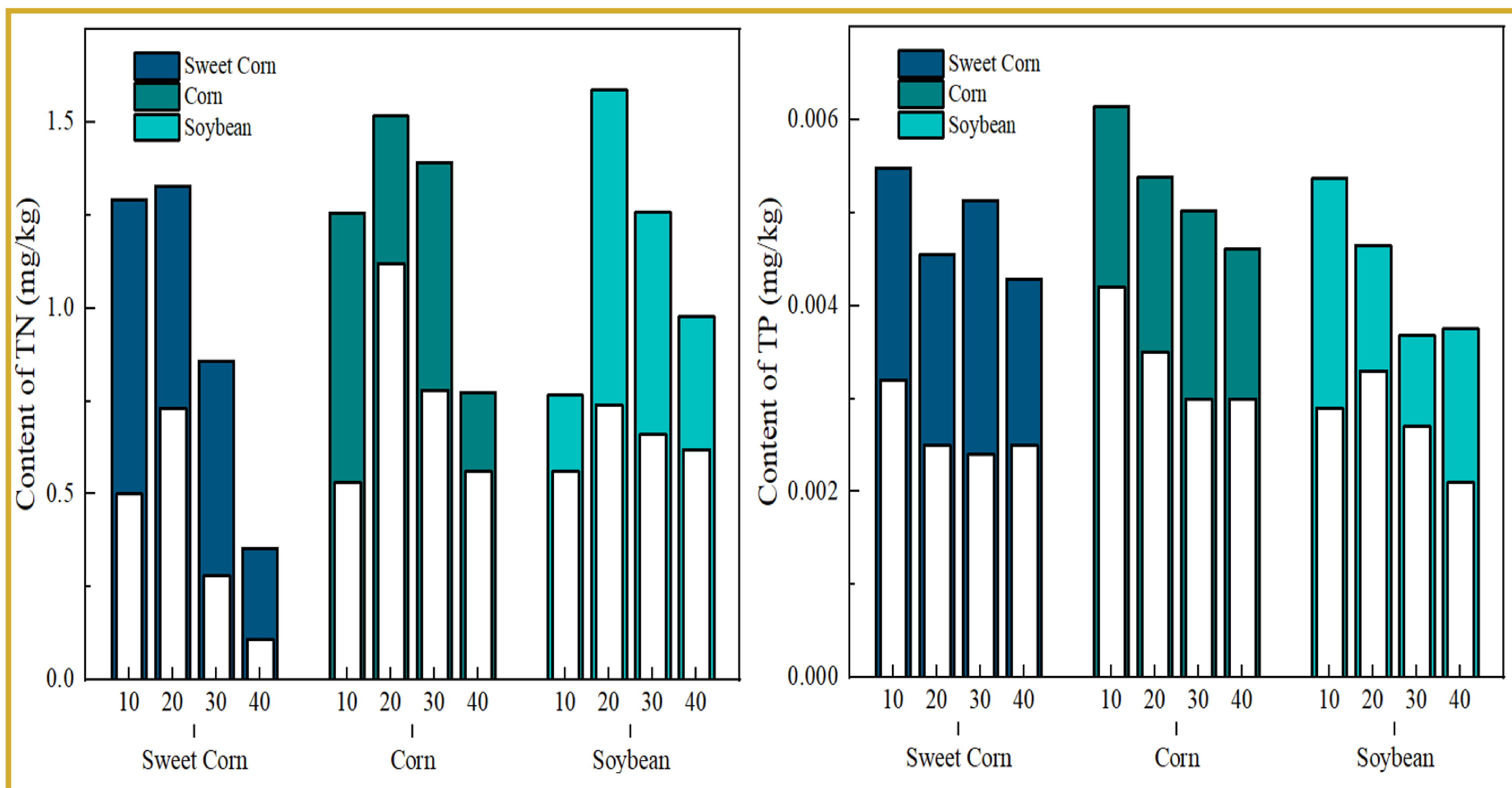

Figure 4 Pollution emission factor

Results

- The optimized water consumption per unit area is 6509.15 m^3 /ha, which is 7.4% lower than the current water consumption.
- The optimized irrigation water use efficiency is 1.76, which is 1.4% higher than the status quo.
- The emission factor calculated by the improved input-output coefficient model has an error of 13.7% from the standard.

Conclusions

The constructed model can weigh the contradiction between economic efficiency, environmental pollution and resource utilization, and promote sustainable agricultural development.