

Optimizing sustainable water resource utilization of inter-basin water transfer under climate change

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Abstract: Sustainable water resource utilization in river basins is crucial for achieving the United Nations Sustainable Development Goals under climate change scenarios. However, arid and semi-arid river basins face significant challenges in balancing water supply efficiency and pollution discharge.

This study develops an optimization framework for sustainable water resource utilization through inter-basin water transfer (IBT) systems under climate change. The framework is demonstrated through a case study of the Yellow River Basin (YRB) in China, a critically water-stressed region.

The results show that climate variability is the dominant driver of water-yield changes, exerting effects that substantially exceed those of land-use modifications. Water allocation patterns exhibit high sensitivity to climate forcing: local sources supply 75.2% of total allocation under the SSP1-1.9 pathway, whereas western route transfers increase markedly under SSP2-4.5 conditions. A strong positive correlation emerges between pollutant emissions and total water allocation, with environmentally stressed regions coinciding with zones of reduced water availability.

This research provides evidence-based decision support for climate-adaptive water resource management in the YRB by adjusting inter-basin water transfer strategies. The framework aims to achieve sustainable development of water resource systems while establishing a transferable methodological approach for water-stressed basins worldwide.

Keywords: *Yellow River Basin, climate change, inter-basin water transfer, sustainable water resource utilization*