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An integrated simulation-optimization modeling approach for coupled risk management of blue water and green water under changing environmental conditions

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Due to the impact of global climate change and land use changes, the spatiotemporal distribution and water cycle processes of watershed water resources are affected. In order to sustainably manage watershed water resources, it is necessary to accurately assess the available water volume to meet the coordinated management of the watershed's socio-economic subsystem and eco-environment subsystem. The amount of Bluewater resources (BW) is closely related to the amount of Greenwater resources (GW). BW is directly related to human consumption in the socio-economic subsystem, while GW is used to maintain the health of the ecosystem. A method called the integrated simulation-optimization modeling system (ISOMS) was developed to evaluate adaptive strategies for dealing with the combined effects of climate change and land-use changes. ISOMS not only predicts future hydrological trends under varying environmental conditions but also generates comprehensive risk management plans that incorporate different types of uncertainties, including random and fuzzy factors. The Copula function is introduced to handle the interaction between available BW and available GW. The results showed that: (i) uncertainties in the hydrologic system could result in alterations to the distribution of water resources; (ii) system benefits are, to some extent, affected by land use change and climate change; (iii) the shortage of BW is affected by the level of risk, and the joint risk increases, resulting in an increase in water scarcity; (iv) the planned annual agricultural water consumption is the highest, followed by domestic water consumption, and industrial water consumption is the lowest. Through the results of the model operation, the joint risk assessment and adaptive management of BW and GW in the East River Basin (ERB) under changing environments, as well as the BW allocation plan, are obtained to provide support for scientific and reasonable resource collaborative decision-making and promote the synchronized advancement of the socio-economic subsystem and ecoenvironment subsystem in the ERB.