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A risk-based decision-centric assessment of water supply capacity in a complex river basin under climate change

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Climate change can degrade performance of hydrologic systems that are traditionally operated with heuristic operation policies, and thus necessitates adaptive solutions for relevant authorities. While the vulnerability-based framework provided a new paradigm to minimize the vast gap between impact assessment studies and policy development, challenges still remains with uncertainty in the stress tests. The stress tests that measures system vulnerability (or robustness) are highly dependent on modeling assumptions and simplifications. Thus, obtained evaluation metrics need to be used in a probabilistic manner. To reduce over-reliance on the modeled system performances, this study proposes to incorporate the logistic regression into the system stress tests for a vulnerability-based impact assessment. In our case study, the response surface of system performance was replaced with the "logistic surface" that describes the risk of system failure against predefined performance thresholds. Using the modified surface, we evaluated water supply and environmental reliability for a complex river system in South Korea within the eco-engineering decision-scaling framework. Results showed that human-demand-only operations could entail water deficiency at locations requiring environmental demands. To reduce the ecological risk, water users at regions with low water demands need to take risks of unsatisfactory water supply. Within the eco-engineering decision-scaling framework, the modified approach made it possible to simultaneously consider multifaceted stakeholders' interests in a probability domain. This study suggests that the logistic surface can efficiently measure system robustness to climatic changes from multiple perspectives. It also could provide the risk of system failures in a complex hydrologic system for policy development.