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Disentailing Sources of Future Uncertainties for Water Management Policies in a Subtropical Water System.

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Changing climate, growing population, and urbanization are likely to exacerbate the competition for water resources in the coming years, and to challenge the effectiveness of water management policies. In this rapidly evolving multi-stakeholder context, it is crucial to explore the sensitivity of water supply strategies to deeply uncertain climatic and socio-economic forcings, fostering the identification of policies that integrate optimality and low vulnerability against likely adverse future conditions. Here, we propose an integrated framework combining optimization, sensitivity and uncertainty analysis to retrieve the main sources of vulnerability to water management strategies across a multidimensional objective space. Our framework is tested in the Umbeluzi river, Mozambique, operated to meet three conflicting objectives: the water demand in the city of Maputo, hydropower production, and irrigation supply. Rapid urbanization, economic growth and water development plans mark the Umbeluzi as archetypal of most river basin in developing countries. The main sources of uncertainty we consider are: the projected increase in water demand following urbanization and irrigation development in the area; the magnitude of streamflow depletion due to climate change; and the completion date of the greater Maputo water supply expansion project. The optimization approach is based on Evolutionary Multi-Objective Direct Policy Search (EMODPS), while the sensitivity and uncertainty analysis are founded on the PAWN and the GLUE methods, respectively. Numerical results show that, while socio-economic and infrastructure are equally important for compromise solutions, climate becomes the most influential factor for asymmetric tradeoffs.