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Application of multicriteria hybrid model to address wastewater reuse strategies: the case of Elqui River basin in Chile

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Since 2010, Chile's central basins have faced an extended drought, stressing water systems. Particularly at Elqui River Basin, while direct reuse of treated wastewater is considered a management strategy to address water scarcity, regulatory and socio-economic barriers hinder its implementation. Still, a knowledge gap remains regarding the optimal allocation of such Non-Conventional Waters (NCW) and the systemic impact of reallocating the specifically 'freed-up' freshwater rights at the basin scale.

This study introduces a methodological framework coupling a hybrid Multicriteria Decision Making (MCDM) model with hydrological simulation. To address the complex interdependencies between conflicting decision factors, we apply a DANP (DEMATEL-based ANP) approach. Through a panel of experts, we build an Influential Network Relation Map (INRM) to derive global weights for technical, economic, and environmental criteria. This model prioritizes NCW allocation scenarios initially among competing sectors (e.g. mining, agriculture, urban, and ecosystems) and subsequently at the sectorial scale (e.g. irrigation canal sections).

The resulting prioritization schemes are input into a WEAP model of the basin. We simulate the hydrological trade-offs, evaluating how replacing freshwater with NCW impacts reservoir reliability and water demand satisfaction metrics. The study concludes by discussing the implications of these hybrid allocation schemes for integrated water resource management at the basin scale.