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Balancing Local and Global Sustainability of Urban Water Supply Systems with Water Security and Resilience Goals

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The sustainability of urban water systems is commonly analyzed based on local characteristics, such as the protection of urban watersheds or the existence of nature-based solutions for stormwater drainage. Water embedded in food and other goods consumed within cities, or the pollution caused by their production is generally not assessed as part of urban water system sustainability. However, indirect feedbacks can produce negative impacts (e.g., drought and water quality impairments) resulting from these water and ecological footprints. We therefore suggest that, within the context of nexus thinking, embedded water and ecosystem impacts should be part of urban water governance considerations.

We quantify the local and global sustainability of urban water supply systems (UWSS) based on the performance of local sustainable governance and the size of global water and ecological footprints. Building on prior work on UWSS security and resilience, we develop a new framework that integrates security, resilience, and sustainability to investigate trade-offs between these three distinct and inter-related dimensions. Security refers to the level of services, resilience is the system's ability to respond to and recover from shocks, and sustainability refers to the long-term viability of system services. Security and resilience are both relevant at local scale (city and surroundings), while for sustainability cross-scale and -sectoral feedbacks are important. We apply the new framework to seven cities selected from diverse hydro-climatic and socio-economic settings on four continents. We find that UWSS security, resilience, and local sustainability coevolve, while global sustainability correlates negatively with security. Approaching these interdependent goals requires governance strategies that balance the three dimensions within desirable and viable operating spaces. Cities outside these boundaries risk system failure in the short-term, due to lack of security and resilience, or face long-term consequences of unsustainable governance strategies. Our findings have strong implications for policy-making, strategic management, and for designing systems to operate sustainably at local and global scales, and across sectors.

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