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Climate change adaptation through integrated management of water reuse technologies

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The integrated management of water reuse technologies and their coordination with the operations of the other water system components are fundamental to fully exploit the reuse potential. Yet, these technologies are usually designed considering their individual parameters (e.g., efficiency, durability, maintenance costs, energy consumption), more than the integration with traditional water management practices, and the impacts on the final users at the system scale.

Here, we adopt a portable framework based on optimal control methods and machine learning to evaluate the cross-sector impacts of water loops. The framework is developed for the Apulia Region, Southern Italy, a drought-prone area characterized by the presence of a complex water distribution network and multiple conflicting users across agricultural districts, industry, and drinking water supply.

The robustness of each adaptation strategy is comprehensively investigated through a scenario-based approach, including the analysis of climatic, socio-economic (drinking, irrigation, and industrial water demand pattern), legal (environmental flow constraints), and technological (water reuse implementation) aspects.

Results show that the combined effect of climate and socio-economic changes will dramatically affect the Apulia water system, leading to unsustainable pressure on freshwater resources. In addition, the implementation of the environmental flow constraints will further reduce the operation space. Future water deficit is thus expected to increase at half-century (2050-2059) as well as in the long-term (2090-2099), especially under the more extreme climate projection (RCP 8.5).

Results also show that water reuse actions remarkably improve the situation, but the effect is only partial and far from entirely closing the gap with the current situation. This means that the specific adaptation actions here adopted are not sufficient and that it is necessary to further promote the spread of the reuse technologies and increase their efficiency.

The proposed framework is a decision support system that aims at assisting policy-makers in the transition to a circular water economy by integrating water management and treatment-reuse technologies.