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Trade-off of cost, reliability and environmental impacts of water transfers in South England

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In the UK, water utilities are facing challenges including population growth, climate change and abstraction reforms intended to restore sustainable amounts of water for the environment. As the population density increases in the south part of England, one of the possibilities of mitigating water scarcity is to transfer water from the north and west of England. However, droughts are spatially coherent events and the most severe droughts usually result in water shortages over wide areas. Consequently, the question is, does the donor basin have enough water itself during drought or low flows periods to transfer to the other basins?

Here we employ a new large ensemble of climate model projections based on the climate models (HadCM3 +HadRM3) using the weather@home system. Weather@home consists of an atmospheric global climate model and a regional climate model sharing essentially the same physics, which are run on volunteers' computers around the world using the infrastructure of climateprediction.ne [Guillod et al., 2017]. Daily rainfall and potential evapotranspiration time series from the weather@home climate simulations were then run through a semi-distributed hydrological model (Dynamic TOPMODEL) for 45 inflow points in the Thames and Severn-Trent water basins. The model was calibrated to naturalized flows at each of these inflow points to provide naturalized future flow predictions for three sets of climate scenarios including a baseline (1975-2010), near future (2020-2050) and far future (2070-2100) period. Two population growth scenarios were also considered.

We employed WATHNET simulation software [Kuczera, 1992] to model two neighboring water companies using flow predictions from the hydrological model, Thames Water and Severn Trent Water, and all of the transfer rules and regulations, including various contractual arrangements, that might govern the transfer of water between neighboring water utilities. WATHNET is a simulation model based on network linear programming.

First we assess the impacts of climate change on both water companies' service reliability without any water transfer in place. Then we employed multi-objective optimization algorithms to explore all the possible future options for both water companies, including transfer options, transfer rules, infrastructure investments and operational rules. We considered four objectives in this study: 1)Mimimising total cost (Capex and Opex) 2)Minimizing restriction cost 3)Minimising transfer reliability and finally 4)Minimising environmental damages of the donor basin by measuring environmental flow deficits

Keywords: Water supply, reliability, water transfer, climate change

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