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Analysing the historic supply-demand dynamics of public water supply across catchments in Wales, UK

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UK water service providers face several challenges in planning future operations and services. Key amongst these is climate change, the impacts of which in terms of surface water quantity (extreme wet or dry periods) and quality are uncertain. Added to this, the future projections of consumer water demand, in response to altered climate, are also likely to change. However, the relationship between hydroclimatic variations (i.e. water supply variability) and the variability of consumer water demand is still poorly understood. In this study, we seek to characterise the links between hydro-meteorological variables and surface water abstraction data at five catchments (Clwyd, Conwy, Dyfi, Teifi and Tywi) across Wales, UK. Wales is used as the study region due to its heavy reliance on surface water abstractions for public water supply (∼96%), and its importance as a water exporting region for other UK areas. We use 34 hydrological years (1982-2015) of daily river flow, air temperature, and precipitation data, and five hydrological years (2012-2016) of daily water abstraction data (provided by Welsh Water) at 15 locations across the five study catchments. The nonparametric Mann-Kendall test is used to analyse long-term trends in both seasonal & yearly averages of the hydroclimatic data, as well as in the number of 'extreme' events (events which are over or under the whole dataset 95th and 5th percentile values respectively per year). Pearson's correlation is also calculated between all datasets for daily data, as well as annual and seasonal averages. We further assess water availability at individual abstraction locations, and at a catchment scale, by comparing both maximum permitted water abstraction volumes, and average seasonal & annual water demand, to flow duration curves.

Results from the trend analysis show that, at seasonal and annual time scales, no significant trends exist in river flow, precipitation, or water abstraction. However, statistically significant increases in autumn (September-November) air temperatures across the 34-year dataset are observed in all catchments, 1.4°C on average. Trends observed in extreme events include a reduction in the number of cold summer days (days below dataset 5th percentile), across all catchments (from 7.28 to 1.94 days on average). Furthermore, the three southern-most catchments (Dyfi, Teifi and Tywi) show statistically significant decreases in the number of days annually that are warmer than the dataset 95th percentile (from 23.5 to 12.2 on average). Inter-dataset correlations show a significant positive relationship between air temperature and the volume of water abstracted in all catchments; the converse is true for precipitation and water abstraction. We envisage this work to better inform the projections of future water supply-demand dynamics in Wales, thereby allowing for more appropriate planning and adaption decisions.