National scale drought risk and adaptation modelling for Great Britain: Infrastructure strategies to 2050

The challenge

Protecting drinking water, farming, energy and industry systems from drought in the context of increasing demand and a changing climate will require sustained investment. Even within a national picture where overall supply exceeds demand, heterogeneity of water availability in space and time leads to expensive and damaging water shortage.

In order to cope with this pressure, the natural systems that provide water supplies can be augmented through engineered infrastructure. The challenge for drought management in the 21st Century lies in the implementation of appropriate solutions that can meet changing requirements without compromising the environment and other users of water, or placing excessive financial burden on citizens.

Traditional storage and transfer technologies are required in parallel with new ideas for water supply and efficiency of water use. Establishing the appropriate combination of these options is a complex engineering and economic systems problem. With growing pressure on water supplies and major investment decisions ahead, a more strategic national approach is required.

What was achieved

We found that investment in new technologies and system efficiencies were most likely to result in a secure, low-carbon water resource system. Strategies which follow conventional engineering approaches, including those with a long term perspective, were environmentally more consequential and led to lower supply/demand margins by 2050 due to their implicit inefficiencies.

However, strategies based entirely on efficiency or new technologies could not meet demand across the country and therefore mixed strategies were required. Climate change and demographic scenarios have complex interaction, with dry climate scenarios leading to localised problems in the south and east, and population growth scenarios causing impact more broadly across England and Wales. Generally, vulnerability to drought is prevalent across Southern England, with the North of England and Wales at risk in more extreme scenarios.

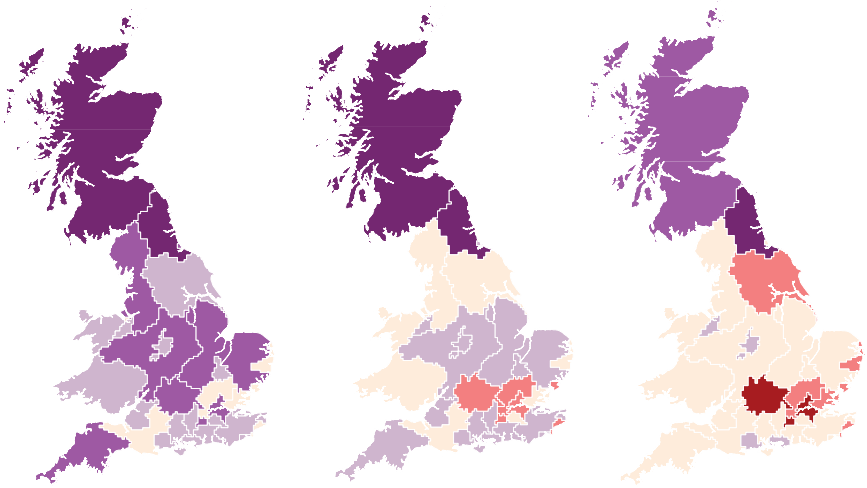
How we did it

Our drought model relies on a simplified reconstruction of the existing regional water resource management arrangements in Britain. Mainland Great Britain is divided in 130 Water Resource Zones (WRZ), or Megazones in Scotland. Models of water availability of each WRZ determine values for potential water supply (deployable output). This includes river intakes, reservoir intakes and groundwater. Flow values are taken from the National River Flow Archive, with recorded flow scaled to the representative river intake flow or reservoir watershed on the basis of sub-catchment area. Reservoirs are modelled as a single storage with maximum capacity set to the total capacity for reservoirs in the WRZ.

Water demand for each WRZ is the sum of domestic and non-domestic demand. Domestic demand for a WRZ is determined by multiplying the projected population by the average per capita water demand for the WRZ. Non-domestic demand is calculated as a percentage of domestic demand for a given WRZ based on current region figures.

Alternative water supply options include desalination, aquifer recharge, demand reduction, effluent re-use, leakage reduction, inter-company transfers, and new ground water supplies. Investment and operating costs for each of these options are based

2050 WATER SUPPLY-DEMAND BALANCE (ML/DAY) IN A "NO BUILD" STRATEGY



Low population growth
High flow climate scenario

Central population growth
Central flow climate scenario

High population growth
Low flow climate scenario

on a series of regression analyses of estimated costs against yields taken from 800 examples of water infrastructure projects. Climate change and population scenarios are used to modify supply and demand figures. Strategies are implemented using weighted preferences for water resource options.

References

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