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Using seasonal forecasts to inform the management of water resources during drought

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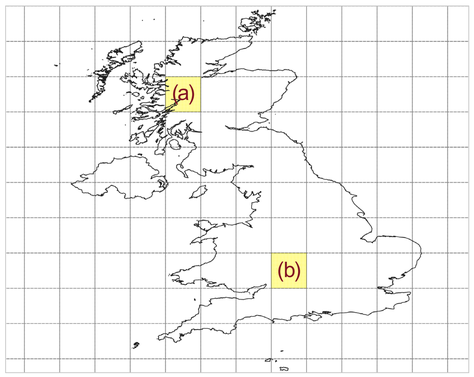


Location of presented data

1 Introduction

Water is considered to be one of the main mechanisms through which people will experience climate change, with the number of people estimated to become exposed to water scarcity projected to increase sharply in the future. UK water companies are required by regulation to publish Water Resource Management Plans every five years with a view to maintaining the security of water supplies to customers as sustainably as possible.

Details of what demand and supply measures a company can put in place as a drought develops are reported alongside how the company is planning for droughts worse than those experienced historically.

There is no water resources outlook that forecasts the potential impacts of drought on customers and the environment that are underpinned by seasonal forecasts.

Current drought forecasting mechanisms in the UK consist of meteorological or hydrological indicators of drought. Operationally, UK water companies typically consider two or three synthetic profiles of future precipitation (e.g. 80% of long-term average) or specific sequences within the historical record as a proxy for what could happen.

The Copernicus ECMWF Climate Change Service (C3S) provides freely available climatic datasets, including seasonal forecasts, through the Climatic Data Store. The objective of this work is explore how such seasonal forecasts may be used alongside the latest developments in water resources planning to evaluate, visualise and communicate the potential impact of emerging droughts to the water industry.

A prototype web application is being developed (see flow diagram) with the primary purpose of supporting water companies' drought resilience and management.

2 Data

Data verification

Using the latest generation of ECMWF's seasonal forecasting system, SEAS5, precipitation, temperature and mean sea level pressure variables for both hindcast (1993-2016, 25 ensemble members) and forecast (2017-2019, 51 ensemble members) daily products were downloaded and aggregated at monthly time steps (see figures below).

Every climate variable was verified using observation (GEAR precipitation) or reanalysis (ERA5) products. The verification analyses were undertaken using three different methods for every month and lead time available. The three methods used were:

- Continuous Ranked Probability Score (CRPS): a measure of the overall performance of the ensemble forecast, compared to observational data, using cumulative distribution functions of the two datasets.
- Relative Operative Characteristic (ROC): a measure of the ability of an ensemble forecast to discriminate a pre-defined event (i.e. an "event" was defined as a month where the precipitation is less than or equal to either 60% or 80% of the long-term average monthly precipitation).
- Reliability diagram: a measure of how well the predicted probabilities of an event correspond to their observed frequencies (and provide a visual representation of the associated reliability, sharpness and resolution).

The skill of the forecasts were further evaluated by comparing the CRPS against a climatological reference and the ROC against a random chance reference.

North Atlantic Oscillation

In the UK, changes in local weather patterns, including precipitation, are strongly influenced by changing local pressure patterns. The North Atlantic Oscillation (NAO) describes the relative changes in pressure between the Azores and Iceland that influence the intensity and location of the North Atlantic jet stream and therefore the movement of regions of low pressure, or depressions, and their associated precipitation. Conceptually, being able to accurately predict the phase of NAO should provide information on how wet or dry a winter may be. Positive NAO phase, where there is a stronger than usual difference in pressure are indicative of mild, stormy and wet winters. Conversely, negative NAO phase is associated with drier, more settled winter conditions.

The NAO index was calculated from the mean sea level pressure and used to verify the quality of the forecasted NAO index.

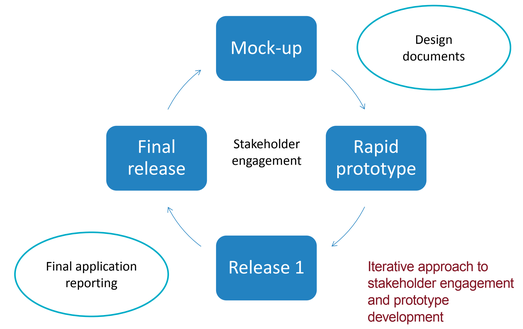
Simplified data flow diagram to create the web application

Example of forecasting data: Forecasted precipitation (a) and temperature (b) between 2017 and 2019. Each colour represents a forecast initialised on a certain month. Solid lines are individual ensemble members, dashed lines represent the 5% and 95% percentile.

3 Stakeholder engagement

Stakeholder engagement is critical to this work. Engagement activities are iterative and include:

- Engagement of users in the development of the tool through user support.
- Introducing water industry stakeholders to Copernicus Datastore.
- Engagement with water industry stakeholders through quarterly calls.
- Demonstration of the tool for the pilot studies.

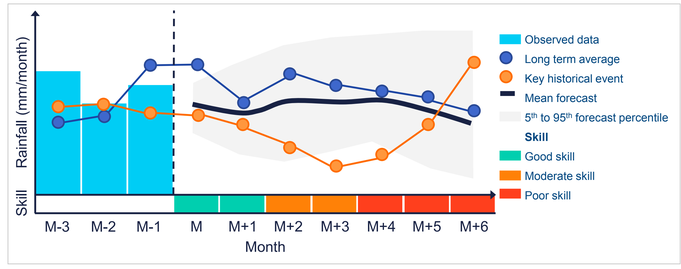


Results to date:

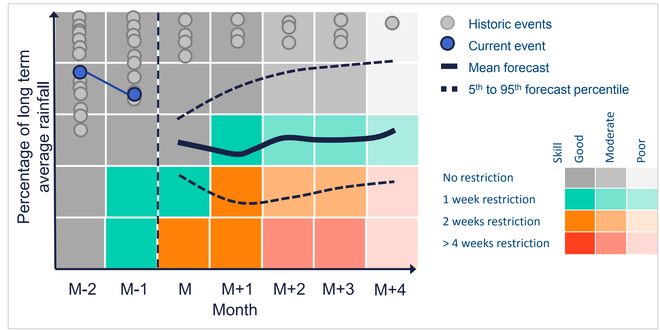
- Forecasts are currently used in a qualitative manner, though planners are keen to explore the potential to add seasonal forecasts to their toolset for planning and managing droughts.
- Planners in water companies would require seasonal forecasts to be presented in a visually concise manner, preferably in a format that management are already familiar with.
- Planners are interested in viewing seasonal forecasts alongside key historical information.

4 Next steps

The next stage of the work is to develop a prototype version of the web application and to finalise the visualisation of the forecasts and associated results in close consultation with water industry stakeholders.



Mockup of high level visualisation of seasonal forecasts alongside historical variables



Mockup of potential incorporation of seasonal forecasts with drought response surfaces used by several water companies for long term planning.

Scan for a PDF of the poster

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