CASE STUDY 9

WATER MANAGEMENT TO IDENTIFY PERIODS OF STRESS TO THE SUPPLY-DEMAND BALANCE

Focus: The use of seasonal forecasts for water management to identify periods of stress to the supply-demand balance

Industrial and research partners

The SECLI-FIRM project aims to demonstrate how improving and using long-term seasonal climate forecasts can add practical and economic value to decision-making processes and outcomes, in the energy and water sectors. To maximise success, each of the nine SECLI-FIRM case studies is co-designed by industrial and research partners. For this case study, the industrial partner is Thames Water and the research partner is the UK Met Office.

Boosting decision making

- The water industry case studies will explore the application of seasonal forecasting to identify periods of stress to the UK supply-demand balance. These seasonal signatures may highlight chronic or acute periods of stress many weeks out, which will affect the operational management of the water system and the experience of the consumer through supply restrictions.

The seasonal forecasting context

- This case study will explore the ability to identify periods of chronic stress (prolonged excessively high demand driven by either leakage or consumption). Climatologically, these will include conditions indicative of dry and hot summers, or drought conditions, or peaks in demand due to long periods of below average winter temperatures. If such conditions were predictable at seasonal timescale, it would help to flag high demand and support preparedness in terms of capacity and demand management.
- This case study will also explore the ability to identify acute stress (highly variable demand) including heat waves or extremely cold and/or freeze-thaw conditions. If such conditions were predictable at medium/seasonal timescale, it would help flag high variability in demand and support preparedness in terms of resilience.

Sectoral challenges and opportunities

- The United Kingdom (UK) water supply market operates within the private sector comprising of a number of autonomous water companies. The sector is overseen by the Office of Water Regulation (OFWAT), which focuses on consumer regulation. The Environment Agency focuses on environmental regulation. The water businesses constantly balance supply of raw water with demand. Both supply and demand have a significant dependency on the weather.
- By timely identification of potential risks, we will explore whether it is possible to secure customer supply and optimise operational costs.

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Water management

Climate change, along with population growth and environmental concerns, could present a real challenge to the water industry in the future by reducing the amount of water available for abstraction from the environment. Improved seasonal weather forecasting may allow us to mitigate the impact of extreme weather events that climate change could bring, on both our customers and the environment.

Business process

The Met Office working in partnership with Thames Water have developed a model that accurately predicts peaks in demand dependent on the weather. The model has been paired with short range weather forecasts in order to produce weather dependent demand forecasts out to 12 days ahead. The demand forecasts have been successfully integrated into the production planning process of a number of water companies demonstrating considerable cost – saving benefits. As such this case study explores the benefits of extending the demand forecast to sub-seasonal and seasonal time frames.

The following case studies have been identified in order to examine the benefits of integrating seasonal forecast data into the decision process during periods of stress to the supply-demand balance covering the winter and summer months.

Summer
During July 2017 extreme heat was followed rapidly by wet weather which meant demand moved from abnormally high to abnormally low in the space of a few weeks. When events driving this kind of volatility last for more than a few days, increases in demand cannot be absorbed by judicious use of reservoir storage. At best, this leads to increased operational expenditure, and stress on the biological production processes. At worst, the increased customer demand may lead to low pressures or even supply interruptions.

Winter
During the winter of 2017/18, significant increases in water demand were experienced because of unusual, prolonged freezing and rapid thawing weather conditions. This resulted in widespread pipe bursts above and below ground on both the customer and the utility pipework. Consequentially there was a significant rise in demand, which placed great stress on water production and distribution assets, and reservoirs. Extreme actions were taken to rapidly increase water production capacity (e.g. the cancellation and postponement of maintenance activities) to meet the increased demand.

All case studies have considered the alternative decisions that could be made if the seasonal forecast information was available and evaluated in respect of the outcomes.

Industry context

Management of supply and demand to optimise operational efficiency

Business process

Using existing industry demand models to assess the value of seasonal forecasts for several high impact events

Climate events

Summer 2012 and 2017

Winter 2010/2011 and 2017/2018

Case Study Highlights
Tailoring of the forecast:

Research[1] suggests that at longer lead-times broad-scale circulation types are more predictable than the actual weather itself. The water demand forecast was extended from 14+ days ahead to sub-/seasonal lead times (1 month +) over the winter and summer using weather patterns which are representative of the variability in large-scale atmospheric circulation over the UK and surrounding area (Figure 1). The probability of exceeding critical operational water demand thresholds is estimated from the weather patterns and compared to the climatology (Figure 2).

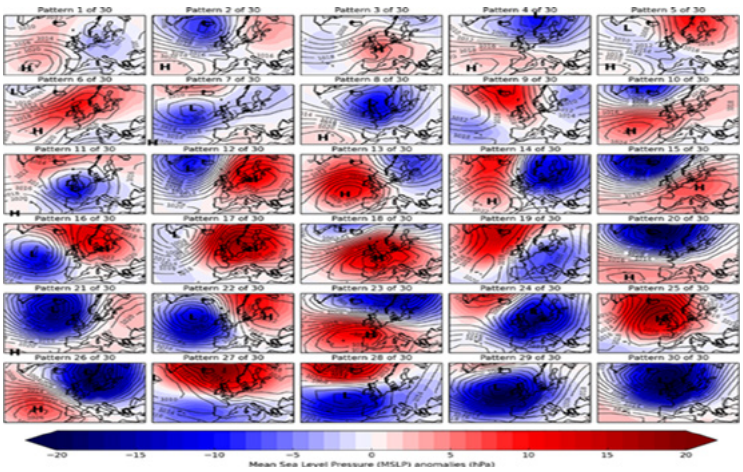

Figure 1: Set of 30 weather patterns. Mean sea level pressure (MSLP) anomalies plotted as filled contours (hPa) and MSLP mean values plotted in foreground (2 hPa intervals).

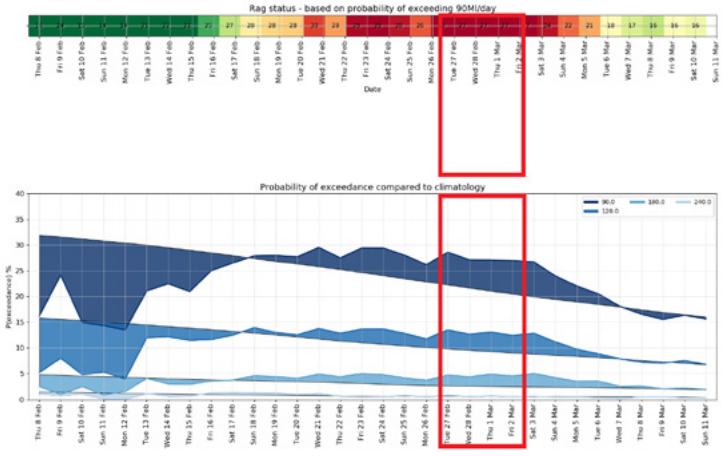

Figure 2: The new seasonal water demand forecast tool. This example shows what would have been issued on 8th February 2018. Top panel: probability of demand exceeding the 90Ml/day threshold. Bottom panel: risk of exceedance of multiple demand thresholds including 90Ml/day. Red box: increased risk of the spike in demand at the start of March 2018.

Tailoring seasonal forecasts

At longer lead-times broadscale circulation types are more predictable than the actual weather itself. Skill in the forecasts of pressure patterns has been exploited in order to forecast water demand at longer lead times.

Forecast skill:

The forecast was verified to assess the quality of the forecast at lead times between 14 days and three months ahead:

- Performance is dependent upon season.
- Skill verification statistics indicated higher skill is associated with higher demand thresholds in winter. In summer there is less skill as the meteorology (rather than the conversion to demand) is poorly predicted. The forecast can also discriminate between high impact demand events better than climatology in winter. The opposite is true for summer and autumn.

Value add:

Forecast skill is not equivalent to forecast value. Despite skill verification statistics finding little skill beyond ~15 days, an assessment of the potential value of the forecast shows there is value to the user out to the full 30 days for water demand forecasts exceeding 90 Ml/day.

The 2018, 'Beast from the East', case study (Figure 2) indicates the forecast service would have provided advanced warning of a high demand event which cost the water industry £7 million in compensation.

Plus, a real time trial service in January/February 2021 demonstrated how Thames Water were able to build resilience in their network. Despite experiencing similar weather to the 'Beast from the East', the impact of the event was much less severe.

> The forecast provided us with increased confidence to start earlier preparation for a peak demand event. This included setting up a 'silver command team' to manage and monitor the situation.
>
> *Thames Water*

Forecast skill

Skill is dependent upon season. There is higher skill in winter, especially at higher demand thresholds. Forecasts can discriminate between high impact demand events better than climatology in winter.

Value add

Using case studies and real-time analysis, clear cost saving benefit to the water sector could be achieved through the earlier identification of severe demand events in the winter.

Decision tree

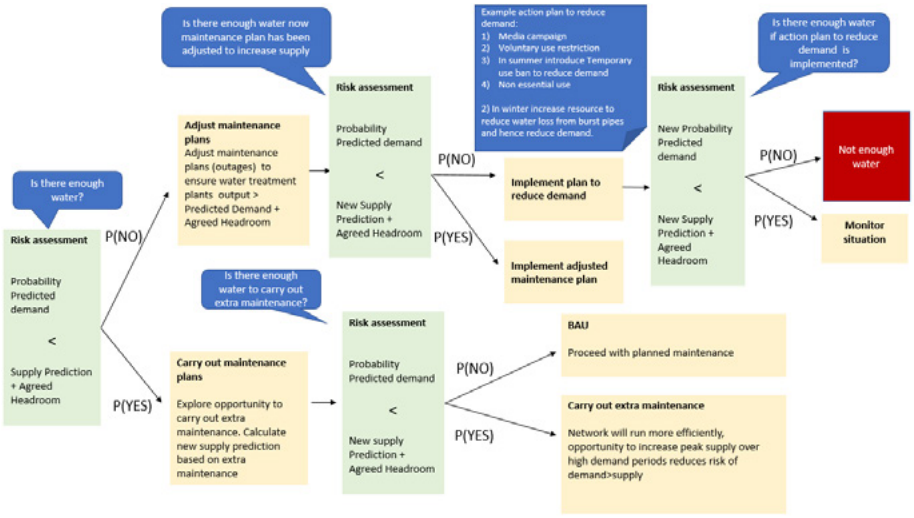

Figure 3: 'Operational supply demand balance' decision tree.

The future

A trial forecast service was set up at the start of November 2020. The forecast has been updated twice a week with the latest ECMWF forecast and disseminated to Thames Water. The Met Office is running user groups with the wider water sector about how the seasonal water demand forecast could be rolled out across the industry and applied to other impacts such as burst pipes and flood events.

Reference:
1. Neal, Robert & Fereday, David & Crocker, Ric & Comer, Ruth. (2016). A flexible approach to defining weather patterns and their application in weather forecasting over Europe: Weather patterns and their forecasting application. Meteorological Applications. 23. 10.1002/met.1563.

The future

User groups with the water sector will inform how the seasonal water demand forecast could be rolled out across the sector and applied to other impacts.

For more about this and the eight other case studies, visit www.secli-firm.eu

The Added Value of Seasonal Climate Forecasting for Integrated Risk Management (SECLI-FIRM)

For more information visit:

www.secli-firm.eu or contact us at: **info@secli-firm.eu**

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