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.

SECLI FIRM

Grant Agreement n. 776868

www.secli-firm.eu

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 project will use existing models that incorporate the dependency of demand on weather out to 12 days ahead. Several water companies in the UK use these models and the case studies will evaluate the use of seasonal forecast information for catchments with distinct climatology. The water demand models developed using observed weather data may not require additional calibration to utilise seasonal forecast data.

The water industry case studies will explore the application of seasonal forecasting to identify periods of stress to the supply-demand balance covering the winter and summer months. All case studies will consider the alternative decisions that could be made if the seasonal forecast information was available and will be evaluated in respect of the outcomes.

Chronic loading case studies

One case study will explore the value of seasonal forecasts leading up to a period of water use restrictions. For example, the UK experienced a run of dry months and then a very wet April in 2012. Water restrictions were imposed in early spring, prior to the arrival of wet conditions. This case study will explore the current skill of seasonal forecasts to predict rainfall and temperature over the UK and determine the benefits of such information for Thames Water in supporting go/no-go decisions on demand restrictions.

Acute loading case studies

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.

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.

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

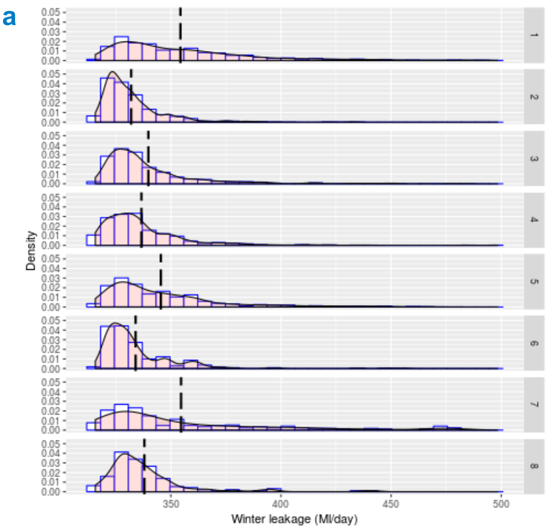
Summer 2012 and 2017

Winter 2010/2011 and 2017/2018

Progress update – Extending current demand forecasts using Weather patterns

Research[1] suggests at longer lead-times broad-scale circulation types are more predictable than the actual weather itself. In recent years, the Met Office has established a set of 8 and 30 predefined weather pattern (WP) definitions, which are representative of the variability in large scale atmospheric circulation over the UK and surrounding area (Neal et al.'s methodology[1]). As such case study 9 has been exploring the relationship between water demand and these weather patterns.

Figure 1 shows the relationship between water demand in the winter and the 8 weather patterns. The graph shows that the risk of peak demand is much higher in certain weather patterns, with the greatest risk occurring on days in the winter experiencing WP 1 and 7. WP1 represents a negative North Atlantic Oscillation (NAO), in which colder weather conditions are expected to occur across the UK. This is consistent with the type of weather that causes increased leakage and burst pipes, resulting in higher water demand.



By combining the probability of water demand remaining below critical thresholds when the UK is experiencing a certain WP and the forecasted probability of being in that WP it is possible to generate a forecast of the probability of not exceeding critical demand thresholds at sub-/seasonal lead times. It is thought that this methodology may offer more reliable sub-/seasonal signals than that of attempting to directly forecast the weather drivers of the current water demand model.

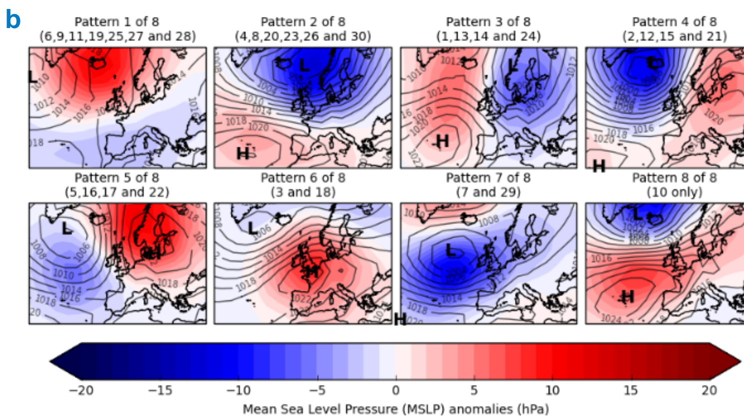


Figure 1 – (a) Distribution of demand in the winter dependent on (b) weather pattern.

Tailoring seasonal forecasts

Research suggests at longer lead-times broad-scale circulation types are more predictable than the actual weather itself. Therefore Case study 9 has been exploiting the skill in the forecasts of pressure patterns in order to forecast water demand at longer lead times.

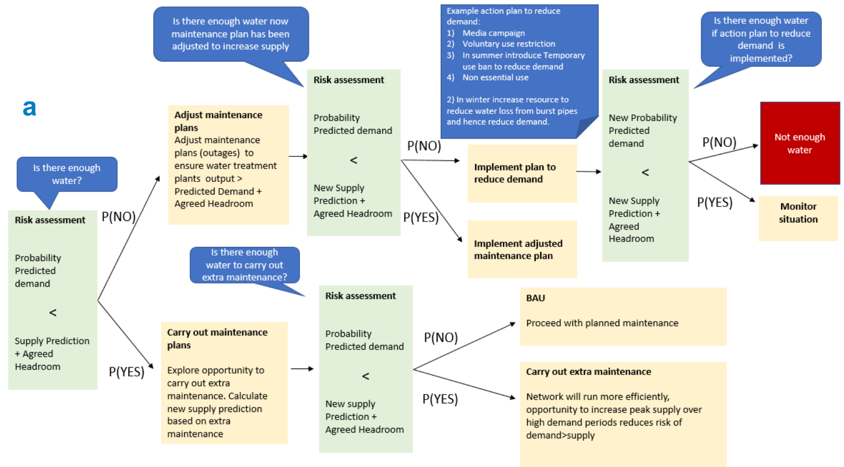
1. Neal, Robert & Fereday, David & Crocker, Ric & Comer, Ruth. (2016). A flexible approach to defining weather patterns and their application in weather forecasting over Europe: Weather patterns and their forecasting application. Meteorological Applications. 23. 10.1002/met.1563.

Value assessment

Industry workshops have enabled two important operational supply – demand balance decisions that can be improved on a seasonal time frame to be identified:

1. Asset maintenance (Managing water treatment maintenance plans to ensure water treatment plants are able to operate at full capacity when required and to minimise expenses from last minute cancellations)
2. Asset management e.g. resource management and optimisation of water treatment works

These decision processes have been captured in decision trees (Figure 2) in order to provide a baseline from which objective improvement in the management of the supply demand balance can be drawn. This case study has established that the current industry standard for risk management decisions taken on longer lead times, i.e. 2 weeks + ahead, are currently based on climatology therefore this will be the baseline from which verification in the skill and quantification of the benefits of seasonal forecast information will be based.



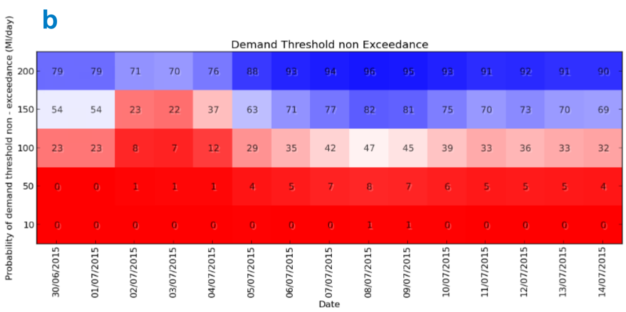


Figure 2 – (a) 'Operational supply demand balance' decision tree. (b) Example forecast displaying the non-exceedance probability for critical demand thresholds.

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**

Value assessment

The current industry standard for risk management decisions at longer lead times (2 weeks + ahead) are based on climatology information therefore this will be the baseline from which verification in the skill and quantification of the benefits of seasonal forecast information will be based.

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

SFCS9: 03.2020

Grant Agreement n. 776868