

OPTIMISING UNDER UNCERTAINTY

WATER RESOURCES PLANNING AND DROUGHT MANAGEMENT



Planning for water resources is an uncertain business. The impacts of changing climates are being felt and population and demographic pressures are evident.

The need to identify robust and credible long term plans for the management of water resources, and communicate these effectively to stakeholders, has never been greater in the water industry.

Robust planning requires explicit and clear recognition of the many uncertainties around available supplies and customer demands, now and in the future, and potential options available to meet any shortfalls.

Credible planning requires effective communication with stakeholders within and outside water companies.

ICS has developed a risk based approach that can help water companies meet these needs. Working with partners we have developed new methods and approaches that place tools such as stochastic optimisation, customer valuation, and visualisation at the heart of an enhanced approach to water resource planning.

Integrating risk and value with uncertainty

Central to our new approach is the ability to identify a single optimised plan across multiple scenarios (futures) and water resource zones simultaneously, whilst integrating customer views and other drivers such as drought management plans.

Handles uncertainty in a formal stochastic optimisation framework

Libraries of scenarios for supply and demand can be created to generate a range of probabilistic futures. A single plan is optimised to satisfy these futures against your company's planning objectives.

Determines the level of service

The relationship between the level of service delivered to customers and the level of confidence in the plan can be understood. Pre and post investment positions can be explored and the robustness of plans tested, including the economic level of service at a defined level of confidence.

Integrates drought management plans

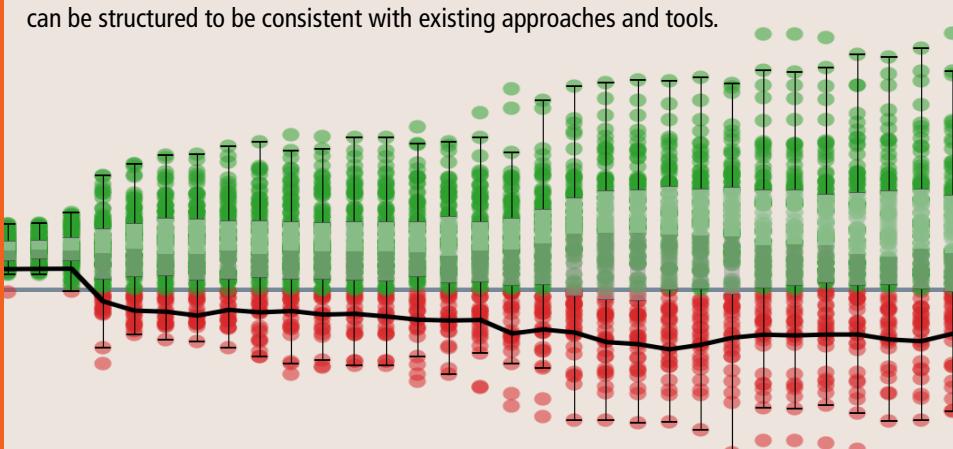
Drought management interventions and their costs can be considered.

Integrates customers preferences and values

Restrictions and drought management measures cause inconvenience to customers. Customer preferences and values for different levels and severity of water restrictions can be explicitly recognised within this optimisation framework.

Builds on existing methods for optimised plan balancing

Inputs such as cost data, solution interdependencies, must do interventions, and lead times can be structured to be consistent with existing approaches and tools.



An example of uncertainty (100 future scenarios) in the Supply Demand Balance for a water resources zone before planned investments. Deficits are shown in red. The black line is the 10% extreme quantile, so an optimised plan with a 90% level of confidence will address all scenarios above the black line.

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Delivers best practice approach

The industry, Ofwat, and the EA, all recognise the limitations of existing planning approaches and the need to develop more advanced decision making frameworks that include uncertainty whilst integrating customer's views.

The **ICS** approach delivers best practice by:

- Integrating uncertainty in planning. Multiple uncertainties and objectives are translated into a single optimal plan.
- Recognised UKWIR methodologies for supply / demand balance planning are embraced and enhanced.
- Outputs from customer research can be explicitly incorporated.

Practical solution methods

Incorporating uncertainty into optimisation generates many more possibilities to be appraised. Our new approach delivers computational efficiencies to allow focus on understanding and interpretation.

- Solution times for complex problems in minutes or hours not days or weeks.
- Rigorous solution methods backed by leading edge academic expertise.

Scenario planning

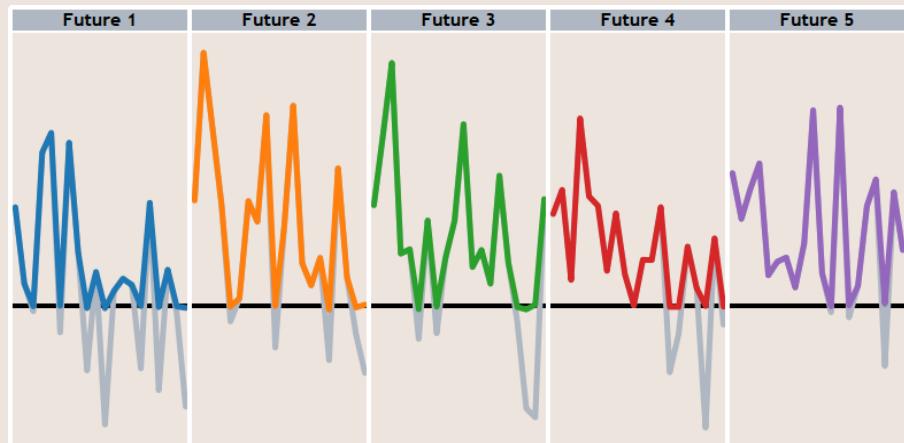
The approach provides considerable flexibility around planning objectives and horizons. Questions that can be answered include:

- What is my least cost plan across all futures for my chosen level of service and / or level of confidence?
- What is the economic level of service?
- What level of service can be achieved for given cost?
- How do current planning approaches compare with a fully stochastic approach?

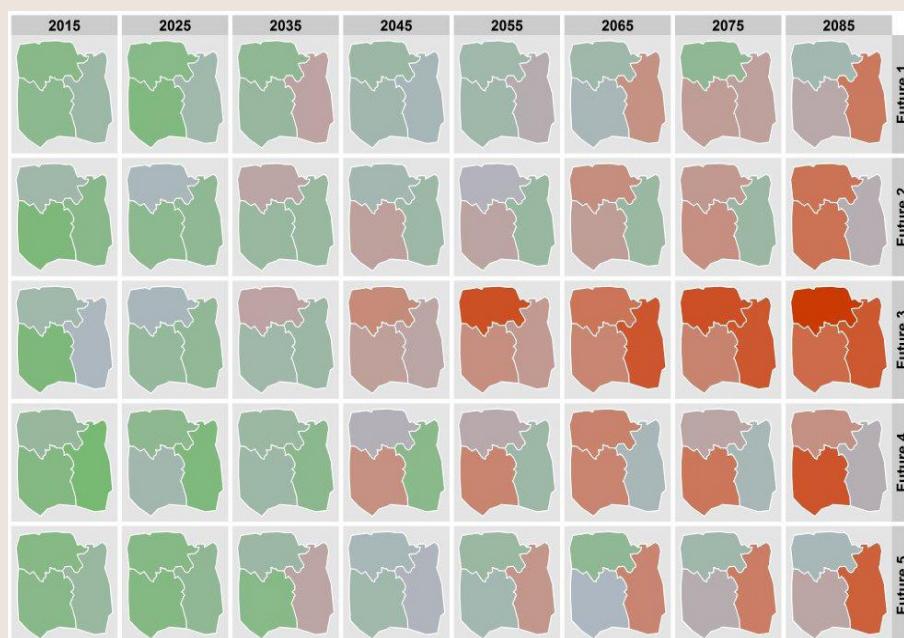
Visualisation of outputs

Making decisions about water resource plans is complex and this makes communication a challenge. We use a highly visual presentation of outputs to engage different stakeholders in evaluating plans, including:

- Trade offs between risk, cost, level of service and level of confidence can be explored interactively.
- Multiple dimensions can be illustrated quickly and succinctly. Let the picture tell the story.
- Informed discussions aided by shared understanding with regulators, customers and internal stakeholders.



The pre (grey) and post (colour) investment Supply Demand can be viewed across the different futures / scenarios over the specified time horizon.



The Supply Demand Balance position (colour) can be viewed visually across zones (shape), years (columns) and future scenarios (rows).