GUROBI OPTIMIZATION

Allocating Water Resource Management Investments

Gurobi partner Decision Lab helped WRSE create long-term water management plans in the face of uncertainty.

WRSE is an alliance of the six water companies that cover the South East region of England. Their aim is to secure the water supply for future generations through a collaborative, regional approach to managing water resources. WRSE aims to provide an affordable, resilient and sustainable water supply that delivers for the public, industry, and the natural environment for years to come.

Industry: Consulting
Location: Europe
Use Cases: Operations, Resource Planning
Website: wrse.org.uk

Results

- Used the Gurobi Optimizer to identify the optimal path forward
- Helped water companies build regional resilience and plan for the unexpected

Partner Spotlight

Decision Lab is an award-winning UK technology company that combines Mathematical Modelling, Optimisation, Simulation, Data Science and Artificial Intelligence to build the tools and models that turn the impossible, toughest problems into bold and clear paths for enabling decision-making.

Learn more at decisionlab.co.uk

Water Resources South East (WRSE) is an alliance of the six water companies that cover the South East region of England, which aims to secure the water supply for future generations through a collaborative, regional approach to managing water resources.

As a regulatory requirement, English and Welsh water companies must produce Water Resources Management Plans every five years, demonstrating how they will meet their future demand. The plans must follow the Economics of Balancing Supply and Demand framework, and models are used to optimize potential investments to achieve the needed increase in water supply capacity. They must, however, consider factors such as water quality, water lost through leakage, carbon footprint reduction, customer service, and more. WRSE had a wide range of considerations, and some are hard to quantify. Their aim was "to develop an affordable, sustainable, and resilient regional approach to water resource management," which would support the water companies in their planning.

This is a complex problem with potentially very large supply-demand deficits. Because of the long planning horizon, the uncertainties of climate

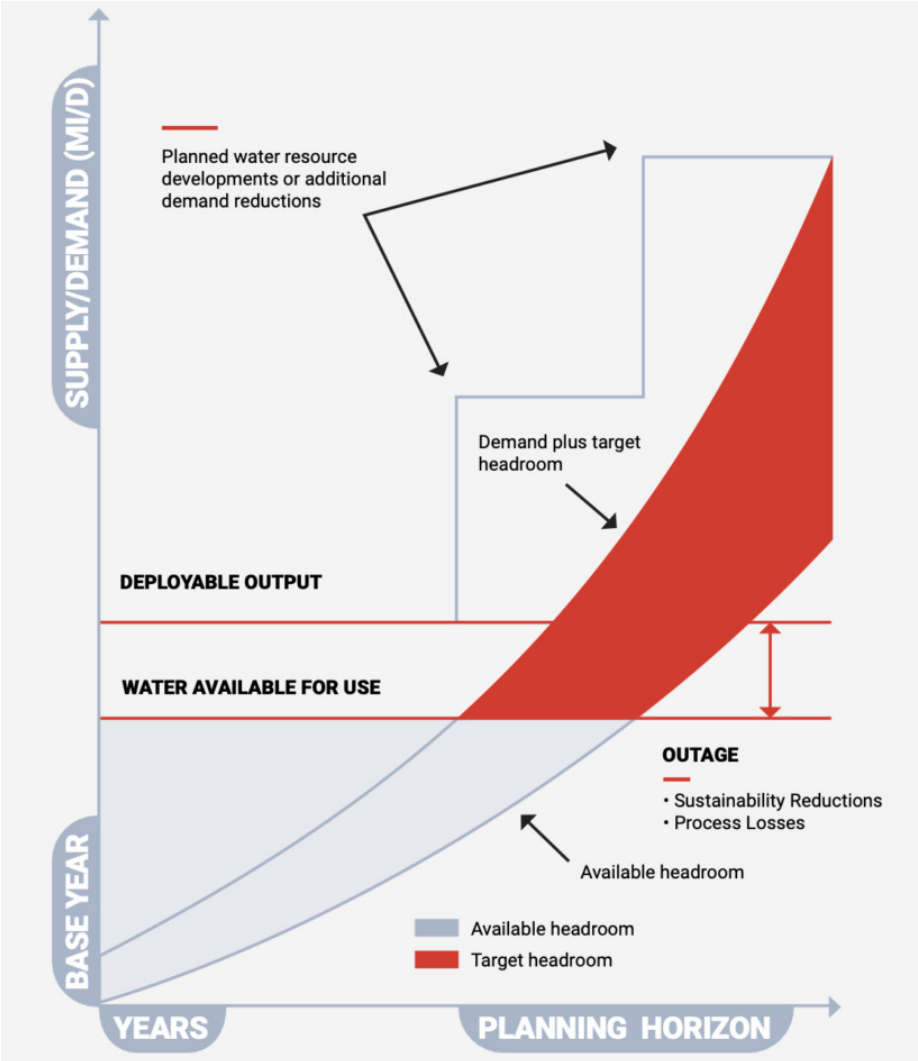

Figure 1. Padula, Silvia, et al. "Least economic cost regional water supply planning – optimising infrastructure investments and demand management for South East England's 17.6 million people." Water resources management 27.15 (2013): 5017-5044

change, population growth, and legislative drivers are significant. WRSE needed to optimize against this uncertain future to produce resilient plans. Previously, they focused on identifying the least-cost plan that met demand—a relatively straightforward optimization problem. But producing plans that are resilient and adaptable to uncertain events decades in the future and that incorporate other performance metrics (environmental benefit, customer preference, etc.) is a major technical challenge.

How could WRSE plan 75 years ahead for such a complex problem with so many uncertainties?

Optimizing for the Unexpected

Without the benefit of hindsight, it is unrealistic to predict the optimal path. So WRSE reached out to UK-based consultant Decision Lab—which helps companies solve complex business challenges like these. Decision Lab advised WRSE that mathematical methods would be key to getting WRSE as close as possible to the optimum plan, whatever the future may hold.

To do this, Decision Lab developed a completely new water investment model. It uses cutting-edge optimization techniques—including stochastic

programming, real-option analysis, adaptive pathways, and multi-criteria optimization—overlaid on the least-cost optimal solution. They formulated it as a mixed-integer linear programming problem. This is a large, complex optimization model due to the number of parameters and constraints involved; the multiple options to be modeled; the lengthy planning horizon; multiple objectives; and the need to produce solutions that deal with an uncertain future.

Choosing Gurobi

Decision Lab considered different optimization solvers, but it was clear early on that an open-source solver would not be up to the task. The team identified the Gurobi solver as the best product available to meet their needs. The Gurobi team was also able to help Decision Lab tune their model and the solver settings to get better performance and faster run times.

Securing Water for South East UK and Beyond

The project benefited from a close technical relationship between the model developers and WRSE, and investment from Decision Lab itself. The model will support the water companies in South East England in developing their water resource management plans and WRSE's South East England regional plan. The water companies will go through the regulatory submissions process over the next two years, and this model will support billions of pounds of water company investment between 2024 and 2029. The hope is that the model will help with planning for other parts of the country and even outside the UK, as many countries face significant challenges of future water deficits.

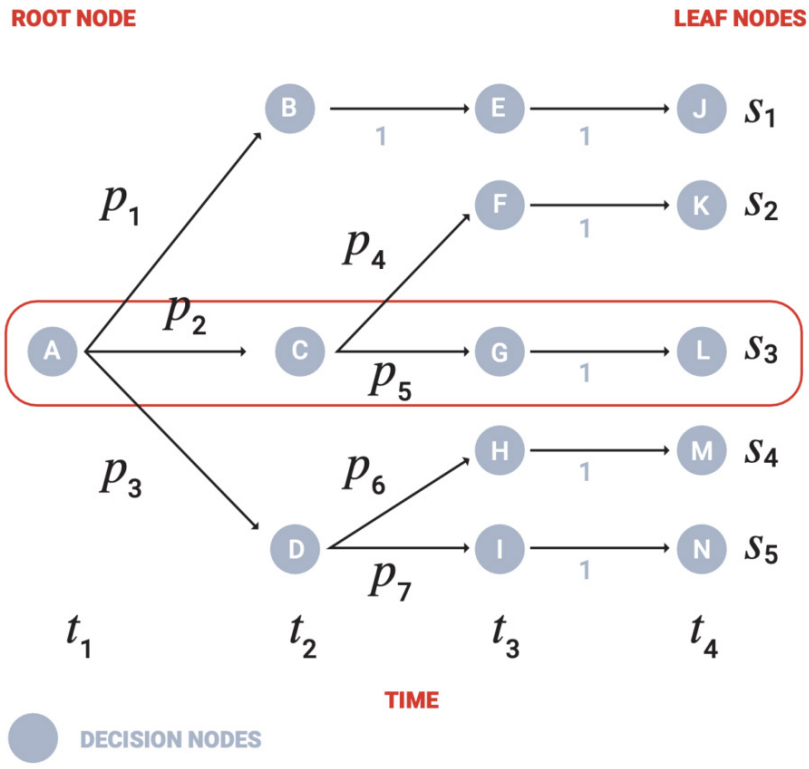

Figure 2. Erfani, T., Pachos, K. and Harou, J.J., 2018. Real-options water supply planning: Multistage scenario trees for adaptive and flexible capacity expansion under probabilistic climate change uncertainty. Water Resources Research, 54(7), pp.5069-5087.