Research Proposal: Adaptive water resources planning to manage future risks to London’s water supply

DPhil Studentship Opportunity for October 2016 enrolment

Proposal

Managing water supplies in a changing climate is a growing challenge. The uncertainty associated with future rainfall, river flows, water quality and groundwater makes it difficult to plan for the future with any degree of certainty. Under the circumstances, it may be desirable to adopt flexible strategies that keep options open for the future. There is a desire to develop ‘adaptation pathways’ for water resources management systems. Adaptation pathways demonstrate the possible sequences of options that might be adopted to cope with a wide range of future conditions.

The Environmental Change Institute in the University of Oxford has developed advanced methodologies for risk assessment of water resource systems and for decision making under uncertainty. This work will combine these methodologies in order to develop and demonstrate new approaches for water resources planning. The research will focus on the Thames river basin, where climate change and increasing water demand are challenging water supplies.

The research will combine several cutting-edge research areas in order to develop and integrated approach to decision making for the Thames:

1. Statistical analysis of hydrological variability (in surface and groundwater) in order to estimate the probabilities of droughts on a range of scales.
2. Analysis of the risks of harmful water quality, which may jeopardise water supplies.
3. Simulation modelling of the water supply infrastructure in order to estimate the probabilities of water shortage.
4. Development of decision strategies and pathways that ensure that risks to the water supply system are always within the bounds of tolerability.

The project will be supervised by Prof Jim Hall, Director of the Environmental Change Institute, University of Oxford.

The project will suit students from any quantified background, including engineering, physical or environmental sciences. Students with a background in hydrology and water resources would be particularly suitable. Applicants should have a first class undergraduate degree in any of the above subjects or have (or be projected to achieve) a distinction in a Master's degree in a relevant subject.

UK and EU applicants will be eligible for funding from the Engineering and Physical Sciences Research Council (subject to confirmation), with additional financial support from Thames Water through a CASE award.

In the first instance applicants should send a CV and covering letter to Professor Jim Hall. The closing date for applications is 25 January 2016. A selection interview will be held in Oxford in mid-February 2016. Informal enquiries can be directed to jim.hall@eci.ox.ac.uk.

Please note that the successful candidate will then need to submit an application to the University of Oxford before 10th March. This application is made through the School of Geography and the Environment.

Background

Thames Water faces strategic challenges with water resources, due to increasing population, changes to abstraction licensing and the uncertain impacts of climate change. A number of new methodologies have been under development in the UK and internationally to analyse climate risks to water resources systems and appraise planning options under uncertainty. Thames Water has supported studies to explore the potentially applicability of these methodologies for water resources management planning.

For the last four years Thames Water, in partnership with the Environment Agency and with co-funding from EPSRC, has supported a DPhil studentship at the University of Oxford on “Climate change and water resources: risk-based approaches for decision-making”. The doctoral student, Edoardo Borgomeo, passed his DPhil examination in August 2015. The research:

- Established principles and demonstrated practical methodology for risk-based water resources assessment, incorporating probabilistic climate projections from UKCP09
- Developed and demonstrated a methodology for testing the robustness of the water supply system to prolonged droughts
• Used multi-objective optimisation to test a large number of sequences and combinations of supply options, exploring the trade-offs between risk (of not meeting Levels of Service) and cost

The research resulted in four significant papers on water resources planning and analysis of the vulnerability of water resources to extreme droughts:


Meanwhile, the MaRIUS (Managing the Risks, Impacts and Uncertainties of droughts and water Scarcity) project, which is led from the University of Oxford and also involves Thames Water on the stakeholder advisory group, is:

• Developing a more detailed and accurate model of the Thames Water supply system, using the WATNET simulation tool

• Developing new climate model outputs to supersede UKCP09 which will contain a larger number of synthetic drought events, and a large ensemble of ‘fully transient’ simulations of synthetic climate sequences from 1900 to 2100 which can be used for water resources planning

• Exploring water quality/quantity/temperature interactions and the ways in which they influence drought planning.

Thus the University of Oxford, in partnership with Thames Water, has developed sophisticated capability to analyse risks to water supply and appraise alternatives for water resources management. However, significant research challenges remain for Thames Water, in particular relating to:

• Stochastic uncertainties on a broad scale (including the Severn as well as the Thames basins)

• Potential impacts of water quality on the reliability of water supplies

• Analysis of water resources strategies designed to adapt to future uncertainties.

There is considerable potential to combine the more sophisticated process understanding being developed in the MaRIUS project with the risk and decision analysis methodologies that the Oxford team are developing, building on the previous work by Edoardo Borgomeo. We therefore propose a new phase of research that will explore the challenges outlined above, via a doctoral studentship.

Proposed scope

The proposed research will bring together three methodological strands:

1. We propose to statistically analyse and simulate hydrological variability (in surface and groundwater) on a range of spatial scales, up to coupled analysis of the Thames and Severn basins. This will be combined with an extended version of the MaRIUS water resources system model to simulate the availability of water for present and future configurations of supply infrastructure

2. We will make use of new scientific understanding of water quality from the MaRIUS project. That will help us to identify critical thresholds for water quality in terms of a small number of indicators (biochemical, temperature, flow). The analysis of risk of shortage will thereby be supplemented with analysis of risk of water quality conditions that might lead to outages of supply infrastructure

3. We will combine extensive stochastic simulation of risks of water shortage and outage with analysis of adaptive decision pathways. Our previous research has used multi-objective optimisation to identify optimal investment pathways. We will replace that with appraisal of adaptive strategies that might keep options open in order to cope with future uncertainties.

As with the previous studentship, the scope and direction of the doctoral studies can be adapted in the light of emerging research challenges and new opportunities for innovation that might arise.