PROJECT TITLE: Modelling coupled human-water systems: Characterising human-water interactions and their impacts on future water scarcity
DTP Research Theme(s): Changing Planet
Lead Institution: University of Bristol
Lead Supervisor: Dr Gemma Coxon, University of Bristol, School of Geographical Sciences
Co-Supervisor: Dr Michael Singer, Cardiff University, School of Earth and Ocean Sciences
Co-Supervisor: Dr Francesca Pianosi, University of Bristol, Department of Civil Engineering
Co-Supervisor: Dr Chris Hutton, Wessex Water
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Project keywords: (hydrology, environmental modelling, human-water systems, water scarcity)

No flow on the River Derwent in 2011 when England had its driest May in over a century

Conceptual diagram of human-water interactions

Project Background
By 2050, it is projected that England will be facing severe water supply shortages due to climate change and increasing demand from growing populations and societal development. Consequently, it is vital that we predict how water resources may change in the future to ensure adequate water supplies for drinking, food, energy production and societal development. Despite the impact of human-water interactions (such as reservoir storage and irrigation) on freshwater resources, only sparse data have previously been available to characterise human-water use and these interactions are often neglected in hydrological models or represented at coarse spatial resolution. This PhD will deliver new understanding of human-water interactions and their impacts on river flows to provide robust assessments of (future) water scarcity that are essential for policy and decision makers.

Project Aims and Methods
The overall aim of this project is to quantify the impacts of human water use and climate change on future water scarcity across the UK by developing novel tools for the simulation of coupled human-water systems at both local and national scales. This will encompass the following objectives:

Build an integrated modelling framework that couples hydro-climatic processes with human-water systems across multiple scales. This will be achieved by incorporating (1) groundwater and surface-water abstractions, (2) reservoirs and (3) return flows into DECIHeR (Coxon et al, 2019).

Characterise behavioural patterns of human-water use from historical hydro-climatic and human-water use data to examine the interactions and feedbacks between natural-human water fluxes over time.

Project human-water use and climatic impacts on future water scarcity using high-resolution, regional climate simulation ensembles (i.e. UKCP18, MaRIUS Drought Event Sets), stochastic rainfall generators capable of simulating potential climate change scenarios (i.e. STORM) and future water demand scenarios from socio-economic datasets. Trade-offs, interactions and the importance of human-water use and climate variability on future water scarcity will be determined using sensitivity analysis techniques.

We expect these objectives to evolve in line with the student’s interests and for the student to refine the research objectives as their ownership of the research develops. The student will have the opportunity to do a three month placement at Wessex Water to determine how the tools and water scarcity projections developed during the student’s PhD can be used for decision making on future water resource planning.
Candidate Requirements
This project will suit a candidate with excellent quantitative skills and communication skills, with the ability to collaborate in a multi-disciplinary team. The candidate will have a skillset acquired through the study of Physical Geography, Civil Engineering, Earth Sciences or similar disciplines that has involved the use of data analysis and numerical modelling at BSc and ideally MSc level. Experience in numerical modelling (e.g. hydrological or earth system modelling) and coding/scripting (e.g. R, Python or Matlab) is highly desirable.

CASE Partner
Wessex Water will bring additional expertise in water resources systems modelling, access to high-resolution abstraction data and insight into how future water scarcity projections are used in decision making. The student will gain understanding of the complexities of undertaking hydrological modelling in catchments with multiple stakeholders and human influences cross-sector and provides the student with the opportunity to deliver real impact with their research to a leading UK water company.

Training
Training will be a core component of this PhD. The student will benefit from working in an experienced multi-disciplinary team that will provide world-leading training in the impacts of humans and climate on water resources (Drs Coxon and Singer), climate projections within the water cycle (Dr Singer), water resource management (Dr Pianosi) and uncertainty and sensitivity analysis (Drs Coxon and Pianosi).

The student will have the opportunity to interact with existing scientific networks nationally through the UK Droughts and Water Scarcity Programme, the GW4’s Water Security Alliance and internationally through the IAHS Panta Rhei ‘Droughts in the Anthropocene’ Working Group. Opportunities will also be provided to attend training courses and international conferences.

References / Background reading list
Best, Anthropogenic stresses on the world’s big rivers, Nature Geosciences, https://doi.org/10.1038/s41561-018-0262-x, 2019

School URL:
https://www.bristol.ac.uk/geography/courses/postgraduate/

NERC GW4+ DTP Website:
For more information about the NERC GW4+ DTP, please visit http://nercgw4plus.ac.uk/
Info on GW4’s Water Security Alliance can be found here: https://www.gw4water.com/

Bristol NERC GW4+ DTP Prospectus:
http://www.bristol.ac.uk/study/postgraduate/2020/doctoral/phd-great-western-four-dtp/

How to apply to the University of Bristol:
http://www.bristol.ac.uk/study/postgraduate/apply/

The application deadline is 1600 hours GMT Monday 6 January 2020 and interviews will take place between 10 and 21 February 2020

General Enquiries:
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