Title: Nature-based solutions for improved water quality in the UK: suitability and scalability

Lead Supervisor: **Kathy Pond,** School of Sustainability, Civil and Environmental Engineering, University of Surrey

Co-supervisors: Donya Hajializadeh, School of Sustainability, Civil and Environmental Engineering, University of Surrey; **Dan Lapworth**, British Geological Survey

To date, the dominant approach to addressing the risks posed by extreme weather, natural disasters and climate change has involved engineered interventions. Globally, investment has been towards grey infrastructure. However, applying nature-based solutions (NbS) is vital to achieve the Sustainable Development Goals and may provide opportunities for improving human health as well as increasing biodiversity, reducing carbon emissions, and solving social problems such as inequalities. Evidence shows that better management of ecosystems can prevent the emergence of pathogens; blue-green infrastructure helps to promote mental well-being.

Meeting the demands of an increasing population combined with the impacts of climate change and extreme weather events, is putting the environment and the rivers we depend on under huge stress. The water industry has to balance the delivery of affordable water to customers and protection of the environment on which we are so dependent. To understand the extent of the benefits of nature-based solutions, it is critical that the evidence baseline of the natural capital available in each catchment is identified, prior to implementing any solutions.

There are many examples across the UK and the rest of the World of how nature-based solutions have shown water quality benefits, supported biodiversity and ecosystem restoration, and delivered value to the communities that experience them. Nature-based solutions will be central to net zero targets and have the added benefits of restoring nature, protecting the long-term security of our water supply and reducing flood risk. However, there is also still uncertainty around whether the required environmental standards can be achieved consistently by these 'softer' approaches and how the regulatory processes will develop to support them.

Using existing and new field data, this project will explore different nature-based solutions and gather evidence to ensure that water companies have complete confidence that nature-based solutions can achieve the required standards, even in combination with a more traditional asset-based approach. The project will comprehensively evaluate the primary and co-benefits of NbS using historical and new field data. Through a novel integrative individual-based ("Digital Twin") model, combining hydrological and hydraulic processes, while accounting for socio-economic determinants, we will identify optimum NbS or combinations of NbS under different climatic conditions, which can maximise the benefits for communities, the environment and stakeholders.

Using a cross-sectional study approach, this project aims to explore a portfolio of sustainable, locally tailored NbS interventions and/or hybrid interventions, designed to improve water quality as the primary benefit whilst maximising co-benefits alongside, through multidisciplinary and integrated data collection and mathematical modelling.

The first year of the project will focus on the critical appraisal of case studies where successful and unsuccessful NbS interventions have been implemented to address water quality and associated co-benefits. Historical spatio-temporal information on water resources will be collected and analysed in a case study area to undertake a gap analysis.

In year 2 new qualitative and quantitative data, based on the outcomes of the first year's work will be collected from a case study area, and analysed to assess the benefits, co-benefits, and challenges of NbS and generate data feed module for the Digital twin. Analysis of existing datasets, targeted fieldwork and collection of new data sets will be undertaken based on outcomes of year 1 and interactions with stakeholders and partners to underpin modelling activities.
Finally, the benefits, co-benefits and disbenefits of different packages of NbS (and/or hybrid) solutions in the context of future climate scenarios through the integration of hydrological and hydraulic processes, incorporating historical and new baseline data, into a novel Digital twin will be analysed. Conclusions will be made about the optimal solutions

Training opportunities:

This project will provide a range of training opportunities. The School of Sustainability, Civil and Environmental Engineering run an MSc module on nature-based solutions to environmental engineering, available to the candidate, as well as other postgraduate taught programmes in civil engineering. The Doctorate College/BUFI,, run a range of training opportunities such as help in writing your thesis, research methods and other core skills. They will also be encouraged to attend modules on the University of Surrey's MSc in Water and Environmental Health Engineering such as Regulation and Management, Hydraulic Modelling, GIS and remote sensing. Training will be provided by BGS on field sampling/analysis.

Funding particulars: