

Project Title	Development of low cost, high accuracy, freshwater analytical sensors to enable “Citizen Science” monitoring of UK river systems.
University (where student will register)	University of Warwick
Which institution will the student be based at?	As above
Theme (Max. 2 selections)	Climate & Environmental Sustainability <input checked="" type="checkbox"/> Organisms & Ecosystems <input checked="" type="checkbox"/> Dynamic Earth <input type="checkbox"/>
Key words	Citizen Science, Sensing, Freshwater, Rivers, Pollution
Please explain how the project fits within the NERC remit	This project fits within the NERC remit as it consists of developing analytical sensors to monitor the UK river systems (terrestrial and freshwater environments), to ensure the health of the ecosystems and people reliant on these systems is maintained (ecology, biodiversity and systematics & climate and climate change).
Supervisory team (including institution & email address)	PI: Prof. Julie Macpherson (j.macpherson@warwick.ac.uk , University of Warwick) Co-I: Dr. Joshua Tully (joshua.tully@warwick.ac.uk , University of Warwick), Simon Browning (simon.browning@theriverstrust.org , Deputy Technical Director, The Rivers Trust), Michelle Walker (michelle.walker@theriverstrust.org , Technical Director, The Rivers Trust).

Project Highlights:

- Development of new, low-cost, but improved accuracy sensors for use by the general public for citizen science monitoring of river water health in the UK.
- The ability to take your sensor technology from the laboratory into the field.
- Working in a friendly and cooperative research group at a world leading institution, with support from The Rivers Trust and Citizen Science volunteers.

Overview (including 1 high quality image or figure):

Citizen science is any activity that involves the public in scientific research. One area where citizen science projects have demonstrated their value is in sampling the water quality of natural freshwater rivers. Such river monitoring aids in supplementing the limited and often sporadic monitoring performed by government bodies such as the Environment Agency (EA). Citizen science sampling was recently in the news due to Citizen Science data collected from the River Wye proving that run-off from intensive poultry farms was leading to significant phosphate pollution.¹

Key parameters of interest for river health monitoring include temperature, dissolved oxygen (DO), total dissolved solids (TDS, conductivity), pH, phosphate, ammonia, nitrate, and turbidity (suspended sediment).² Currently citizen science sensors, as they tend to be provided to the general public for free

by environmental non-government organisations (Rivers Trusts or Wildlife Trusts), need to be low-cost. However, low cost here often means compromises on range, accuracy, limit of detection and ease of use (available test methods are typically developed for use in aquariums not river systems). In contrast, EA sampling involves high-cost analytical laboratory equipment, which is inaccessible to citizen science samplers. The aim of this project would be to bridge the gap and develop low-cost, easy to use instrumentation, which provides improved accuracy and traceability compared to the existing citizen science sensors. Data collected will also feed into the “Catchment Systems Thinking Co-operative (CaSTCo) project³ - a £7.1M project funded by OFWAT Innovation Fund – whose aim is to develop a national standard framework for catchment monitoring. We will aim to focus on 4 parameters during the PhD, DO, pH, TDS (conductivity) and phosphates; if time is available, we will expand the range.

The Macpherson group is an internationally recognised, friendly, and co-operative electrochemistry research group at the University of Warwick.⁴ If you were to undertake a project with us, you would have the benefit of the day-to-day supervision of Dr Joshua Tully (Research Fellow) and the extensive experience of Prof. Julie Macpherson. The project would also be heavily involved with the Rivers Trust (see below) who lead CaSTCo.³

Methodology:

We wish to explore a number of different analytical approaches to producing the low-cost analytical sensors. These will include electrochemical measurements (where we record a characteristic potential / current), colourimetry (measure solution absorbance), and/or luminescence (measure light emission from the solution). We will couple these methods with low-cost fabrication methodologies, which also encourage maximum design flexibility, for example 3D-Printing and Injection Moulding. An interested researcher could also choose to develop prototype electronics based on Arduino or other microcontrollers. The aim will be to produce functional prototype sensors, which will both be tested by the PhD student and volunteers in the field (access to different river systems will be possible via the Rivers Trust). Note, no prior experience with 3D printing or Arduino electronics is necessary. We believe a student who is interested in sensor development and testing in the field would get the most out of this project.

Training and skills:

Students will be awarded CENTA2 Training Credits (CTCs) for participation in CENTA2-provided and ‘free choice’ external training. One CTC equates to 1/2 day session and students must accrue 100 CTCs across the three years of their PhD.

Students will receive training in the application/theory of analytical measurement techniques, including (i) electrochemical (ii) colorimetric and (iii) luminescence methods. Training will also be given in (i) 3D printing (ii) open-source electronic platforms and (iii) data analysis and handling. The Rivers

Trust will offer training in (i) freshwater environmental sampling; (ii) commercially available monitoring instrumentation; (iii) hands-on sessions highlighting the pros and cons of different measurement approaches.

Partners and collaboration (including CASE):

Name of L1/L2 Partner (where applicable)	The Rivers Trust
Name of CASE partner (where applicable – project proposal must be accompanied by a letter of support from the CASE partner)	The Rivers Trust

Further information on partners and collaboration (including CASE):

The Rivers Trust is the umbrella organisation for 60+ member River Trusts across Britain, Northern Ireland and Ireland. Local Trusts drive positive change for rivers, reducing pollution, building climate resilience and helping nature’s recovery. The Rivers Trust employs around 60 staff, comprising national experts in data analysis, freshwater ecosystems, monitoring technologies, water policy and governance, community engagement, land use impacts, nature-based solutions and much more. Supported by members of The Rivers Trust Technical Team, the successful applicant will have access to experts across the Rivers Trust movement including those at local Trusts (Severn Rivers Trust and Trent Rivers Trust).

Possible timeline:

Year 1: Development of Sensors for Analytes 1 & 2 and laboratory testing of these.

Year 2: Field Testing of Sensors 1 & 2. Laboratory Development of Sensors 3 & 4.

Year 3: Field Testing of Sensors 3 & 4. Engagement in Citizen Science Projects with the sensors developed.

Further reading:

1: Jon Ungood-Thomas (2023) ‘Citizen scientists make a vital difference’: the locals who proved the River Wye was polluted. Available at <https://www.theguardian.com/global/2023/aug/12/citizen-scientists-make-a-vital-difference-the-locals-who-proved-the-river-wye-was-polluted> (Accessed September 6th, 2023).

2: Hassan Omer N (2020) Water Quality Parameters. Water Quality - Science, Assessments and Policy. IntechOpen. DOI: 10.5772/intechopen.89657.

3: Catchment Monitoring Cooperative (no date). <https://monitoring.catchmentbasedapproach.org> (Accessed September 6th, 2023).

4: Warwick Electrochemistry and Interfaces Group. Available at:

<https://warwick.ac.uk/fac/sci/chemistry/research/electrochemistry/home/> (Accessed September 6th 2023).

Further details:

For more information contact: Prof. Julie Macpherson (UoW, j.macpherson@warwick.ac.uk), Dr. Joshua Tully (UoW, joshua.tully@warwick.ac.uk), and Simon Browning (The Rivers Trust, simon.browning@theriverstrust.org). **Application Website:**

<https://www.findaphd.com/phds/browsebydept.aspx?IID=369>