PROJECT TITLE: The impact of river floods on the global carbon cycle

DTP Research Theme(s): Changing Planet
Lead Institution: University of Bristol
Lead Supervisor: Joshua Dean, University of Bristol, School of Geographical Sciences
Co-Supervisor: Jeffrey Neal, University of Bristol, School of Geographical Sciences
Co-Supervisor: Chris Barry, UK Centre for Ecology & Hydrology, Bangor
Co-Supervisor: Gemma Coxon, University of Bristol, School of Geographical Sciences
Project Enquiries: josh.dean@bristol.ac.uk
Project keywords: floods; hydrology; climate change; global carbon cycle; modelling

Flooding dramatically alters the magnitude and source of water & carbon in rivers. CREDIT: Joshua Dean

River flooding can impact the enormous carbon stores and emissions of natural ecosystems. CREDIT: Joshua Dean

Project Background

Rivers are a key nexus between continents, oceans and the atmosphere. As such, rivers play an important role in the global carbon cycle, transporting large amounts of organic and inorganic carbon derived from soils, plants and water-rock interactions (Battin et al., 2023). These rivers are also substantial greenhouse gas (GHG) emitters, and act as key sites of carbon transformation and rapid pathways for carbon emissions to the atmosphere (Cole et al., 2007). Our current understanding of rivers as carbon emitters almost entirely ignores a major feature of river dynamics: flooding. Further, conventional relationships between river flow and water chemistry do not work for river GHG concentrations and emissions. There is thus an urgent need to improve our fundamental knowledge of how river GHG emissions respond to flood conditions. This project will address two key research gaps: (1) the magnitude to which river floods contribute to global carbon emissions, and (2) how might river GHG emissions respond as climate change alters flood dynamics (Devitt et al., 2023). The changing hydrological cycle and global carbon cycle are intrinsically linked, and this project seeks to disentangle one the most significant and challenging knowledge gaps of this key linkage between the Earth's systems.

Project Aims and Methods

The project's core aim is to develop new understanding of the importance of river flooding to the movement of carbon within the terrestrial, marine and atmospheric carbon cycles, both now and in the future. This will encompass the following objectives that can evolve depending on the applicant's interests:

1. Develop a conceptual model of riverine greenhouse gas (GHG) export/emissions during flood events.

2. Utilise existing hydrological models to quantify crucial timing ("hot moments") in flood GHG emissions (exploring the trade off between GHG inputs to rivers and hydraulic-driven GHG emissions).

3. Apply advanced numerical methods to existing local, regional and/or global datasets to quantify the potential importance of flood GHG emissions in the context of the global carbon budget.

Candidate requirements

Experience with environmental modelling, coding (in R, python or matlab), and hydrology are important for success in this project. Experience in flood modelling and carbon cycling would be beneficial. We welcome and encourage student applications from under-represented groups. We value a diverse research environment.

Project partners

The UK Centre for Ecology & Hydrology (https://www.ceh.ac.uk/) will bring a wealth of expertise at the nexus of hydrology and the global carbon cycle. They will provide further training and support to the successful applicant, including access to incredible datasets on river hydrology and the transport and emission of greenhouse gases from rivers in the UK and around the globe. This includes opportunities for the successful candidate to contribute to fieldwork and modelling on projects of international significance.

Training

The student will benefit from training in hydrological modelling, data synthesis, analysis and visualisation, and measurement of GHG emissions. The student will benefit from training provided by the Bristol Doctoral College (http://www.bristol.ac.uk/doctoral-college/) including computer coding, the numerical evaluation of complex datasets and high impact scientific writing. The student will have opportunities to interact with scientific networks through the GW4's Water Security Alliance, and through projects run by the supervisors, including training, conferences and networking across Europe, the USA, Australia and New Zealand.

Background reading and references

Battin, T.J. et al.: River ecosystem metabolism and carbon biogeochemistry in a changing world, Nature, 613, 449-459, https://doi.org/10.1038/s41586-022-05500-8, 2023.

Cole, J.J. et al.: Plumbing the global carbon cycle: Integrating inland waters into the terrestrial carbon budget, Ecosystems, 10, 171-184, https://doi.org/10.1007/s10021-006-9013-8, 2007.

Devitt, L., Neal, J., Coxon, G., Savage, J., & Wagener, T.: Flood hazard potential reveals global floodplain settlement patterns, Nature Communications, 14, 2801, https://doi.org/10.1038/s41467-023-38297-9, 2023.

Useful links

https://watershedcarbonlab.weebly.com/
http://www.bristol.ac.uk/geography/courses/postgraduate/

Bristol NERC GW4+ DTP Prospectus:
http://www.bristol.ac.uk/study/postgraduate/2024/sci/phd-great-western-four-doctoral-training-partnership-nerc/

How to apply to the University of Bristol:
http://www.bristol.ac.uk/study/postgraduate/apply/
Please note: If you wish to apply for more than one project please contact the Bristol NERC GW4+ DTP Administrator to find out the process for doing this.

The application deadline is Tuesday 9 January 2024 at 2359 GMT. Interviews will take place from 26 February to 8 March 2024.

For more information about the NERC GW4+ Doctoral Training Partnership please visit https://www.nercgw4plus.ac.uk.

General Enquiries: Bristol NERC GW4+ DTP Administrator
Email: bristol-nercgw4plusdtp-admin@bristol.ac.uk