Project Title: Advancing large scale flood modelling with the surface water and ocean topography mission

Lead Institution/Department: University of Bristol School of Geographical Sciences
Primary Supervisor: Professor Jeffrey Neal
Co-Supervisor: Professor Paul Bates, Dr Stephen Chuter (Fathom)

Summary

Fluvial flooding is the most destructive of all natural disasters, causing financial losses that surpass £50 billion per year globally, with over 2 billion people residing on floodplains at risk of exposure. Despite great advances in global flood inundation modelling over the last decade, our sparse observations of key hydrological parameters such as river level, discharge, bathymetry and bank height are the significant limitations to their accuracy[1], leading to unknown social and economic risks. With projected increases in both severity and regularity of high impact flood events due to climate change, more comprehensive observations of these global hydrological variables are essential.

This project will use the revolutionary observational capability of the NASA/CNES/CSA/UKSA Surface Water and Ocean Topography (SWOT) satellite to, for the first time, observe these critical hydrological parameters globally[2], supporting a step change in flood inundation model accuracy. Launched in 2022, SWOT is a novel synthetic aperture radar and altimetry mission, providing the first continuous level monitoring of all major rivers worldwide. This transformative capability will provide opportunities for the student to pursue a variety of research interests related to the integration of SWOT observations into flood inundation modelling; with key relevance to commercial and humanitarian stakeholders.

Methods

This project will utilize SWOT Pixel Cloud (L2_HR_PIXC) altimetry data and other SWOT river variables to investigate how key hydrological variables (river level, discharge and floodplain height)[2] can improve large scale inundation modelling. The project will include research on process based and machine learning approaches to river bathymetry inversion in large scale hydraulic models and new opportunities for model validation and parameter identification. Additionally, SWOT data will be used in combination with complimentary remote sensing (e.g. SAR/Optical imagery) and in-situ data (e.g. river gauges), where advantageous, to further aid model parameterization and for validation.

Fathom will assist with integration of the novel SWOT-derived hydrological parameters into the LISFLOOD-FP modelling framework[3]. This includes providing the student with access to the latest state-of-the-art hydrography and digital terrain models (FABDEM+). This project will build on outputs from the University of Bristol and Fathom UKSA ‘Advancing flood hazard modelling with the Surface Water and Ocean Topography satellite mission’ and the University of Bristol NERC ‘SWOT-UK: The UK contribution to validating SWOT in the Bristol Channel and River Severn, with application to coastal and river management’ projects.

Background reading and references

[1] Oliver E J Wing, Paul D Bates, Niall Quinn, et al. A 30 m global flood inundation model for any climate scenario. ESS Open Archive . October 30, 2023.
DOI: 10.22541/essoar.169867688.87007201/v1

[2] Durand, M., Gleason, C. J., Pavelsky, T. M., Prata de Moraes Frasson, R., Turmon, M., David, C. H., et al. (2023). A framework for estimating global river discharge from the Surface Water and Ocean Topography satellite mission. *Water Resources Research*, 59, e2021WR031614. https://doi.org/10.1029/2021WR031614

[3] Neal, J., Hawker, L., Savage, J., Durand, M., Bates, P., & Sampson, C. (2021). Estimating river channel bathymetry in large scale flood inundation models. *Water Resources Research*, 57, e2020WR028301. https://doi.org/10.1029/2020WR028301

How to Apply: The deadline for this position is 8th April 2024. The studentship will begin in September 2024. Please apply to the “PhD in Geographical Sciences (Physical Geography)” at https://www.bristol.ac.uk/study/postgraduate/apply/