Project Title: From Hazards to Risk: Physics-Informed AI and SWOT Data for Global Flood Mapping and Socio-Economic Vulnerability

Lead Institution/Department: University of Bristol, School of Geographical Sciences
Primary Supervisor: Dr Ce Zhang
Co-Supervisors: Prof. Jeff Neal, School of Geographical Sciences; Prof. Peter Atkinson, School of Geographical Sciences; Dr Alex Bird, Deloitte MCS Limited

Project Summary

Pioneer a new era in flood risk science! This PhD uses cutting-edge AI, Machine Learning, and revolutionary SWOT satellite data to create the first dynamic global flood risk maps. You'll translate remote sensing data into life-saving insights for climate adaptation, gaining valuable skill sets in geospatial data science.

Project Details

Floods are among the most damaging natural hazards globally, yet a significant gap exists between observing a physical flood and understanding its real-world risk to vulnerable communities. This PhD project directly addresses this challenge by developing a novel framework to translate cutting-edge satellite data into actionable, global-scale flood risk information. By integrating revolutionary high-resolution data from the SWOT mission with physics-informed artificial intelligence, this research will move beyond simple inundation mapping. The project's core is the development of a deep learning model uniquely constrained by the fundamental laws of hydrodynamics, ensuring its predictions are both data-driven and physically plausible.

This AI will harness unprecedented data from SWOT, Sentinel-1/2, and various static datasets. To create a dynamic link between physical hazards and societal impact, the framework will integrate global exposure and vulnerability datasets, including population density from WorldPop and economic activity grids. Using vulnerability indices, the project will translate flood hazards into quantifiable socio-economic risk, with results validated against historical flood records and economic loss databases. This dual physical-social approach will produce high-resolution risk maps that empower decision-makers to pinpoint vulnerability hotspots, design targeted interventions, and ultimately build more flood-resilient societies globally.

References

- Cai, S., Mao, Z., Wang, Z., Yin, M., & Karniadakis, G. E. (2021). Physics-informed neural networks (PINNs) for fluid mechanics: A review. Acta Mechanica Sinica, 37(12), 1727-1738.
- Mudashiru, R. B., Sabtu, N., Abustan, I., & Balogun, W. (2021). Flood hazard mapping methods: A review. Journal of hydrology, 603, 126846.

- Slater, L. J., Arnal, L., Boucher, M. A., Chang, A. Y. Y., Moulds, S., Murphy, C., ... & Zappa, M. (2023). Hybrid forecasting: blending climate predictions with AI models. Hydrology and earth system sciences, 27(9), 1865-1889.

Essential/Desirable Skills

Good conceptual and practical knowledge of AI and satellite sensor technology is desirable. Programming (ideally in Python) and machine learning skills are assets. However, enthusiasm for flood risk modelling and curiosity about the best ways to assess vulnerability to exposed populations using geospatial science are by far the most important requirements. We welcome and encourage applications from under-represented groups.

Entry requirements

You must have a UK 2:1 honours degree or higher in a relevant subject. You can also have its international equivalent.

If English is not your first language, you will need an International English Language Testing System (IELTS) overall score of 6.5, with a minimum of 6.0 in all components. Visit our English language proficiency pages to find out about other qualifications we accept.

Useful Links

- https://www.bristol.ac.uk/geography/courses/postgraduate/
- https://www.bristol.ac.uk/study/postgraduate/research/geographical-sciencesphysicalgeography/
- Flood-CDT Projects | National Oceanography Centre

How To Apply

The deadline for application is **8 January 2026**. Please apply to the 'Geography (PhD)' here: https://www.bristol.ac.uk/study/postgraduate/apply/.