Project Title: Understanding the compound nature of coastal flood hazard in the UK to improve forecasts and projections

Lead Institution/Department: Met Office and University of Bristol School of Geographical Sciences
Primary Supervisor: Dr Sana Mahmood (UK Met Office and University of Bristol)
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Summary

Coastal flood hazards (e.g., estuarine flooding, coastal overtopping, coastal erosion) mainly occur in response to meteorological events that drive multiple hazards, such as wind, rain, storm surge, high waves, high river flows (Bevacqua et al., 2020). Current guidance and coastal flood prediction generally doesn't account for interdependencies and potential non-linear amplification of these hazards. Understanding both the present-day combined multi-hazard flood risk and the potential changes under future sea-level rise are fundamental to robust coastal adaptation planning. This PhD will gain new insight into past multi-hazard dependencies and their future evolution, as well as define multi-hazard thresholds for weather forecasting, by answering these questions:

(i) what are the relationships between tides, waves, storm surges and river flows observed in the historical past?

(ii) How important are the interactions between these flood hazard drivers in modifying the overall risk?

(iii) How might these drivers and their interactions change under future sea-level rise?

This PhD will advance multi-hazard coastal forecasting and understanding, to promote improved national forecasts made by the Flood Forecasting Centre; a joint centre between the Met Office and the Environmental Agency.

Methods

This PhD project will make use of a new regional coupled modelling system developed for the Northwest European Shelf, including atmospheric, wave, ocean and river models at km-scale (Lewis et al. 2019, Lewis & Dadson, 2021). A unique feature of this system is its ability to run in both weather forecast and climate projection modes. The PhD student will evaluate this new coupled modelling capability, with a particular focus on wave, surge and river flows. They will also test new developments in the land-surface scheme (e.g., groundwater scheme) relevant to compound flood events. The project will use a first-of-its-kind 20-year simulation to better quantify multi-hazard dependencies. This will enable the definition of multi-variate thresholds for weather forecasting and inform multi-variable co-variances for statistical models used to infer return levels for coastal resilience. The student will make use of future projections (10-year time slices, complemented by targeted storm-event downscaling) to better quantify future changes in multi-variate coastal hazards. The project will be supported by a strong multidisciplinary team and benefit from the many collaborations around the Regional Environmental Prediction project, between Met Office, National

Oceanography Centre, UK Centre for Ecology and Hydrology, British Geological Survey, Plymouth Marine Laboratory and Bristol University.

Background reading and references

Bevacqua, E., Vousdoukas, M. I., Zappa, G., Hodges, K., Shepherd, T. G., Maraun, D., et al. (2020). More meteorological events that drive compound coastal flooding are projected under climate change. *Communications Earth & Environment*, *1*(1), 47. https://doi.org/10.1038/s43247-020-00044-z

Lewis, H. W., Castillo Sanchez, J. M., Arnold, A., Fallmann, J., Saulter, A., Graham, J., et al. (2019). The UKC3 regional coupled environmental prediction system. *Geoscientific Model Development*, *12*(6), 2357–2400. https://doi.org/10.5194/gmd-12-2357-2019

Lewis, H. W., & Dadson, S. J. (2021). A regional coupled approach to water cycle prediction during winter 2013/14 in the United Kingdom. *Hydrological Processes*, *35*(12), e14438. https://doi.org/10.1002/hyp.14438

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/