Project Title: Beyond the peak – towards improved understanding of flood signatures, their drivers and trends

Lead Institution/Department: UK Centre for Ecology and Hydrology and University of Bristol, School of Geographical Sciences
Primary Supervisor: Gianni Vesuviano (CEH) **Co-Supervisor:** Adam Griffin (CEH), Gemma Coxon, Jamie Hannaford (CEH)

Summary

Floods have been identified as one of the most dangerous hazards in the UK causing potentially billions of pounds of economic and social damage per year. Flood risk is becoming an increasing concern as studies suggest that flood frequency and magnitude are changing over time in the UK, with events that would have been rare in the recent past seeming to become less rare now.

While the most recent major UK flood episode in late 2023/early 2024 saw some extreme peak flows, it was also remarkable for its repeated nature (with a relentless series of extreme storms, including 'Ciaran' and 'Henk'), spatial extent, and duration. Other recent episodes (e.g. 2019/2020) have also seen repeated flooding and wide spatial footprints. Traditional assessments of flood severity, and of long-term trends in floods, are based on peak flow magnitude, but there is a pressing need to better understand other flood signatures like duration, total volume and spatial extent, how they are changing, and for what reasons. Capturing the likelihood of simultaneous flooding events is also crucial for developing tools for resource allocation in emergency response to flooding.

Methods

This PhD will exploit a novel dataset that captures detailed information on flood characteristics (signatures), including flood duration, total volume and rate-of-rise, catchment properties, and event rainfall, from over 90,000 events and 700 catchments. Using a subset of catchments with high data quality, trends in flood signatures will be identified through non-stationary statistical methods such as GAMLSS models, after grouping events into similar families (e.g. intense convective storms in urban catchments). Co-occurrence of trends in flood signatures will be investigated, applying spatial clustering to identify locations with similar trends in flood signatures. Rainfall, land-use change (UKCEH Land Cover Maps), and atmospheric circulation indices (moving beyond simple indices like the North Atlantic Oscillation and towards underlying air pressure and sea-surface temperature fields) will be investigated as covariates to link event signatures to meteorological and anthropogenic changes in the study catchments, disentangling land-use change and regional climatic change impacts, and presenting opportunities to explore potential impacts of climate-change driven changes in flood signatures. Regional responses to a changing climate could be considered with respect to flood durations, volumes, rate-of-rise, or sequencing/clustering, offering a huge advance on current approaches that largely focus on changes in peak flows only.

Background reading and references

Zheng, Y., **Coxon, G.**, Woods, R., Li, J. and Feng, P. (2023). Controls on the spatial and temporal patterns of rainfall-runoff event characteristics ‐ a large sample of catchments across Great Britain. *Water Resources Research*, e2022WR033226.

Hannaford, J., Mastrantonas, N., **Vesuviano, G.** and Turner, S. (2021). An updated national-scale assessment of trends in UK peak river flow data: how robust are observed increases in flooding? *Hydrology Research 52*, 699-718.

Griffin, A., **Vesuviano, G.** and Stewart, E. (2019). Have trends changed over time? A study of UK peak flow data and sensitivity to observation period. *Natural Hazards and Earth System Sciences 19*, 2157-2167.

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/