

## **New river flow maxima in Northern England, December 2015: Implications for flood hazard and risk assessment?**

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December 2015 was recently confirmed as the UK's wettest month on record by the Met Office. The most extreme precipitation was associated with three extratropical storm systems, named Desmond, Eva and Frank by the pilot Met Éireann/Met Office "Name our storms" project. In response, river levels reached new maxima at many locations across Northern England. Property damage was widespread, with at least 16,000 homes in England flooded.

As with recent predecessors, these events reinvigorated public debate about the extent to which natural weather variability, anthropogenic climate change, increased urbanisation and/or other changes in catchment and river management might be responsible for apparent increases in flood frequency and severity.

Change detection and attribution science is required to inform the debate, but is complicated by the short (typically ~ 35 years) river flow records available. Running a large number of coupled climate and hydrological model simulations is a powerful way of addressing the 'attribution question' with respect to the hypothesised climate forcing, for example, albeit one that remains largely in the research domain at present.

In the meantime, flood-frequency analysis of available records still forms the bedrock of practice in the water industry; the results are used routinely in the design of new defence structures and in the development of flood hazard maps, amongst other things. In such analyses, it is usual for the records to be assumed stationary.

In this context, the specific aims of this research are twofold:

- To investigate whether, under the assumption of stationarity, the outputs of standard flood-frequency modelling methods (both 'single-site' and 'spatially pooled' methods) differ significantly depending on whether the new peaks are included or excluded, and;
- To assess the sustainability of previous conclusions regarding trends in English river flows by reapplying simple statistical tests, such as the Mann-Kendal test, to data series with the new peaks included.

Overall, the research seeks to explore the robustness of commonly-employed statistical flood estimation methods to instrumentally unprecedented extremes. Should it be found that the new records do indeed represent paradigm-shifting 'leverage points', then the suggestion of the Deputy Chief Executive of the Environment Agency, David Rooke - that a "complete rethink" of flood mitigation matters is required in our world of "unknown extremes" - must be given sufficient attention.