



Flood and Coastal Erosion Risk Management Research Programme

Development of interim national guidance on non-stationary fluvial flood frequency estimation

Project summary FRS18087/IG/S

We have developed new tools and techniques to help us detect and take account of non stationarity in flood frequency estimation for flood scheme appraisal.

Background

Traditional methods used to estimate the probability and magnitude (size) of floods (flood frequency analysis) assume that extreme events are 'stationary'. This is where observations of past flood events are assumed to represent the behaviour of future events.

Recent high magnitude flood events on our rivers have prompted many hydrologists to question the concept of stationarity and instead consider 'non-stationarity' which recognises statistically significant changes over time.

Method

The main aim of this project was to develop interim guidance for dealing with non-stationarity in annual maximum river flow series (a record of the largest flood each year at a river gauging station). The objectives were to:

- develop methods for identifying non-stationarity
- develop a scientifically robust process for carrying out non-stationary flood frequency analysis
- outline how to take account of future climate change under non-stationary conditions
- provide guidance and tools for practitioners
- make a high-level assessment of the impact of non-stationarity on flood frequency estimation across England and Wales

It is envisaged that this interim guidance will remain in place for at least 2 years, until superseded by future work.

Results

13% of river flow gauging stations show a statistically significant upward trend in annual peak flows over the period of record at the 5% level (there is a 95% probability that upward trend is present), and this increases to 21% if the significance threshold is relaxed to 10% (there is a 90% probability that upward trend is present). When present, upward trends are seen across much of England and Wales, with some of the strongest and most statistically significant trends in the north and west.

On average, across England and Wales, including non-stationarity in flood frequency estimation makes little difference to estimated design flows. However, in individual cases (which are used for the design of flood risk management schemes), it can make a large difference, usually but not always, leading to an increase in present-day estimates.

The detailed findings of this work are presented in 3 reports:

1. **Science report:** details work on data screening, trend and change point testing, and the development of non-stationary methods for flood frequency analysis.
2. **Practitioner guidance:** when and how to carry out non-stationary analysis, and how to interpret the results.
3. **R package 'nonstat' user guide:** how to use the R package to carry out trend testing and non-stationary flood frequency analysis.

Conclusions

This project recommends the use of non-stationary flood frequency estimation for the planning and appraisal of flood risk management schemes and strategies where there is evidence of non-stationarity in river flow records.

It is also recommended that non-stationary flood frequency analysis should always be carried out alongside more traditional stationary methods.

This summary relates to information from project FRS18087, reported in detail in the following output(s):

Report: FRS18087/IG/R1. Development of interim national guidance on non-stationary fluvial flood frequency estimation – science report

Report: FRS18087/IG/R2. Development of interim national guidance on non-stationary fluvial flood frequency estimation – practitioner guidance

Report: FRS18087/IG/R3. Development of interim national guidance on non-stationary fluvial flood frequency estimation – R package ‘nonstat’ user guide

Digital: FRS18087-IG-D1-nonstat.zip. Zip file of the R package ‘nonstat’

Digital: FRS18087-IG-D2-digital_outputs.zip. Zip file of the digital outputs from the project

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Website: <https://www.gov.uk/government/organisations/flood-and-coastal-erosion-risk-management-research-and-development-programme>

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