



## Flood and Coastal Erosion Risk Management Research Programme

# Rapid evidence assessment of non-stationarity in sources of UK flooding

## Project Summary FRS18087/REA/S1

We have carried out a rapid assessment of scientific literature to answer the question: **What is the evidence for stationarity or non-stationarity in sources of UK flooding?**

### Background

Traditional methods used to estimate the probability and magnitude of floods assume '**stationarity**' of extreme events. This is where observations of past flood events are assumed to represent the behaviour of future events, or in other words, they are stationary.

Current estimates of extreme rainfalls, river flows, waves and storm surges all rely of this assumption.

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

### Method

We synthesised current knowledge on stationarity or non-stationarity of sources of UK flooding using a systematic approach called a rapid evidence assessment. In addition to the primary question in the first paragraph, this assessment we also considered three secondary questions:

- what can cause non-stationarity in the sources of UK flooding?
- what techniques are used to detect and account for non-stationarity in the sources of UK flooding?
- to what extent does an assumption of stationarity or non-stationarity alter the outcome of flood risk analysis?

### Results

The findings of this project are based on information we synthesised from 144 studies that were identified as being the most relevant and robust. This followed our systematic appraisal of 9,749 articles we initially identified. The main findings are:

The studies showed a general, but not universal, consensus that both **extreme precipitation and flood flows on rivers are increasing**.

The causes of this non-stationarity are frequently attributed to **climate change** or **teleconnections** (large-scale patterns of atmospheric circulation).

The literature supports current best practice for calculating **present day coastal flood extremes** which assumes **stationarity** in historical records of wind, waves, storm surge and astronomical tide.

Records of **mean sea level** are **non-stationary** and this effect is also routinely accounted for in risk assessments.

With respect to future flood risk on the coast, studies find evidence that the **future distributions of all coastal flood sources are non-stationary** under climate change.

Flood risk assessments of future risk on the coast currently assume **stationarity of astronomical tides**. This assumption was **not supported** by the literature which suggests that astronomical tides are changing with sea level rise, which are projected to accelerate further in the future.

These results suggest that new guidance and methods are needed to take account of non-stationarity, particularly for rainfall statistics and river flood frequency estimation, and changing astronomical tides when estimating future coastal flood risk.

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

**Report:** FRS18087/REA/R1

**Title:** Rapid Evidence Assessment of Non-Stationarity in Sources of UK Flooding.

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