

Flood seasonality

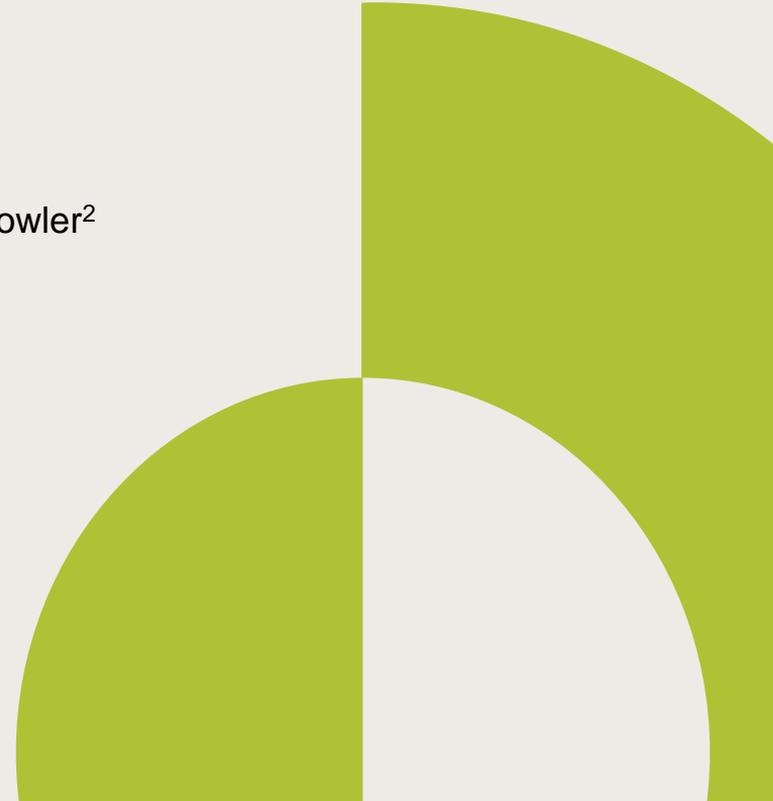
Implications for UK rainfall-runoff modelling

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¹ Mott MacDonald

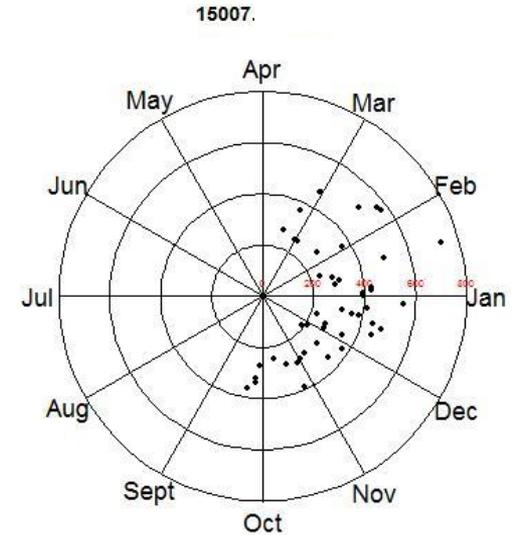
² Newcastle University

³ JBA Consulting



Why consider seasonality?

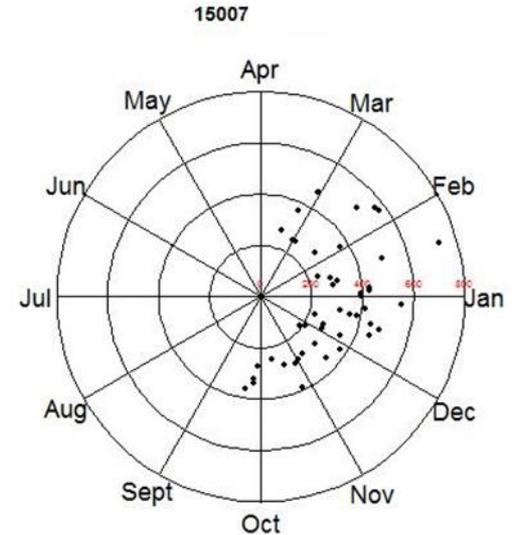
- Temporary works
- Agricultural impacts
- Statistical flood frequency analysis
- Rainfall-runoff modelling
- Climate change



Standardised by QMED

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- **Rainfall-runoff modelling**
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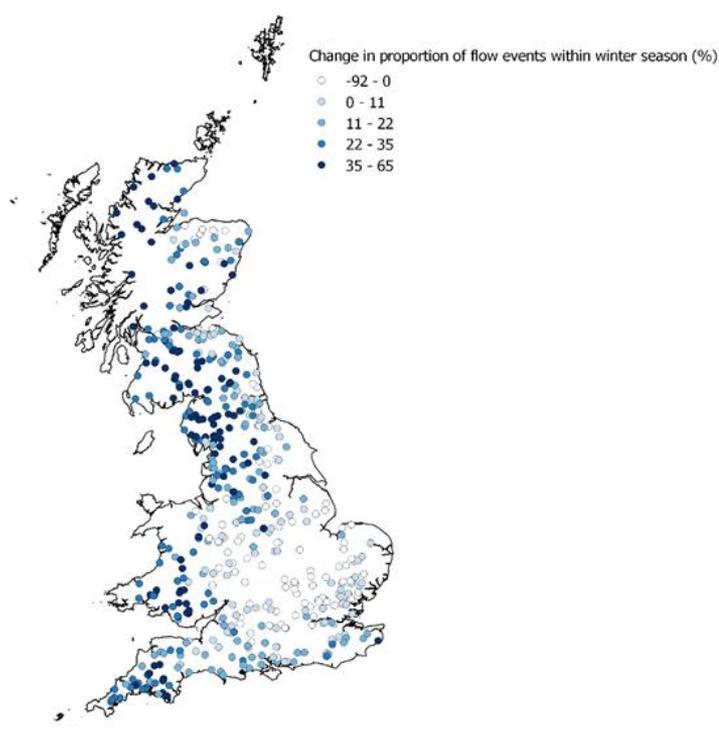


Aim and Methods

To summarise the rainfall-flood relationship in the UK and consider its applicability within rainfall runoff modelling.

- ~500 High flow gauges and gridded datasets analysed to look at the seasonality of rainfall and storm events.
- Pre-processing to remove short records, ensure concurrent time periods across records.
- Development of matching algorithms.
- Ignoring quality of the magnitude estimate, focus on the date only.

Seasonal definition



Seasonality is subjective!

(1) FSR used November-April

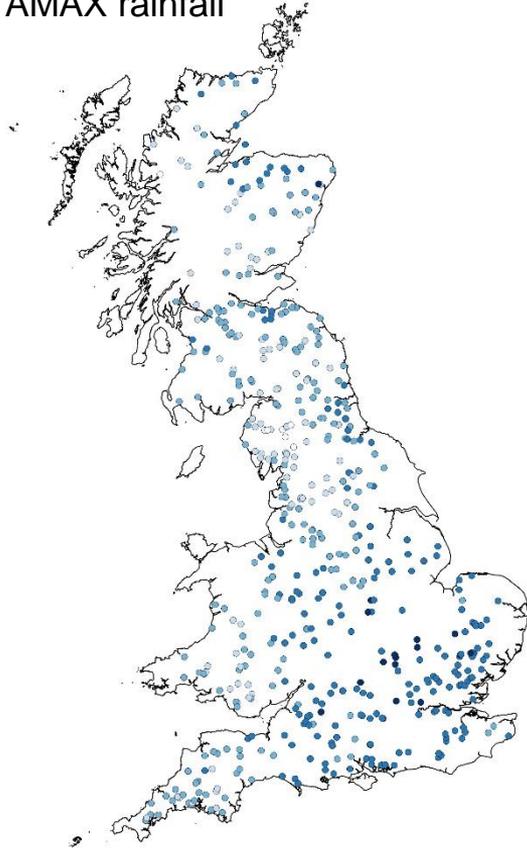
(2) Revised definition October-March

Plot shows percentage change in occurrence when moving from 1 to 2

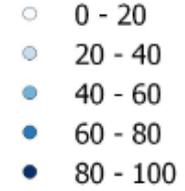
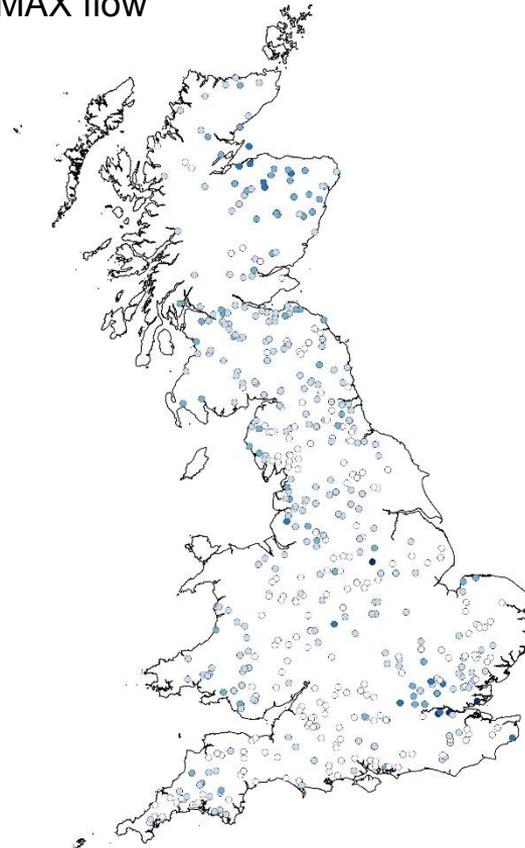
Event Seasonality – Summer (May-Oct)

% of total AMAX record within season

AMAX rainfall



AMAX flow



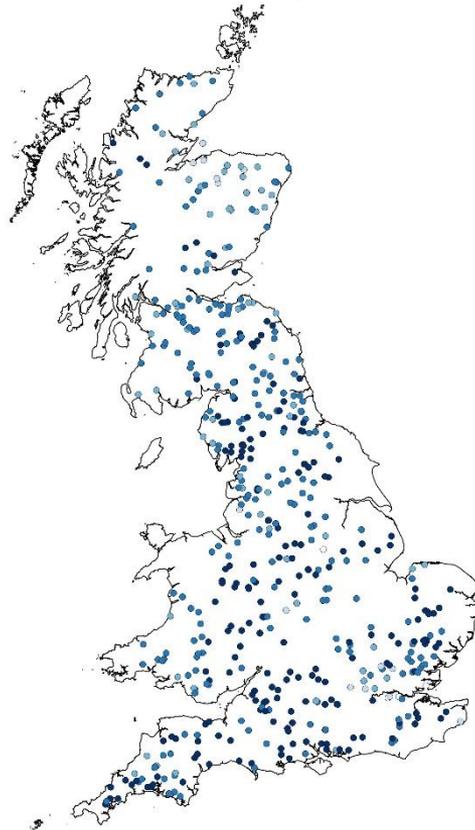
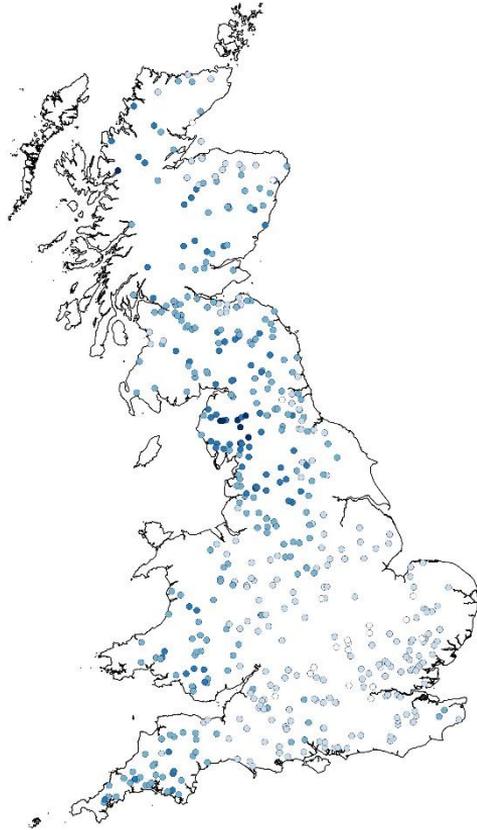
Event Seasonality - Winter (Nov-April)

AMAX rainfall

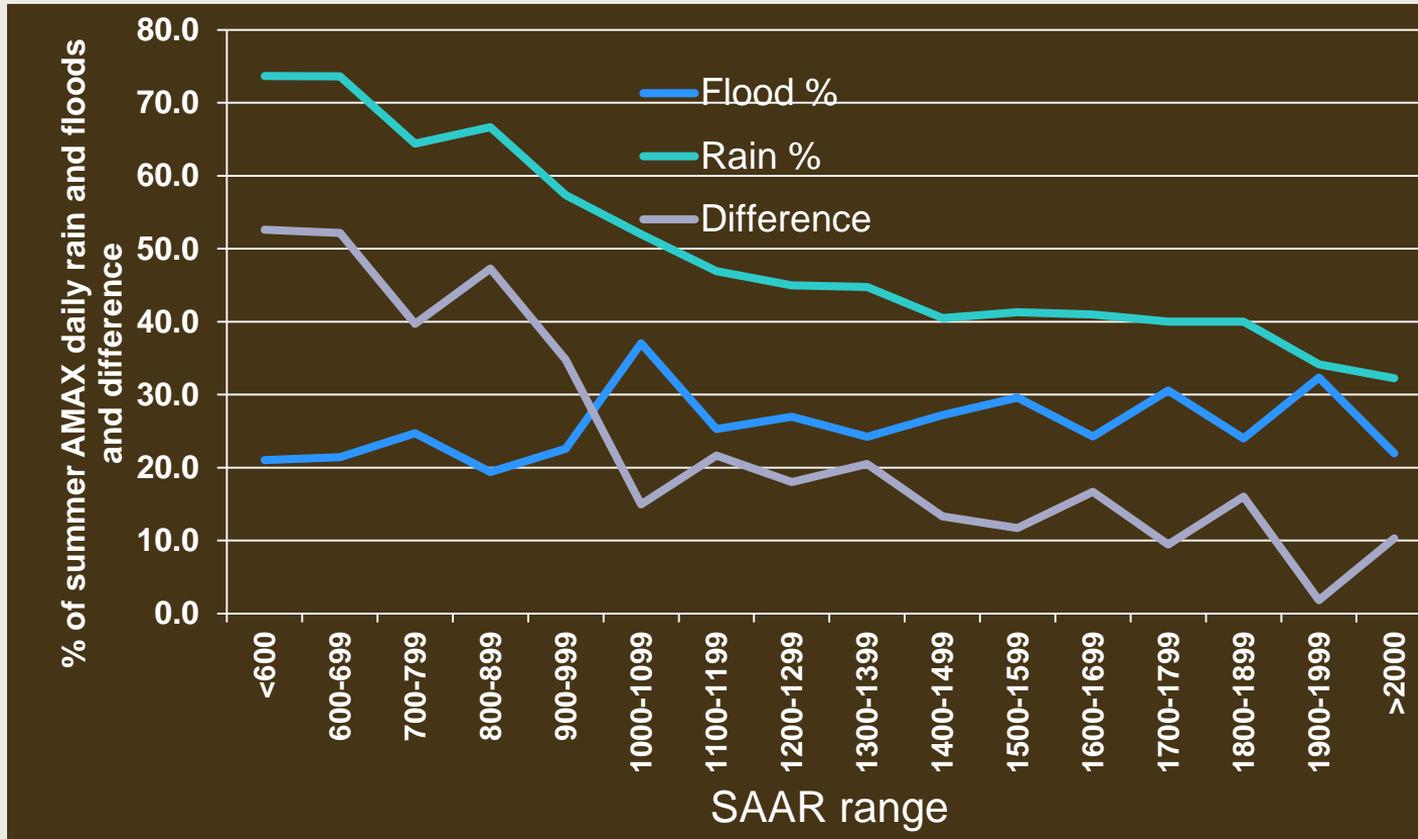
AMAX flow

% of total AMAX record
within season

- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100

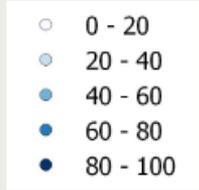
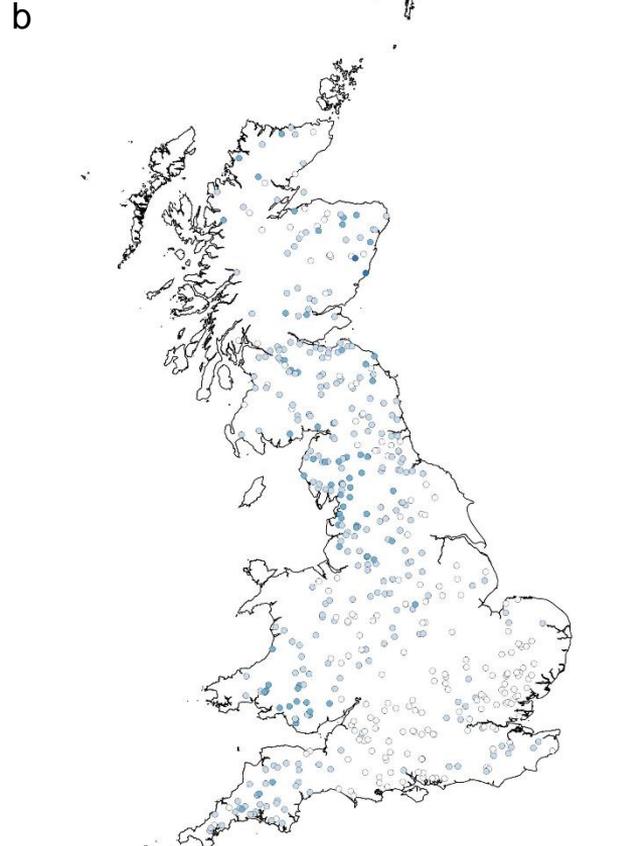
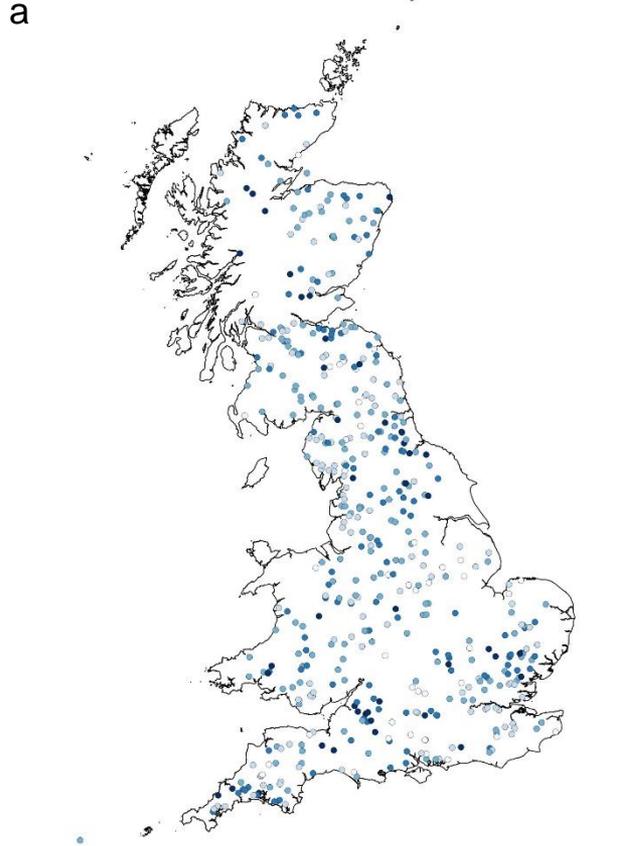


Contrast in rain and flood seasonality by SAAR



Event matching

% of AMAX flows generated from AMAX rainfall in (a) Summer and (b) Winter



Seasonality – restating what we know

1. With respect to flood risk assessment AMAX peak river discharge is always caused by heavy or intense rainfall (or snowmelt).
2. However, AMAX intense rainfall only rarely causes AMAX flood (especially in dry catchments).
3. Thus, heavy rainfall is a necessary but not sufficient condition for flooding to occur.
4. AMAX rainfall occurs predominantly in summer; AMAX flooding occurs predominantly in winter.
5. The discontinuity between rainfall and flooding is explained by consideration of coincident soil moisture deficit.
6. On dry catchments the seasonality of flooding coincides with seasonality of SMD more than with intense rainfall.

Rainfall-runoff modelling – implications for design flood estimation

Event based models tend to use a combination of components to estimate the design flood:

- An estimate of a design storm, usually of a specified duration and with a profile;
- An antecedent rainfall estimate, or soil moisture estimate to generate initial conditions;
- A loss model.

Most models use the 'all-year' DDF estimate for rainfall, then applied to an initial condition and a loss model.

The 'all-year' estimate may not really be the critical one for flood generation – as we have shown, in many catchments the annual AMAX is not responsible for flood generation.

Rainfall-runoff modelling – ReFH/ReFH2

The ReFH model recognises this problem and its development was a step forward in characterising seasonality:

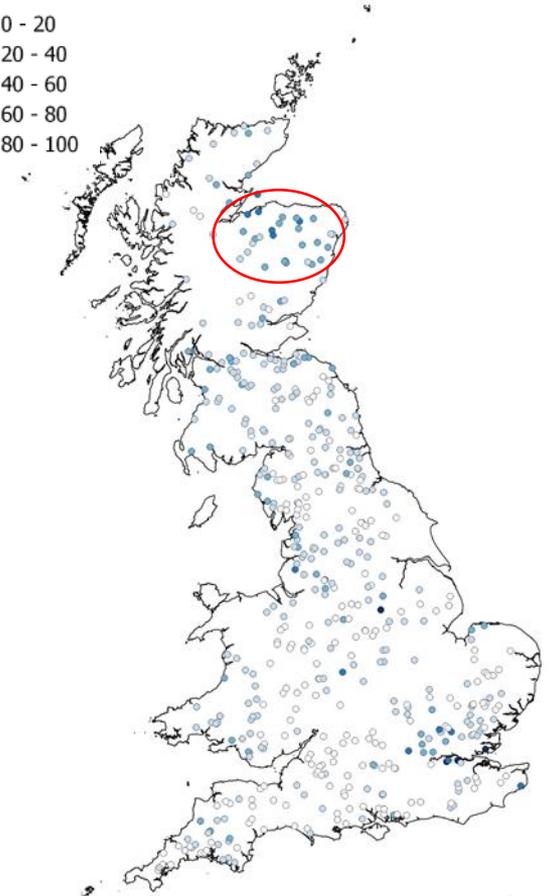
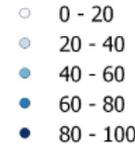
- Seasonally adjusted rainfall (SCF);
- A seasonal initial conditions model;

For ReFH, the original calibration dataset (and applications) splits the catchments into Summer/Winter using URBEXT to define the split.

It's clear this is not entirely appropriate – there are a number of catchments where flooding predominantly occurs in Summer and they are not urbanised.

ReFH2 used a larger Scottish dataset, and while a number of parameters were re-calibrated, as far as is known, this did not extend to altering the seasonal definition.

Proportion of AMAX flows occurring in Summer



Rainfall-runoff modelling – what to do about it?

At the very least, acknowledge the potential mismatch and how it might influence an estimate.

Consider:

1. Whether it matters from an applied perspective for each individual case – this may only be relevant to certain catchments.
2. Joint probability of rainfall and soil moisture?
3. Continuous simulation?

Finally... Given current experience of the role of soil moisture deficit in limiting river flooding from intense rainfall, the intensification of storm rainfall may not lead to greater river flooding unless there is a concurrent increase in the risk of wetter initial conditions. The reverse is more likely to be the case.