

# LOCALISM: A NEW ENDORSEMENT OF AN OLD PARADIGM FOR FLOOD FREQUENCY ESTIMATION

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- General uncertainty assessment for FEH
- Rationale for using local data
- Constrain uncertainty on QMED using local data

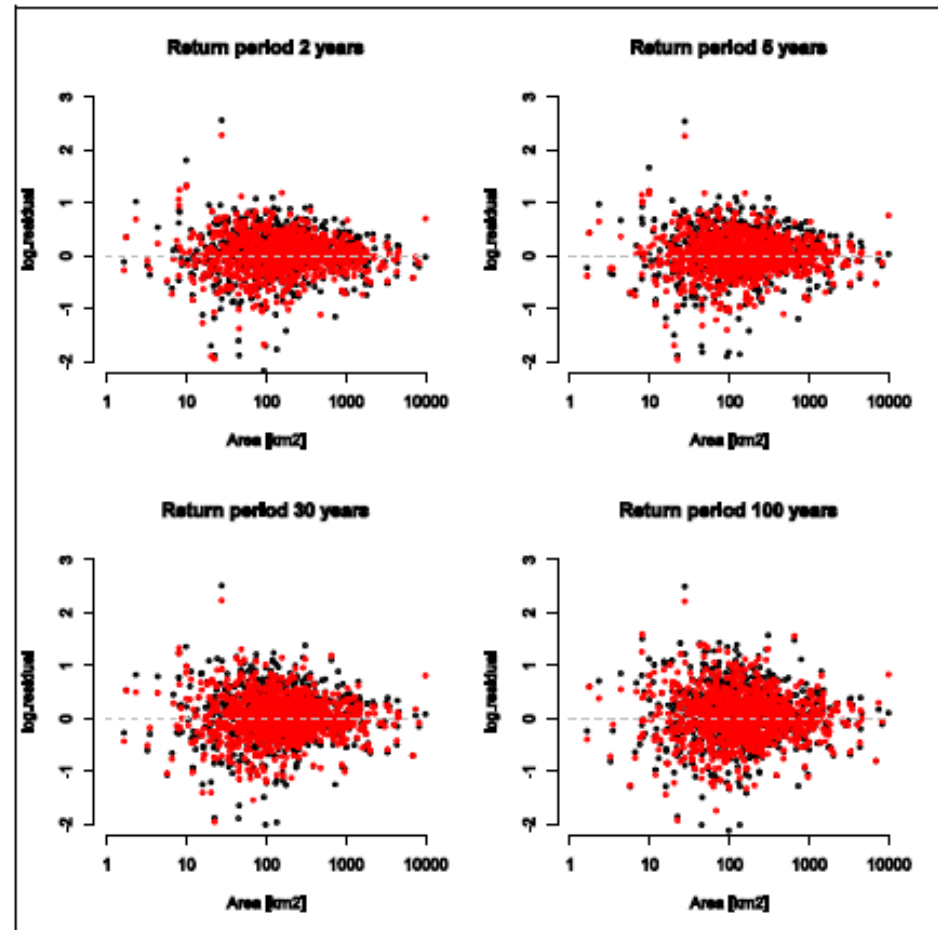
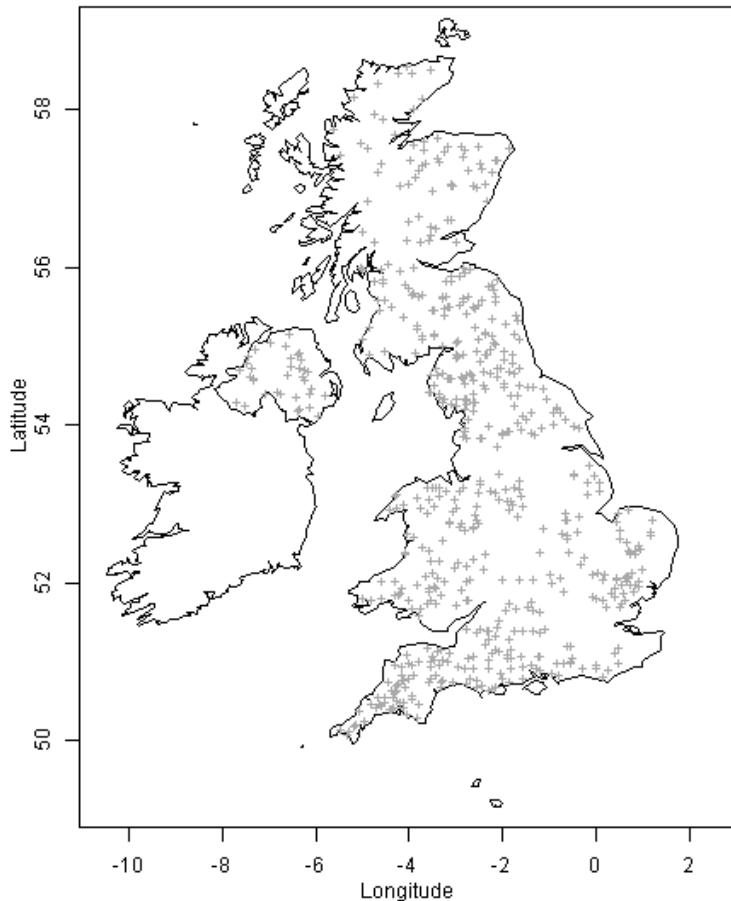
*“You keep saying the FEH methods work reasonably well across the UK, but how come they never work for my catchment?”*

EA-SW hydrologist, 2011

$$e = \ln \hat{Q}_T - \ln Q_T$$

Characterise variability of residuals across many sites

- Estimate  $Q_T$  – no donor
- Estimate  $Q_T$  – use one donor



$$e = \ln \hat{Q}_T - \ln Q_T$$

$$RMSE \text{ of } e = \sqrt{\frac{1}{m} \sum_{i=1}^m (\ln \hat{Q}_T - \ln Q_T)^2}$$

$$fse = \exp \left[ \sqrt{\frac{1}{m} \sum_{i=1}^m (\ln \hat{Q}_T - \ln Q_T)^2 - \frac{1}{m} \sum_{i=1}^m \text{Var}\{\ln Q_T\}} \right]$$

| Return period | fse (regression only) | fse (regression + donor) |
|---------------|-----------------------|--------------------------|
| 2             | 1.47                  | 1.42                     |
| 5             | 1.48                  | 1.43                     |
| 30            | 1.52                  | 1.47                     |
| 100           | 1.54                  | 1.50                     |

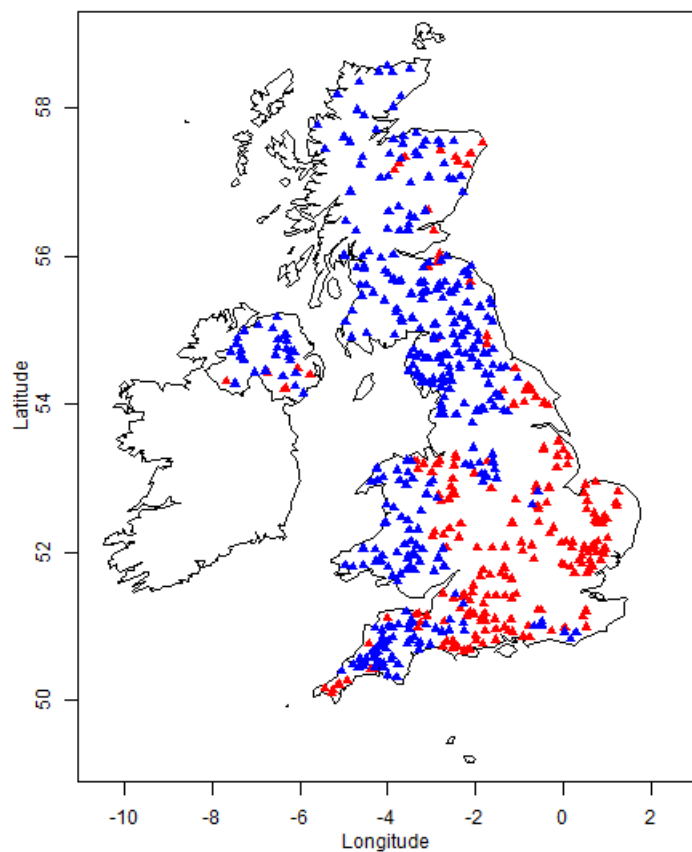
| Return period | fse (regression only) | fse (regression + donor) |
|---------------|-----------------------|--------------------------|
| 2             | 1.47                  | 1.42                     |
| 5             | 1.48                  | 1.43                     |
| 30            | 1.52                  | 1.47                     |
| 100           | 1.54                  | 1.50                     |

Use FEH to get a design flood:  $Q_{100} = 10.0 \text{ m}^3/\text{s}$

Assume  $Q_{100}$  is log-normal distributed, then:

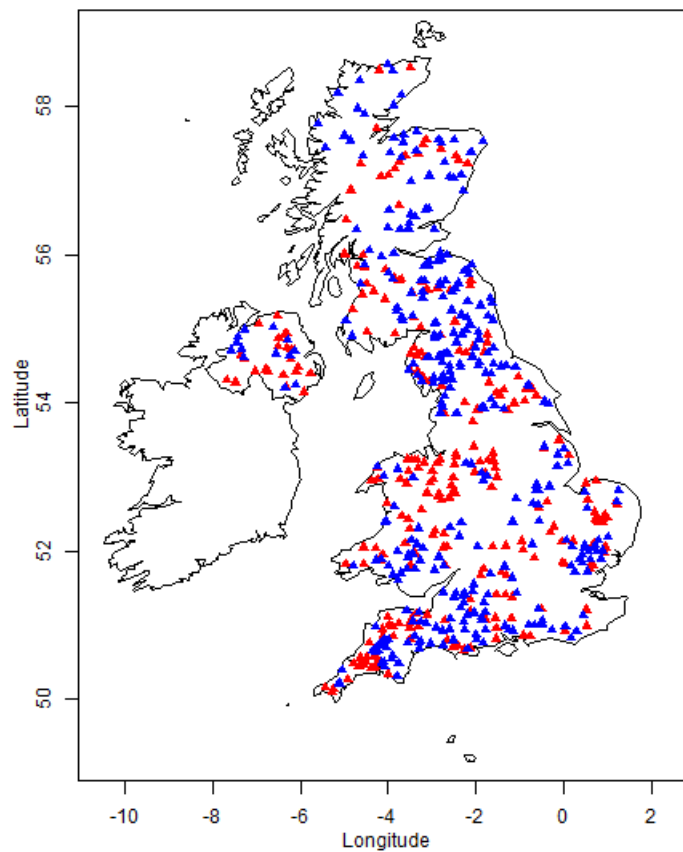
68% confidence interval:  $[10/1.50 ; 10 \cdot 1.50] = [6.7 ; 15.0] \text{ m}^3/\text{s}$

95% confidence interval:  $[10/1.50^2 ; 10 \cdot 1.50^2] = [4.4 ; 22.5] \text{ m}^3/\text{s}$



### Regression model using

- AREA



### Regression model using

- AREA
- SAAR
- FARL
- BFIHOST

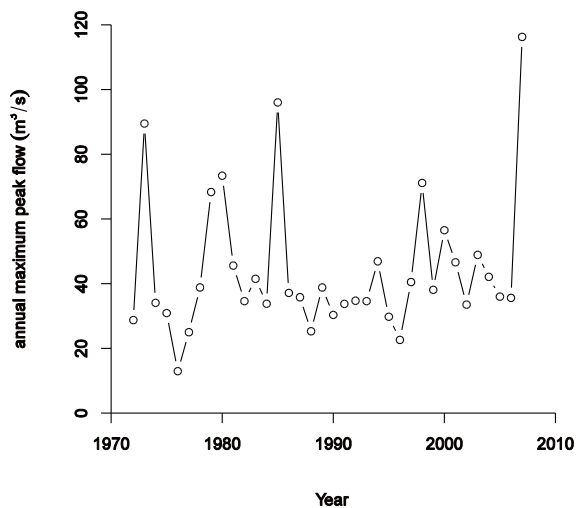
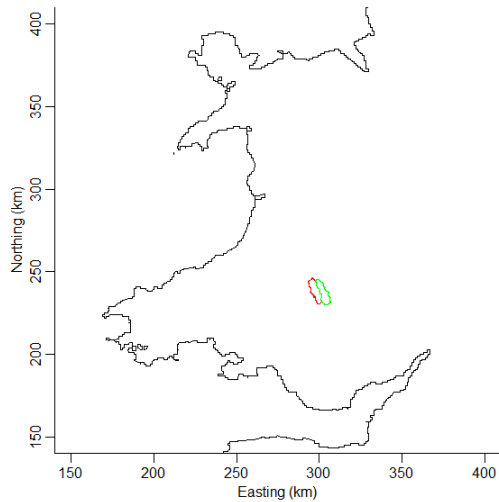
## Estimating uncertainty of QMED for a range of scenarios

| Data availability        | fse formula                        |          |
|--------------------------|------------------------------------|----------|
| Ungauged site            | $fse = \exp(\sqrt{0.1286}) = 1.43$ | Ungauged |
| Ungauged + 1 donor       | $fse^{\sqrt{1-a^2}}$               |          |
| Ungauged + many donors   | $fse^{\sqrt{1-b^T \Omega^{-1} b}}$ |          |
| Gauged (only just) + CD  | $fse^{s_x(s_x^2+0.1286)^{-0.5}}$   | Gauged   |
| Gauged                   | $\exp(2\beta/\sqrt{n})$            |          |
| Gauged + historical data | ???                                |          |

$$a = 0.4598 \exp(-0.020 d_{sg}) + (1 - 0.4598) \exp(-0.4785 d_{sg})$$

$$s_x = 2\beta/\sqrt{n}$$





| Catchment descriptor    | Subject site<br>56013 | Donor site<br>56003 |
|-------------------------|-----------------------|---------------------|
| Easting (cent) [m]      | 297622                | 302454              |
| Northing (cent) [m]     | 238444                | 237136              |
| AREA [km <sup>2</sup> ] | 63.27                 | 62.5                |
| SAAR [mm]               | 1299                  | 1171                |
| FARL [-]                | 1                     | 0.999               |
| BFIHOST [-]             | 0.494                 | 0.528               |

| Method                                        | QMED (m <sup>3</sup> /s) | fse  |
|-----------------------------------------------|--------------------------|------|
| Gauged (n = 36)                               | 36.6                     | 1.08 |
| Regression only                               | 31.6                     | 1.43 |
| Regression + donor transfer                   | 31.3                     | 1.37 |
| Sparsely gauged case (n=5 years) + regression | 39.4                     | 1.10 |
| Sparsely gauged case (n=5) without regression | 42.1                     | 1.20 |

## Conclusions

- FEH is very helpful where no data are available
- Uncertainty of design floods is very high
- Combine FEH with local data can constrain uncertainty
- Measures of uncertainty (fse) available for simple cases
- Combine FEH with local data should be best practise?