Improving statistical models for flood risk assessment

Ross Towe[1,2], Jonathan Tawn[1], Rob Lamb[3], Chris Sherlock[1], Ye Liu[4]

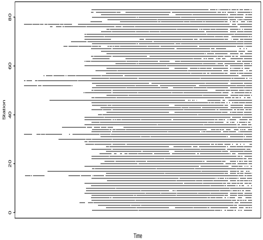
1. Lancaster University 2. JBA Consulting 3. JBA Trust 4. JBA Risk Management

Current research

- A 2-year project between JBA Consulting and Lancaster University
- Aim to improve the spatial and temporal predictions of large and local scale floods
- Use the conditional extreme value model to account for the spatial and temporal dependence of extreme river flows (Keef et al., 2013)
- Record length and amount of missing data varies

Innovate UK

Technology Strategy Board



Recap of the conditional extreme value model

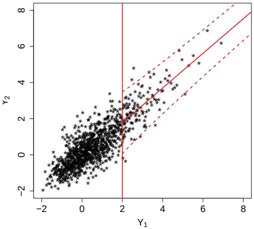
Heffernan and Tawn (2004)

- Data are on common Laplace margins
- X is the conditioning variable
- **Y** is the response of interest at d sites

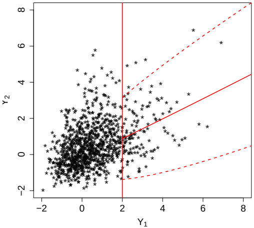
$$Y_i = \alpha_i X + X^{\beta_i} Z_i, \text{for } X > v$$

- α and β are the two dependence parameters of the model
- The vector $\mathbf{Z} = (Z_1, \ldots, Z_m)$ are the residuals of the model
- The empirical distribution of **Z** is used to generate events

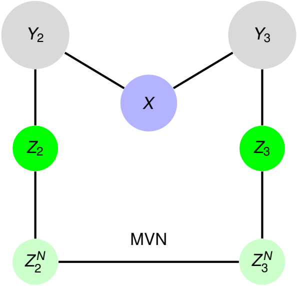
α=0.95 β=-0.26



α=0.60 β=0.40

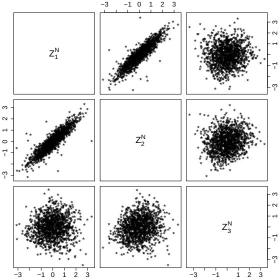


Approach to handle the residual model



Model the distribution of **Z** by,

- Kernel marginal distribution
- Gaussian copula ($\mathbf{Z}^N$)



Testing:

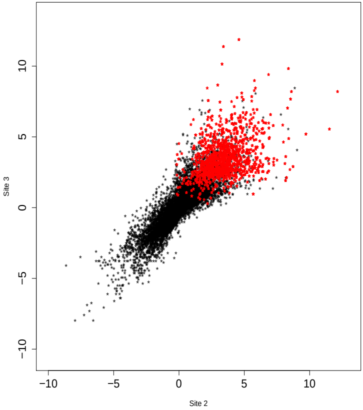
- Can test dependence assumptions by calculating the Mahalanobis distance (Bortot et al., 2000)
- Assumptions hold for observed rainfall and river flow data sets

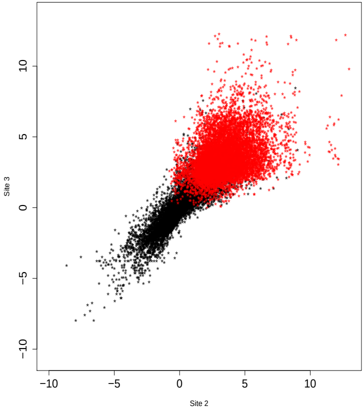
Benefits of the new method

- Three sites with river flow measurements on Laplace margins
- A 100 year event is observed at site 1, we want to know about the joint behaviour of the flows at sites 2 and 3

Benefits of the new method

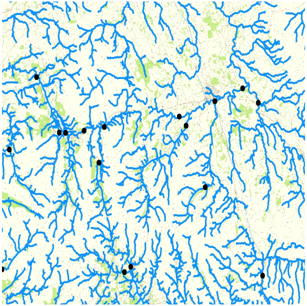
- Three sites with river flow measurements on Laplace margins
- A 100 year event is observed at site 1, we want to know about the joint behaviour of the flows at sites 2 and 3





Further considerations

- Further simplification of the residual model
- Investigation into the definition of an event - can it be motivated by the behaviour of the physical process?
- Improve predictions for ungauged parts of the river network



References

Bortot, P., S. Coles, and J. Tawn (2000). The multivariate gaussian tail model: an application to oceanographic data. *Journal of the Royal Statistical Society: Series C (Applied Statistics). 49*(1), 31–49.

Heffernan, J. and J. Tawn (2004). A conditional approach for multivariate extreme values (with discussion). *Journal of the Royal Statistical Society: Series B (Statistical Methodology) 66*(3), 497–546.

Keef, C., J. Tawn, and R. Lamb (2013). Estimating the probability of widespread flood events. *Environmetrics 24*(1), 13–21.