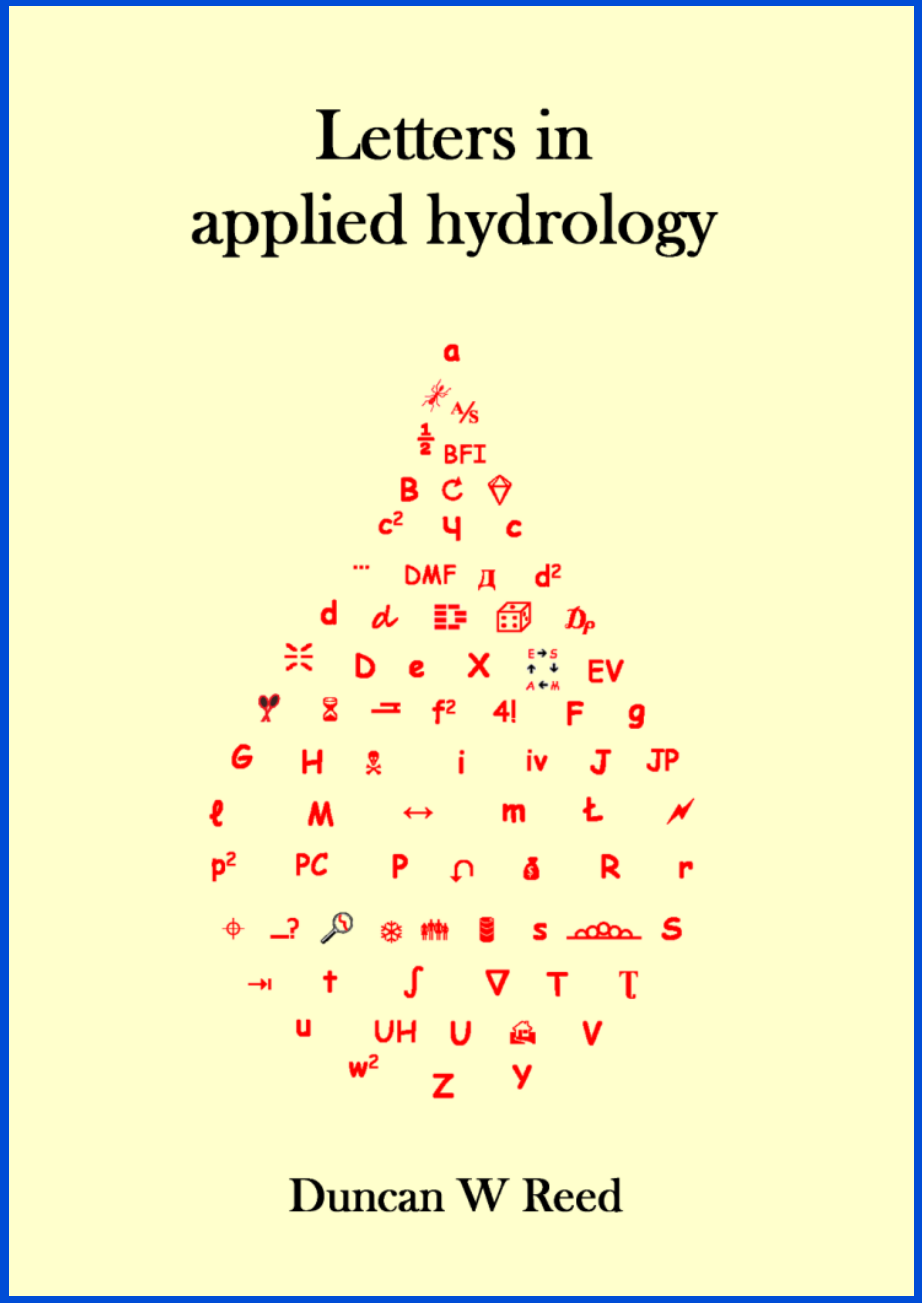


Health warning!

The book is full of puns
(jeux de mots)

It all depends
~~what you~~
~~mean~~
~~median~~

DWR consult

It all depends

- Correlation is an association between variables.
- "Dependence" has a less rigid meaning: helpful when thinking more widely about relationships.
- Inter-site dependence is the tendency for behaviour at one site to be linked to behaviour at another.
- I want to show you that studying dependence in extremes can be interesting & relevant!

DWR consult

Some problems that involve dependence

1. Effectiveness of the conjunctive use of water resources

Integrated water management

http://www.ciwem.org/policy-and-international/current-topics/water-management/integrated-water-management.aspx

- "Water transfer between river basins can … result in ecological stress and change. However different river systems can have different hydrological regimes."
- "The Thames is largely groundwater-driven whereas the larger and less developed Severn obtains most of its runoff from the mountains of Wales."
- "The risk of a drought occurring in both at the same time is low."

Some problems that involve dependence

1. Effectiveness of the conjunctive use of water resources

2. Clustering of events in time, especially spatially extensive extreme events

DWR consult

Temporal dependence in extremes

Date	Country	Insured loss, USDm, at 2011 prices
July–Nov 2011	Thailand	12 000
Aug 2002	Germany & Czech Republic	2 900
Jun 2007	United Kingdom	2 700
Aug 2005	Switzerland	2 400
Jan 2011	Australia	2 300
Jul–Aug 1997	Poland & Czech Republic	2 200
Jul 2007	United Kingdom	2 000
Dec 2010	Australia	2 100
Apr 1993	United States	1 900
Jun–Aug 1993	United States	1 600

http://media.swissre.com/documents/Flood.pdf

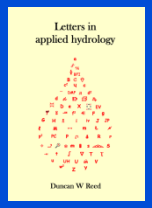
Top 10 insured fresh-water floods in history

Some problems that involve dependence

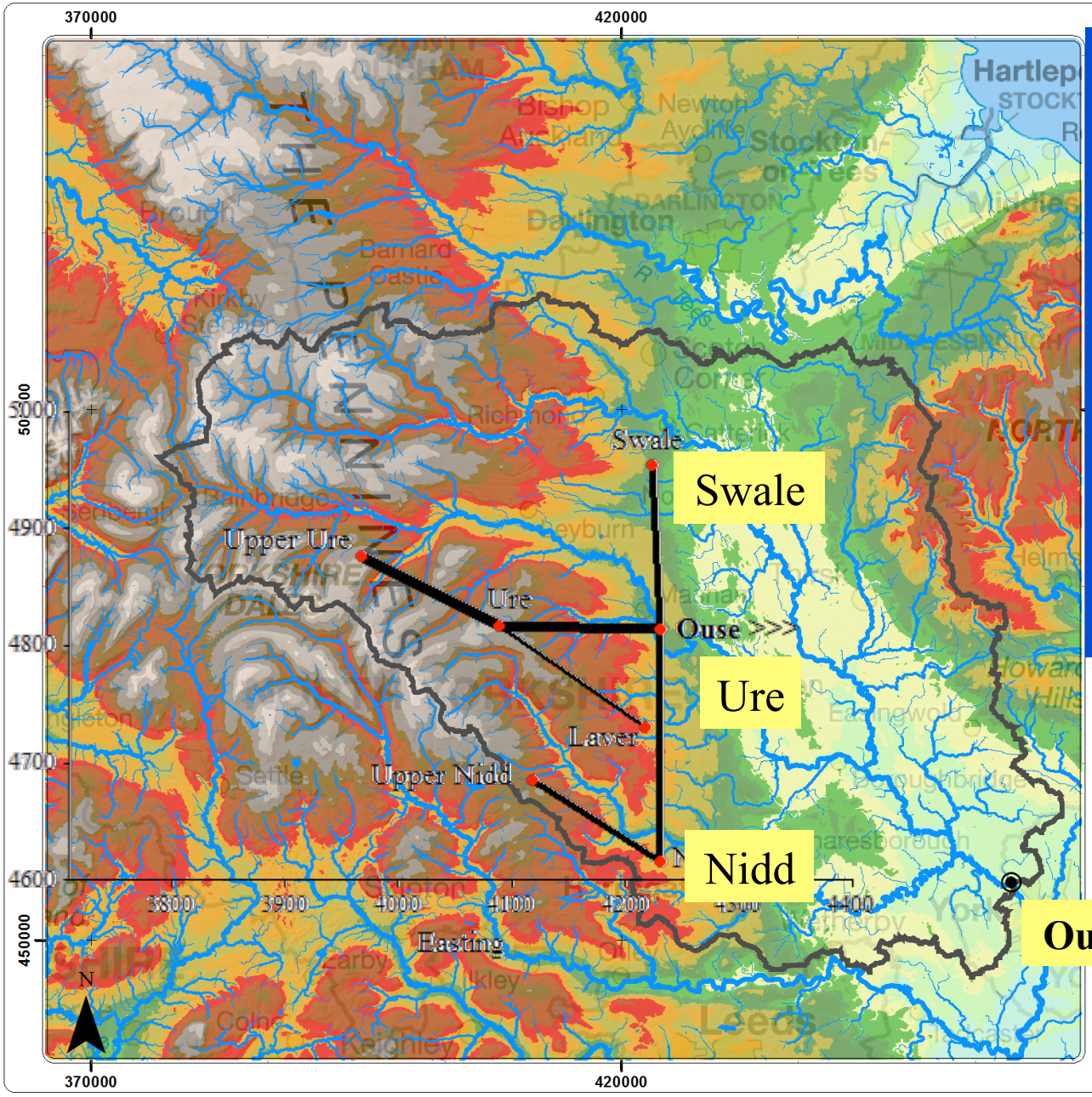
1. Effectiveness of the conjunctive use of water resources

2. Clustering of events in time, especially spatially extensive extreme events

3. Understanding the structure of dependence in floods within/between river basins



Topic d = dependence



Spatial structure of dependence in Yorkshire Ouse

Symbols plotted at catchment centroids

Swale

Ure

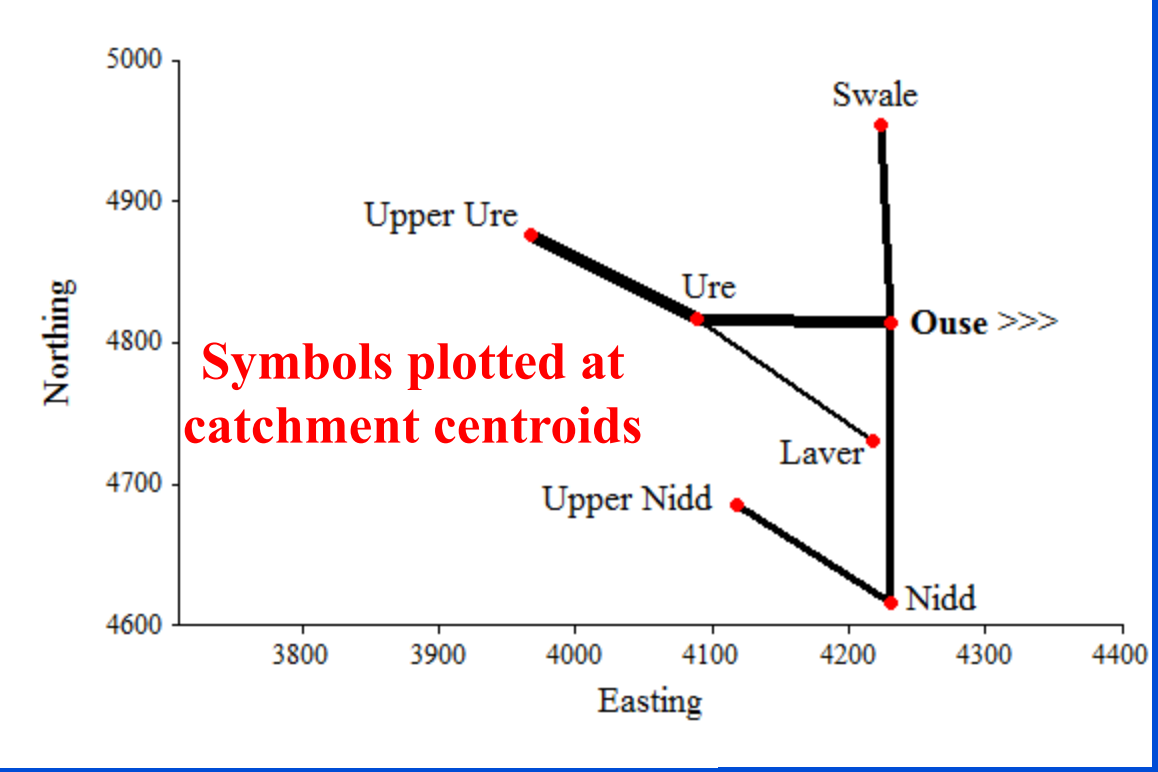
Nidd

Ouse at York

UK National River Flow Archive
http://www.ceh.ac.uk/data/nrfa

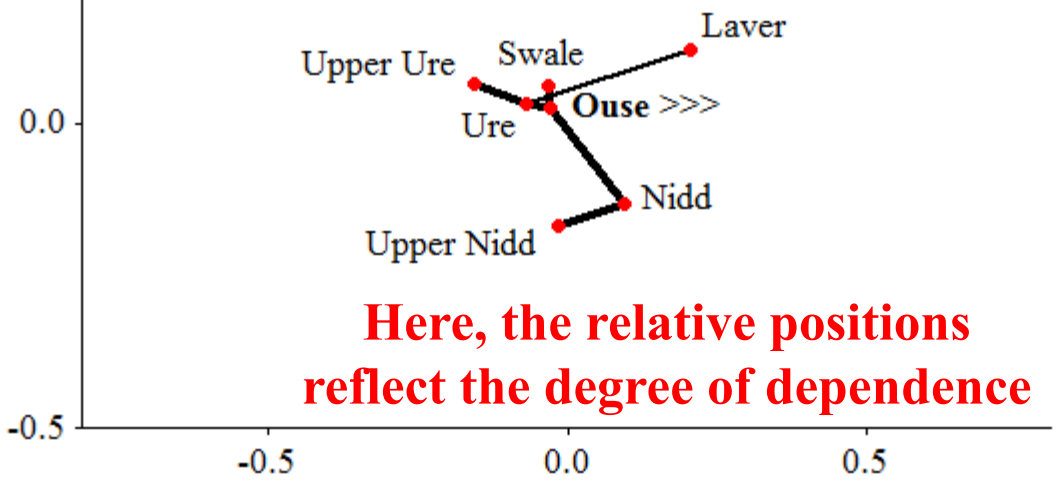
Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

http://www.ceh.ac.uk/data/nrfa/data/spatialdata.html?27009



Spatial structure of dependence in Yorkshire Ouse

Technique used is multi-dimensional scaling



Here, the relative positions reflect the degree of dependence

DWR consult

Annual maximum (AM) analysis

- The AM series is natural and convenient. It has a frequency statement built-in. There is exactly one annual maximum per year!

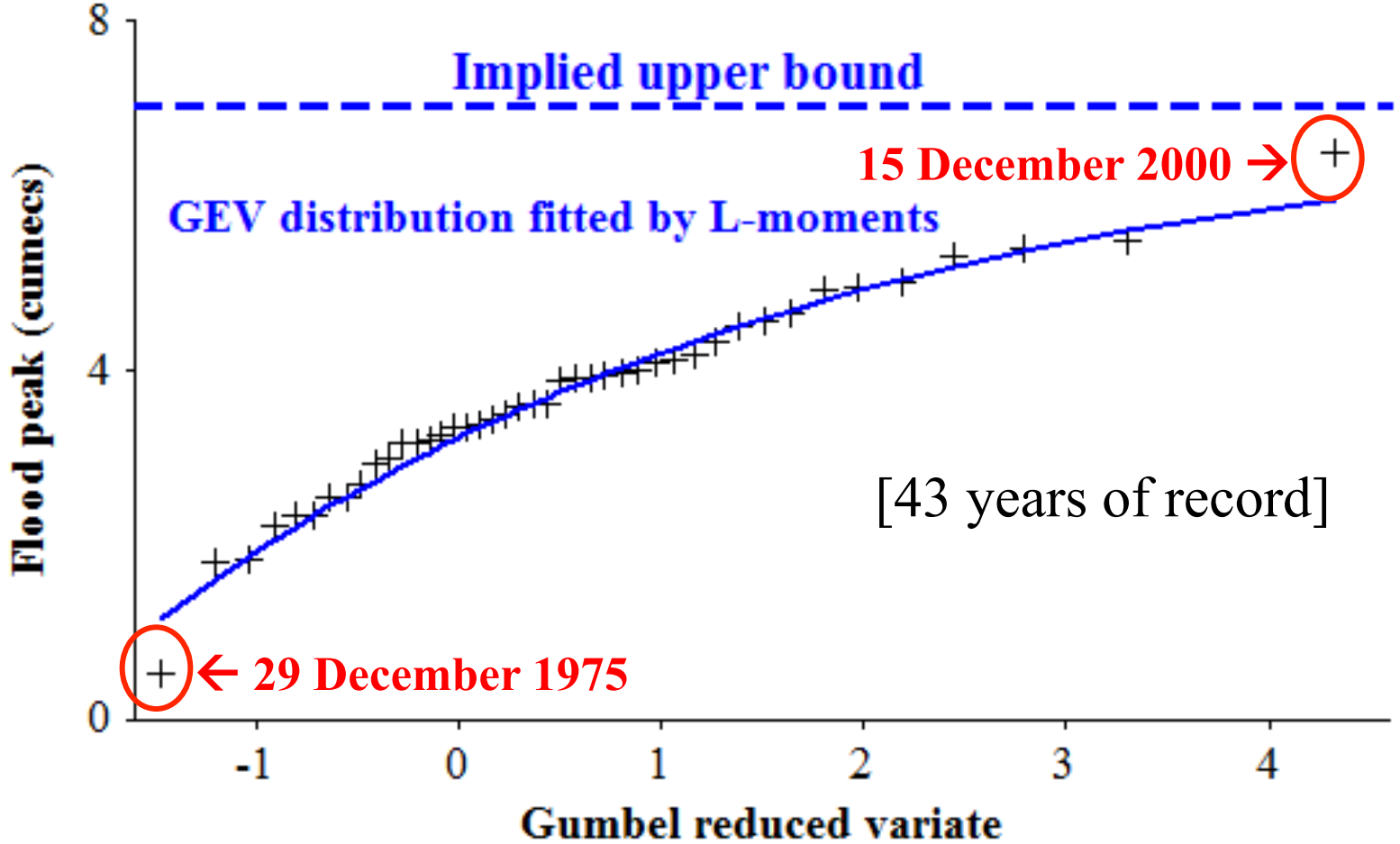
- But why do we analyse AM series rather than 2-year or 5-year maxima?

- Because we are taught to "use all the data" and do not want to omit an important 2nd ranking event.

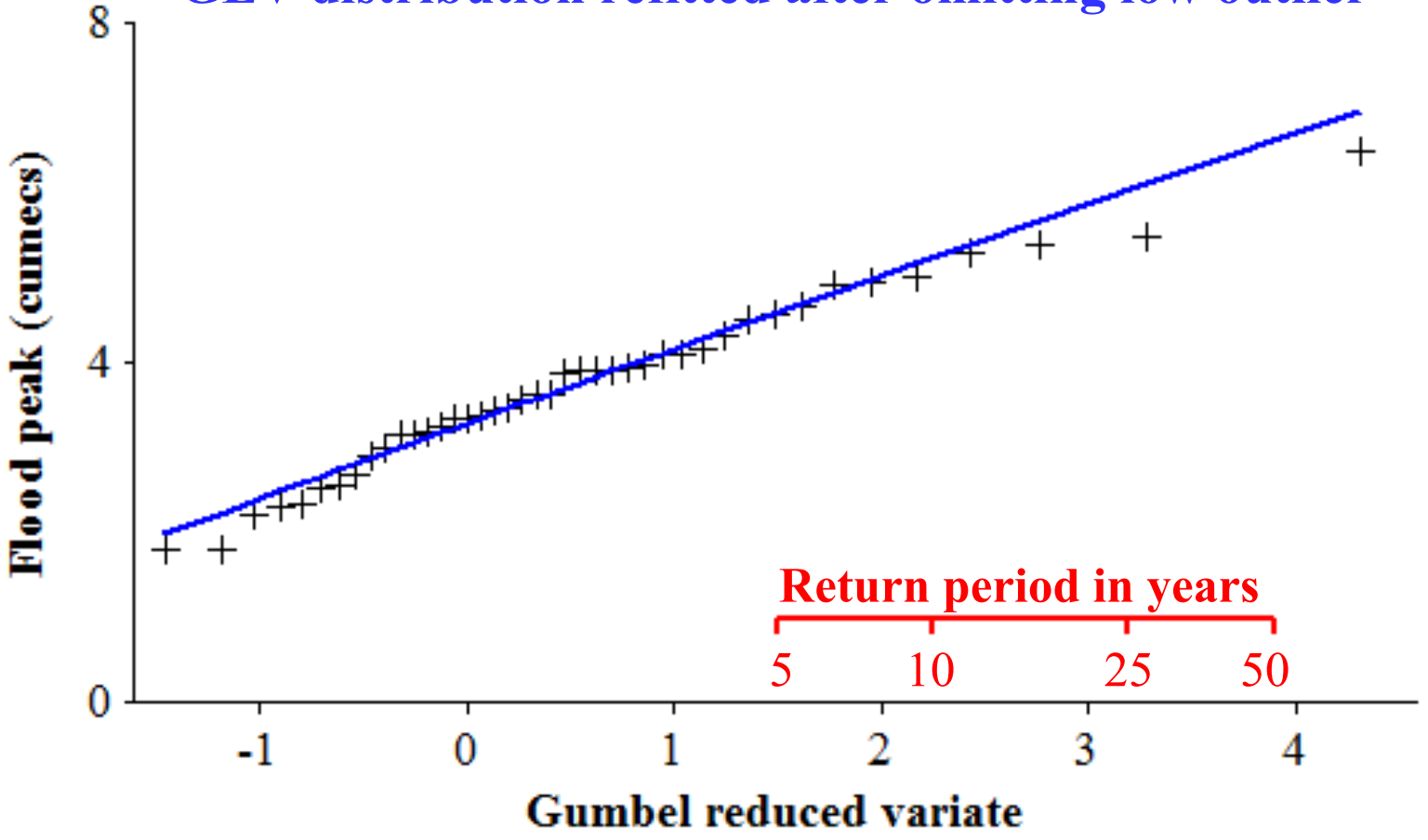
- The penalty is that we sometimes include non-events.

DWR consult

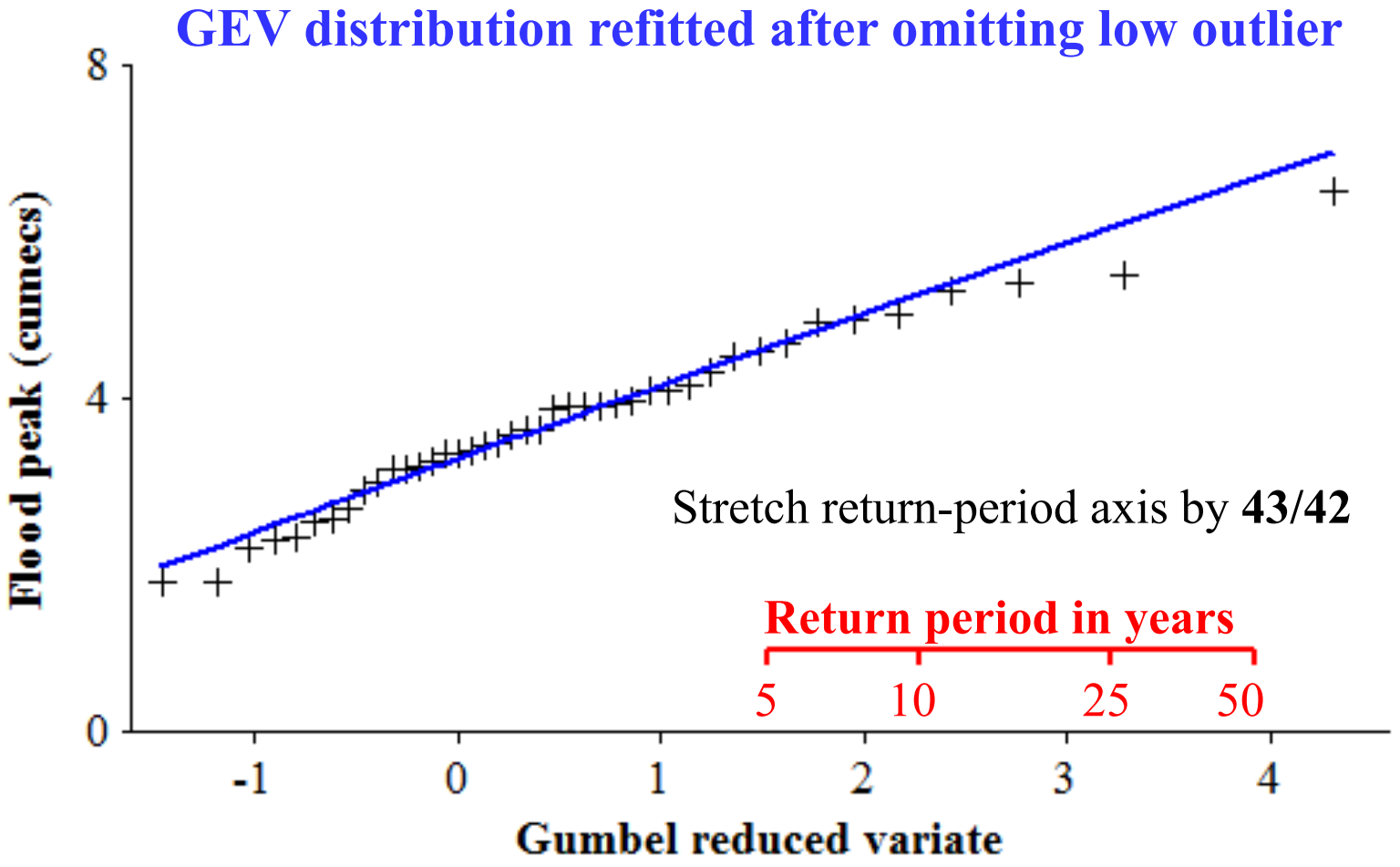
Flood frequency analysis, Coln at Bibury



GEV distribution refitted after omitting low outlier



Topic T = tweak



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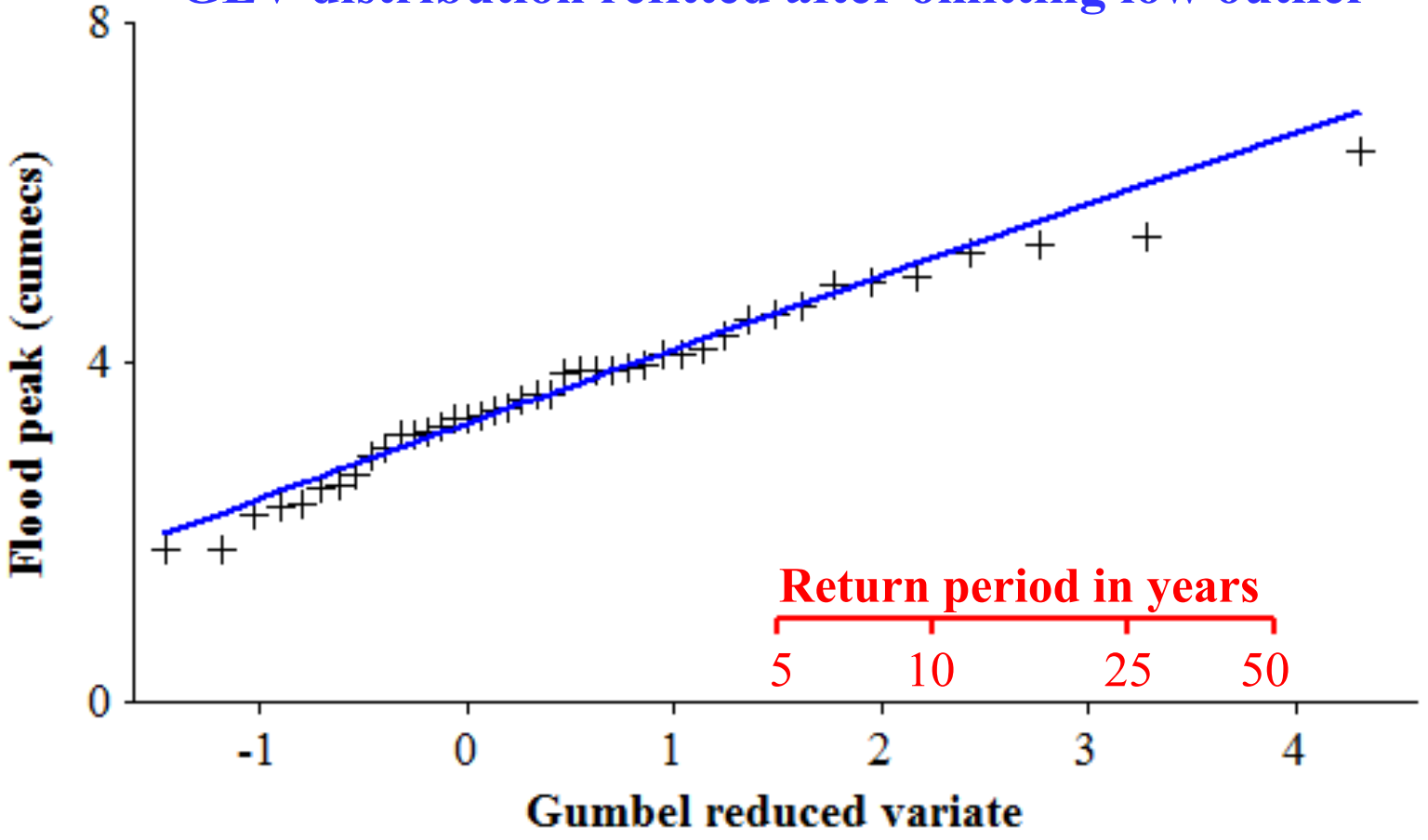

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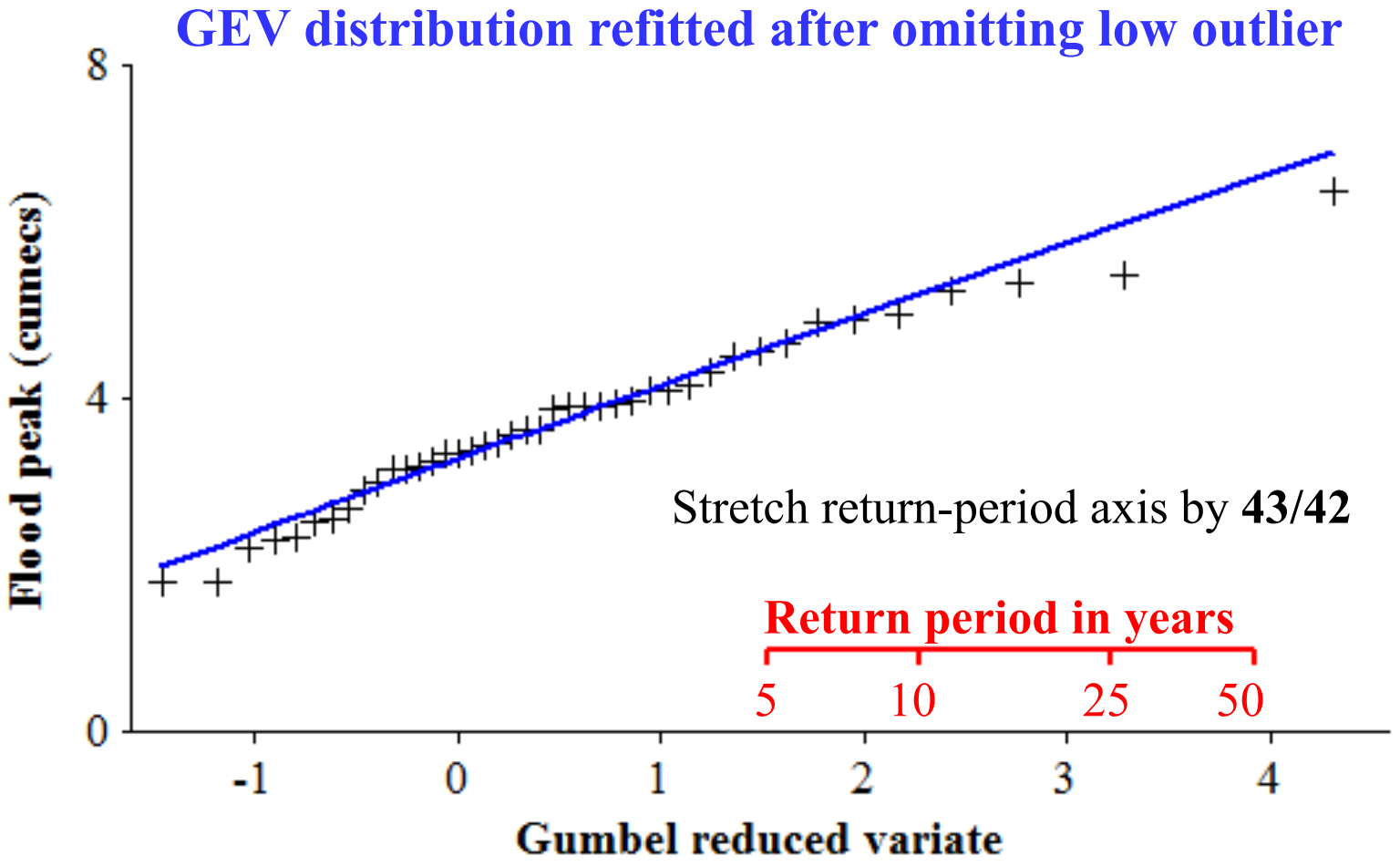
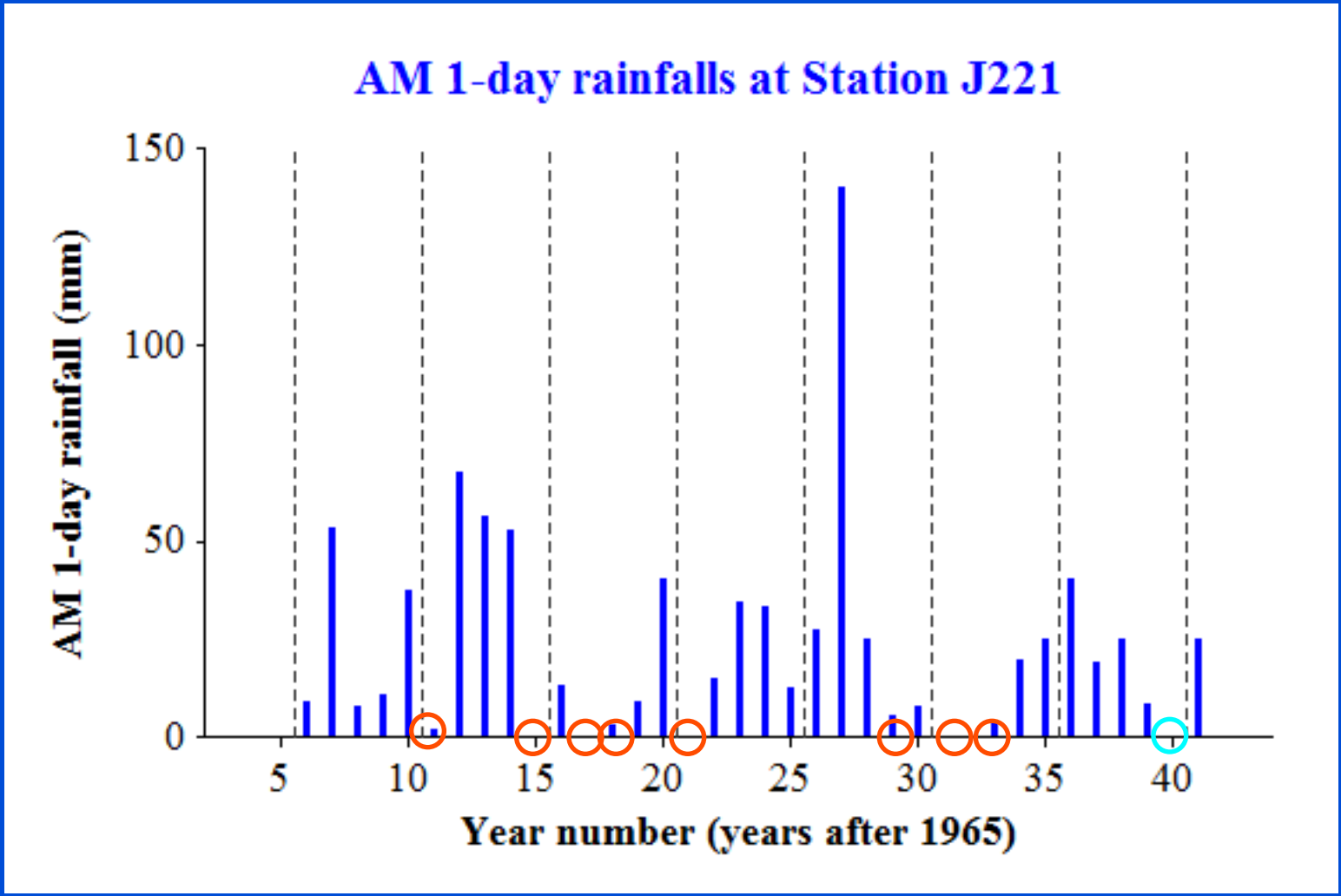
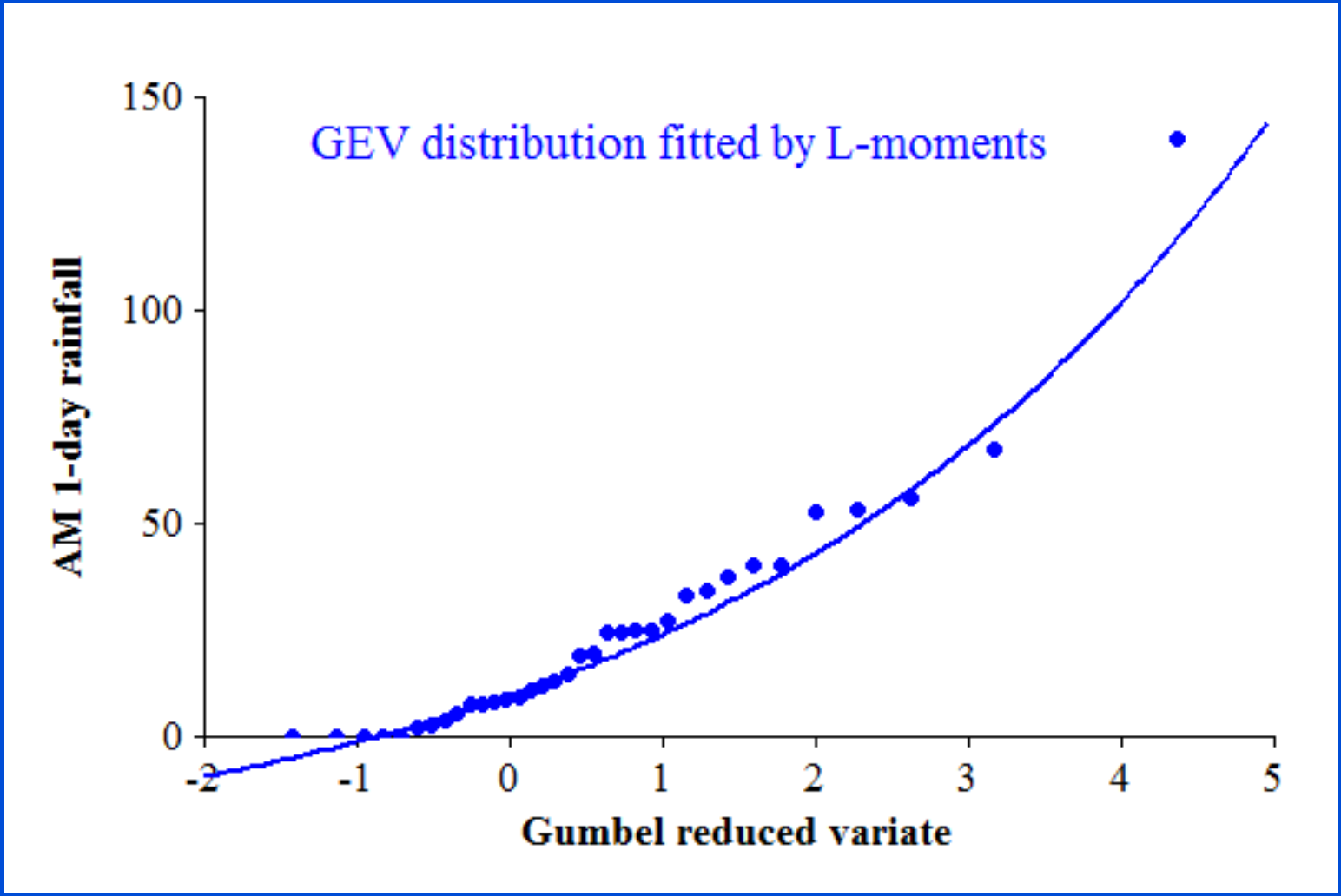


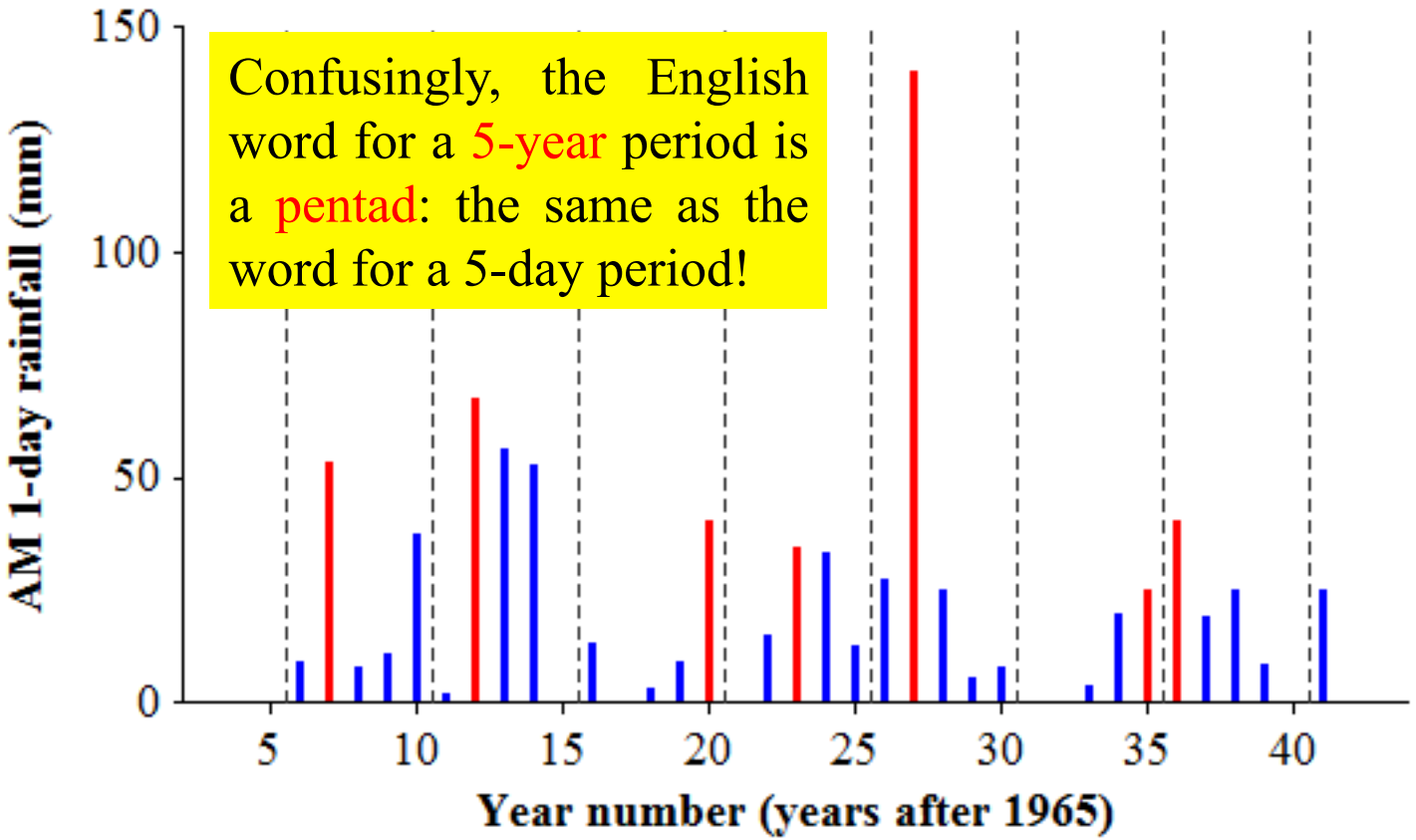
AM rainfalls in an arid zone



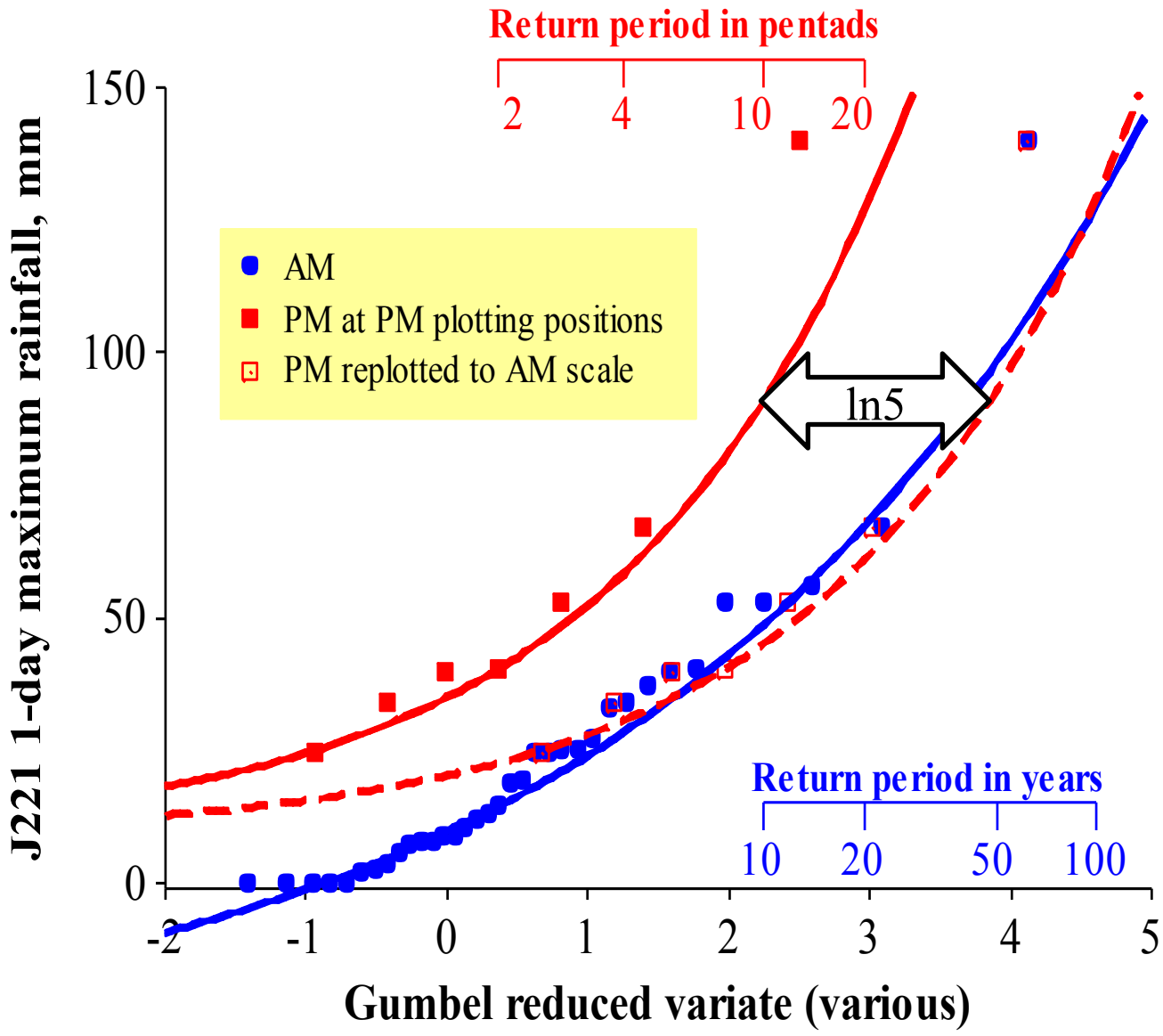
Rainfall frequency analysis (AM series)



PM rainfalls in an arid zone



AM analysis v PM analysis



Inter-site dependence in extremes

- The estimation of rare extremes often calls for pooling data from catchments judged similar to the subject cat^{t}.
- There is dependence in AM values across the network.
- If the network is dense, the dependence will be strong. More typically, the network is sparse and dependence is mild.
- A degree of dependence is good news! Were there no dependence in the extreme values being pooled, it is likely that the catchments are insufficiently similar for their behaviour to be relevant to the subject site!

DWR consult

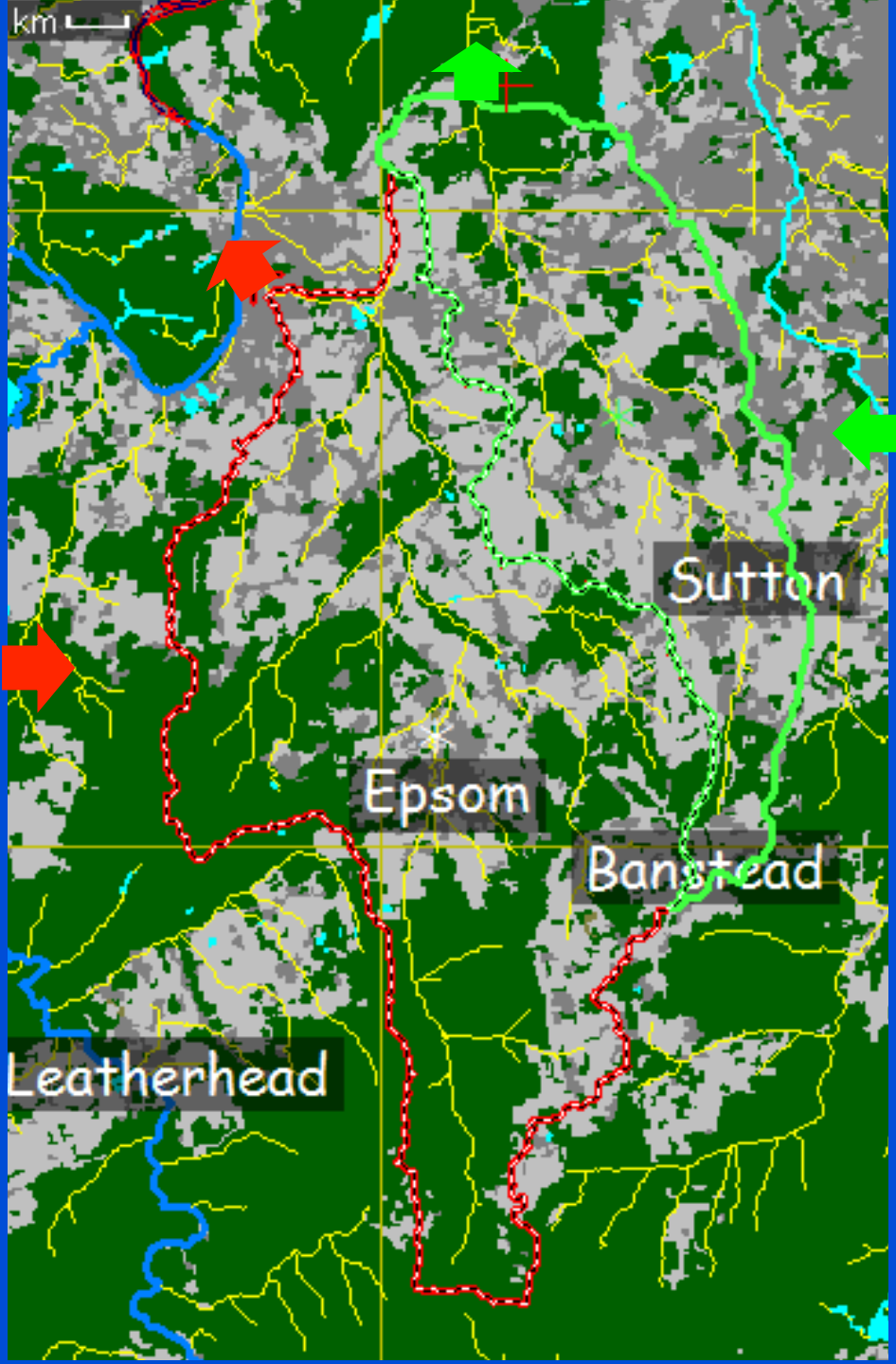
Treatment of inter-site dependence

- It gets complicated when pooling data from N sites.
- The idea of an effective number of independent sites N_e can sometimes be useful. See reference.
- It gets messy if there are gaps in the AM series. One approach is to analyse AMs from the N nearest sites with data that year.
- It is especially tricky in arid zones where the true AM can be very small … or even zero!

Reference: Dales, M.Y. and Reed, D.W. 1989. Regional flood and storm hazard assessment. Report 102, Institute of Hydrology, Wallingford, UK, 159pp. See http://www.ceh.ac.uk/products/publications/Regionalfloodandstormhazardassessment.html

It only takes two

Studying pairwise dependence is a pragmatic and powerful approach



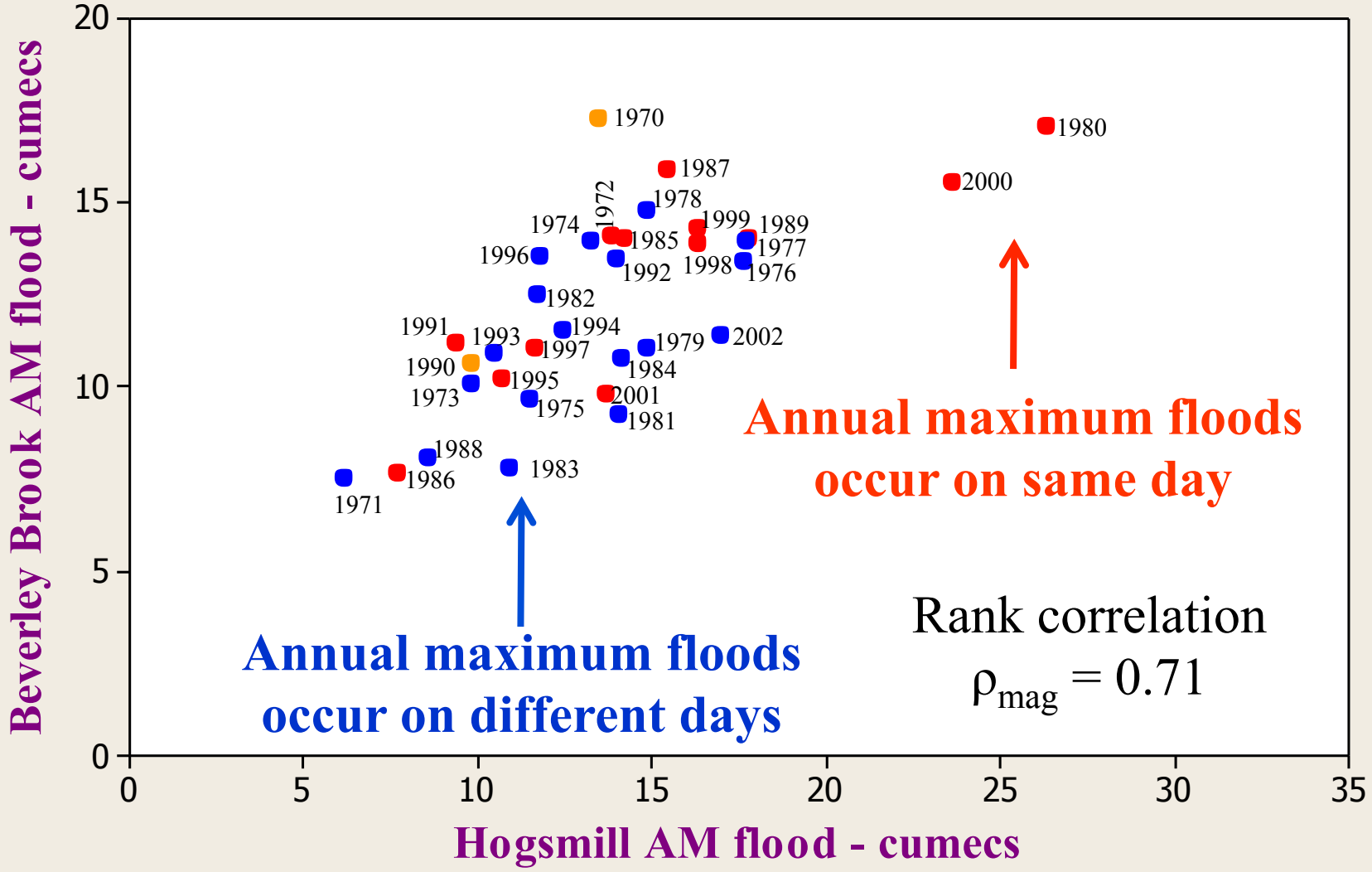
Hogsmill

Beverley Brook

2 urbanised catchments in SW London

DWR consult

Pairwise dependence in AMs



Pairwise analysis is powerful

- Substantial river flood series are held for about a 1000 UK sites.
- That's 1000 x 999 /2 or almost half a million pairs of sites.
- So there is plenty of information about inter-site dependence ... if we choose to study it!

Letters in applied hydrology

Duncan W Reed

a	Analogy
	Antecedent wetness
A/S	Applied statistics
½	Areal reduction factor
BFI	Baseflow index
B	Blending
	Circular diagrams
	Clarity
c^2	Climate change
Ч	Confluence
c	Conservatism
...	Continuous simulation
DMF	Daily mean flow
Д	Dam safety
d^2	Data dredging
d	Dependence
∂	Design
	Development
	Dicey problems
	Society
	Storage
s	Storm
	SuDS
S	Surrogate
→|	Tabony tables
t	Testing a model
∫	Transformation
▽	Triangles
T	Trivia
T	Tweaks
u	Uncertainty
UH	Unit hydrograph
U	Upper limit
	Urbanisation
V	Voronoi
w^2	Weasel words
y	Why we model
Z	Zugzwang

Search on ten characters DWRconsult