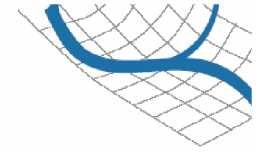


## An Overview of Extreme Rainfall Events from the British Rainfall Archive 1866-1968.

Dr. Harvey J. E. Rodda, Dr. Rose G. Wood and Dr. Nina  
MacDougall

Hydro-GIS Ltd.  
10 Coles Lane  
Chalgrove  
Oxfordshire  
OX44 7SY  
UK

*harvey.rodga@hydro-gis.co.uk*



## Acknowledgement

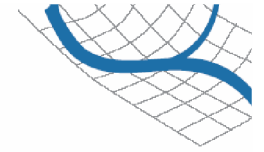
This presentation covers part of the work undertaken in the project:

*Quantifying the Flood Risk of Extreme Events using Density Forecasts Based on a New Digital Archive and Weather Ensemble Predictions*

Funded by NERC as part of the FREE (Flood Risk from Extreme Events) research programme.

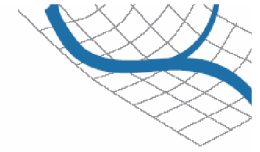
A joint Hydro-GIS / Oxford University study with ECMWF and Met Office as contributors

Project duration: January 2007 – December 2008



## Topics Covered

- British Rainfall
- Digital Archive
- Extreme Rainfall Observations
- Spatial Analysis and Classification
- Uses and Applications



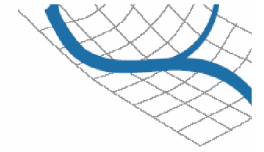
## British Rainfall

Started by George J. Symons in 1860 with observations from 168 stations in the British Isles.

Was under the title “Symons British Rainfall” until his death in 1900

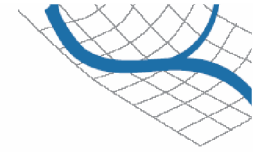
Continued until 1991 as a Met Office publication, with observations from approximately 6000 rain gauges.





## British Rainfall



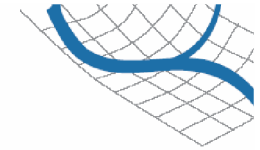


## British Rainfall

Gave a listing of various rainfall observations:

- annual totals
- monthly totals
- days on which rain fell
- maximum falls in 24 hours
- extreme falls in short periods
- droughts
- averages over number of years

Also included special sections on methods of rainfall measurement, notable events, rules for observers, the staff of observers, evaporation and rainfall duration.



## British Rainfall Extreme Rainfalls

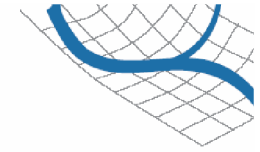
The chapter entitled “Heavy Rainfalls on Rainfall Days” or “Heavy Falls in 24 Hours” provided detailed information on extreme rainfall events:

- 24hr observations from 9am-9am
- Listings of all depths over a specified threshold: > 2.5 inches (63.5mm) or >7.5% of annual total 1866-1961; >50mm or >4% of annual total 1962-1968
- Descriptions of the event from observers including a summary of the weather conditions, the characteristics of the rainfall, ensuing floods and damage
- Isohyetal maps
- Photographs

The chapter was included in detail from 1866 -1968

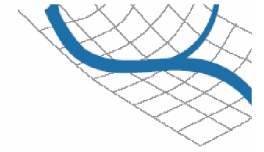
Brief 1-page summaries included in editions from 1985-1991

**This information has been compiled as a digital archive as part of the  
FREE research project**



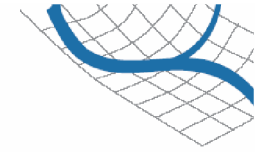
## Table for 24th and 25th August, 1891

| Division | Station                        | Rainfall 24 <sup>th</sup><br>in. | Rainfall 25 <sup>th</sup><br>in. | Total in 48 hrs<br>in. |
|----------|--------------------------------|----------------------------------|----------------------------------|------------------------|
| VIII     | Hawkshead, Eastwaite Lodge     | 2.71                             | 2.46                             | 5.17                   |
| VIII     | Duddon Valley, Seathwaite Vic. | 2.94                             | 2.99                             | 5.93                   |
| VIII     | Monk Coniston Park             | 3.25                             | 2.7                              | 5.95                   |
| VIII     | Skelwith Fold (Ambleside)      | 3.04                             | 2.88                             | 5.92                   |
| IX       | Sedbergh, Brig Flatts          | 3.11                             | 2.18                             | 5.29                   |
| X        | Duddon Valley, Ulpha Vicarage  | 2.58                             | 2.49                             | 5.07                   |
| X        | Seathwaite                     | 6.14                             | 4.10                             | 10.24                  |
| X        | Wyhtburn Vicarage              | 5.28                             | 1.65                             | 6.93                   |
| X        | Borrowdale Vicarage            | 4.41                             | 3.85                             | 8.26                   |
| X        | Buttermere, Hassness           | 4.85                             | 4.31                             | 9.16                   |
| X        | Keswick, Barrow House          | 2.27                             | 3.01                             | 5.28                   |
| X        | Kendal, Natland Park           | 3.61                             | 1.77                             | 5.38                   |
| X        | Dungeon Ghyll                  | 4.25                             | 3.41                             | 7.66                   |
| X        | Ambleside, Nook Cottage        | 2.44                             | 2.68                             | 5.12                   |
| X        | Ambleside, Lesketh Howe        | 2.59                             | 2.78                             | 5.37                   |
| X        | Elterwater                     | 3.07                             | 3.50                             | 6.57                   |
| X        | Grasmere, High Close           | 2.54                             | 3.40                             | 5.94                   |
| X        | Skelwith Bridge                | 2.94                             | 3.05                             | 5.99                   |
| X        | Grasmere, Pavement End         | 3.53                             | 3.43                             | 6.96                   |
| X        | Patterdale Hall                | 2.24                             | 4.15                             | 6.39                   |

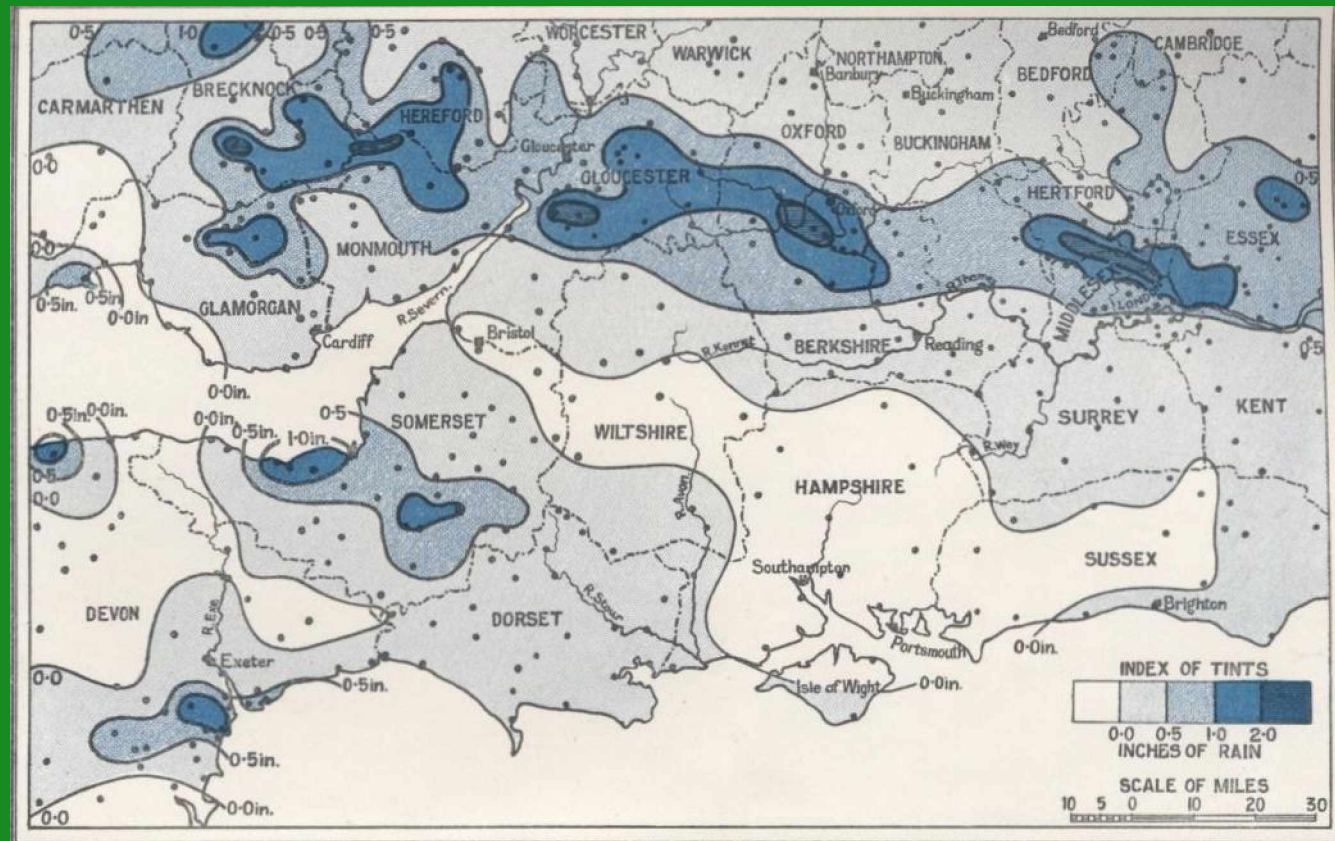


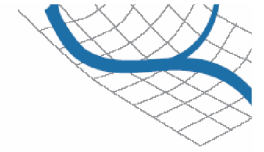
## A sample of text from January 1927

“During the next few days the passage of vigorous secondaries maintained unsettled stormy weather. On the 28th a very deep depression west of Ireland caused widespread gales, which in some districts were of exceptional violence and gave gusts exceeding 100 miles an hour at Dunfanaghy in north-west Ireland, at Tiree to the west of Scotland, at Paisley and at Renfrew. Entries in the table are confined entirely to Dartmoor where the fall exceeded 3 inches on that day.”



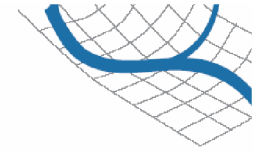
## Isohyetal Map from 22<sup>nd</sup> July 1907





## Flooding in The Rhondda Valley 11<sup>th</sup> November 1929





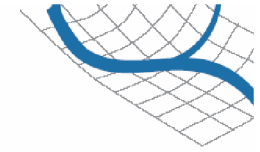
## Quality Control

Every effort was made to ensure the depths entered in British Rainfall were of good quality:

- Correspondence between BR editor and observers
- Unlikely depth observations compared with observations from nearby gauges
- Observations noted when gauges overflowed (“+” included)
- Averages taken to replace spurious values which could not be supported by other evidence

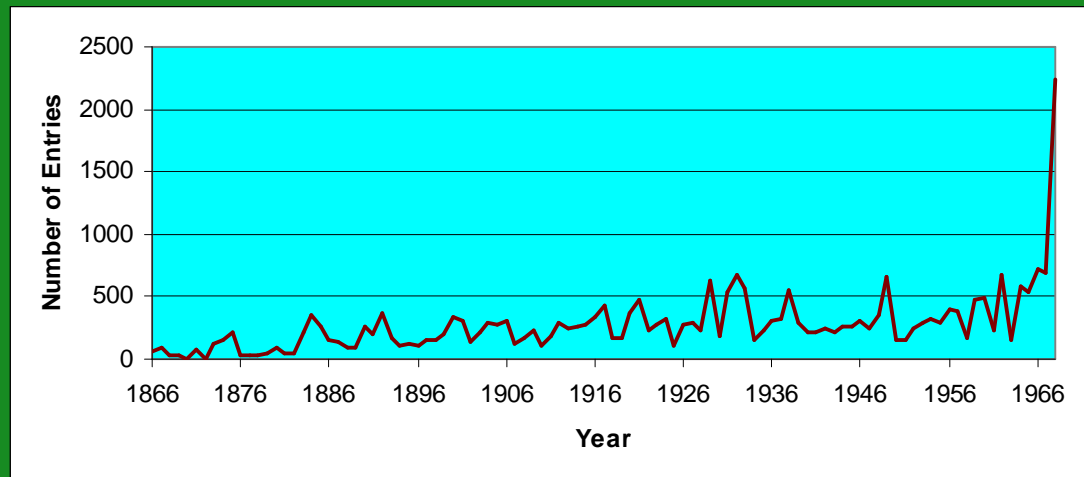
1884

*“Nor does a shadow of suspicion rest upon the record; the gauge is a good one, the observations have always been carefully made, and the above figures are thoroughly supported by the surrounding stations.”*



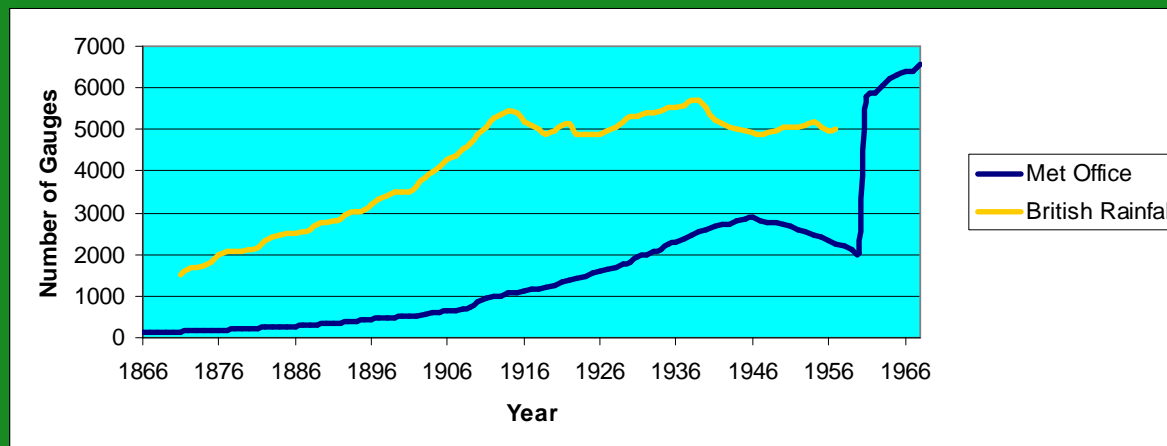
## An Overview of Extreme Rainfall 1866-1968

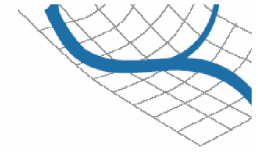
### Numbers of Observations per Year



Minimum 24 (1868, 1878)  
Maximum 2237 (1968)  
Average 280  
Total 28,223

### Numbers of rain gauges per Year



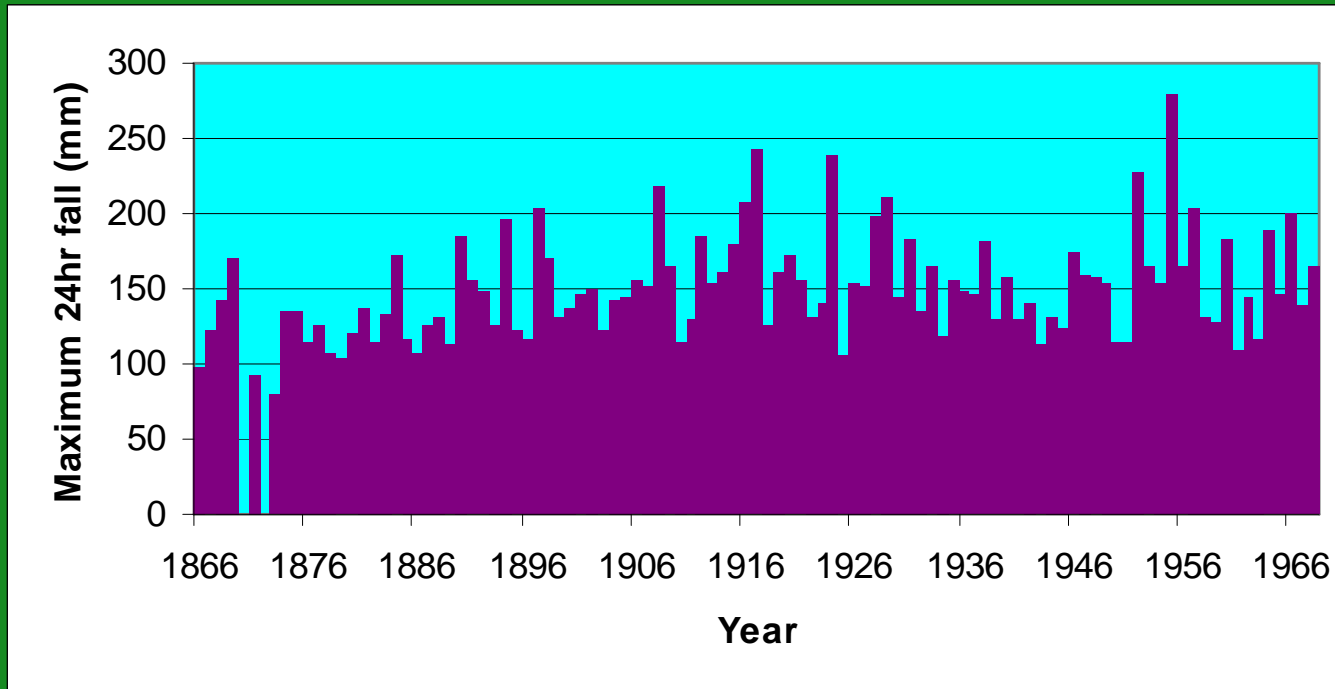


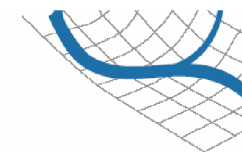
## Maximum Observed 24hr Rainfalls

Maximum 279.4 (1955)

Minimum 91.9 (1871)

Average 149.8



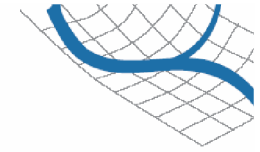


## Maximum Observed 24hr Rainfalls

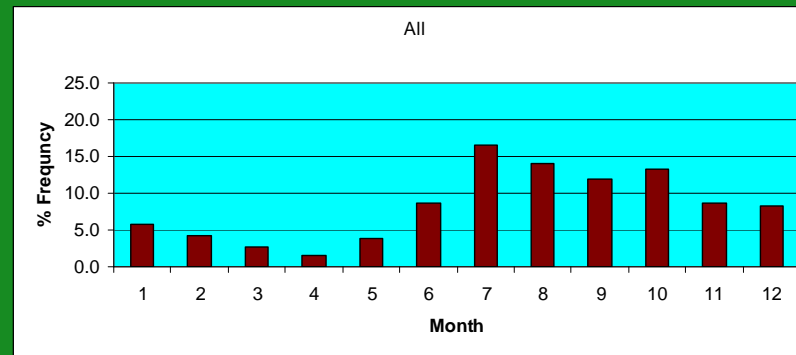
16 Observations over 200mm (128 > 150mm; 1616 > 100mm)

| Date       | Depth (mm) | Depth (in) | Location                          | County (pre 1974) |
|------------|------------|------------|-----------------------------------|-------------------|
| 18/07/1955 | 279.4      | 11.0       | Martinstown (The Chantry)         | Dorset            |
| 28/06/1917 | 242.8      | 9.6        | Bruton (Sexey's School)           | Somerset          |
| 18/07/1955 | 241.3      | 9.5        | Upwey (Friar Waddon)              | Dorset            |
| 18/08/1924 | 238.8      | 9.4        | Cannington (Brymore)              | Somerset          |
| 15/08/1952 | 228.6      | 9.0        | Longstone Barrow                  | Devonshire        |
| 18/07/1955 | 228.6      | 9.0        | Upwey (Higher Well)               | Dorset            |
| 22/11/1908 | 217.9      | 8.6        | Snowdon (Llyn Llydaw Copper Mill) | Caernavonshire    |
| 28/06/1917 | 215.4      | 8.5        | Bruton (King's School)            | Somerset          |
| 28/06/1917 | 213.1      | 8.4        | Aisholt (Timberscombe)            | Somerset          |
| 11/11/1929 | 211.1      | 8.3        | Rhondda (LluestWen Res.)          | Glamorgan         |
| 18/07/1955 | 211.1      | 8.3        | Upwey (Elwell)                    | Dorset            |
| 11/10/1916 | 208.3      | 8.2        | Loch Quoich (Kinlochquoich)       | Inverness-shire   |
| 12/11/1897 | 204.0      | 8.0        | Seathwaite                        | Cumberland        |
| 08/06/1957 | 203.2      | 8.0        | Camelford (Roughtor View)         | Cornwall          |
| 28/06/1917 | 200.7      | 7.9        | Bruton (Pitcombe Vicarage)        | Somerset          |
| 18/07/1955 | 200.7      | 7.9        | Wynford House                     | Dorset            |

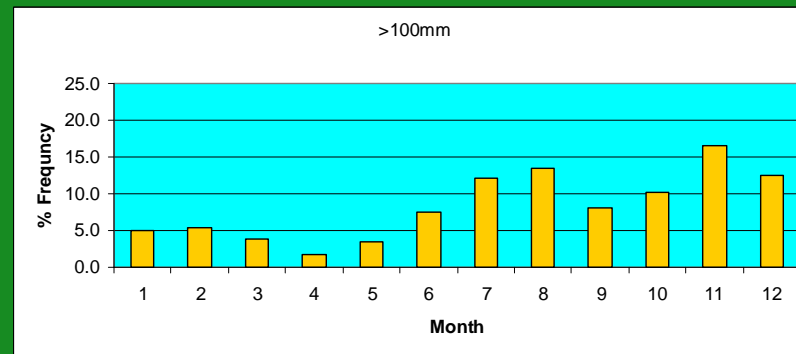
9 observations from just 2 events – July 1955 and June 1917



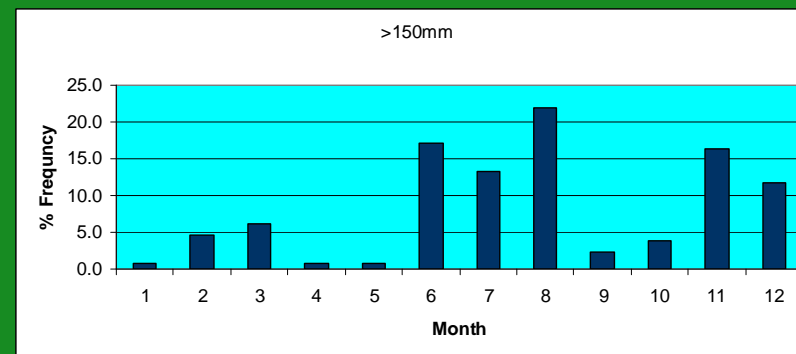
## Seasonality



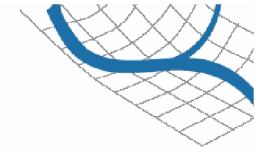
All observations



Observations > 100mm

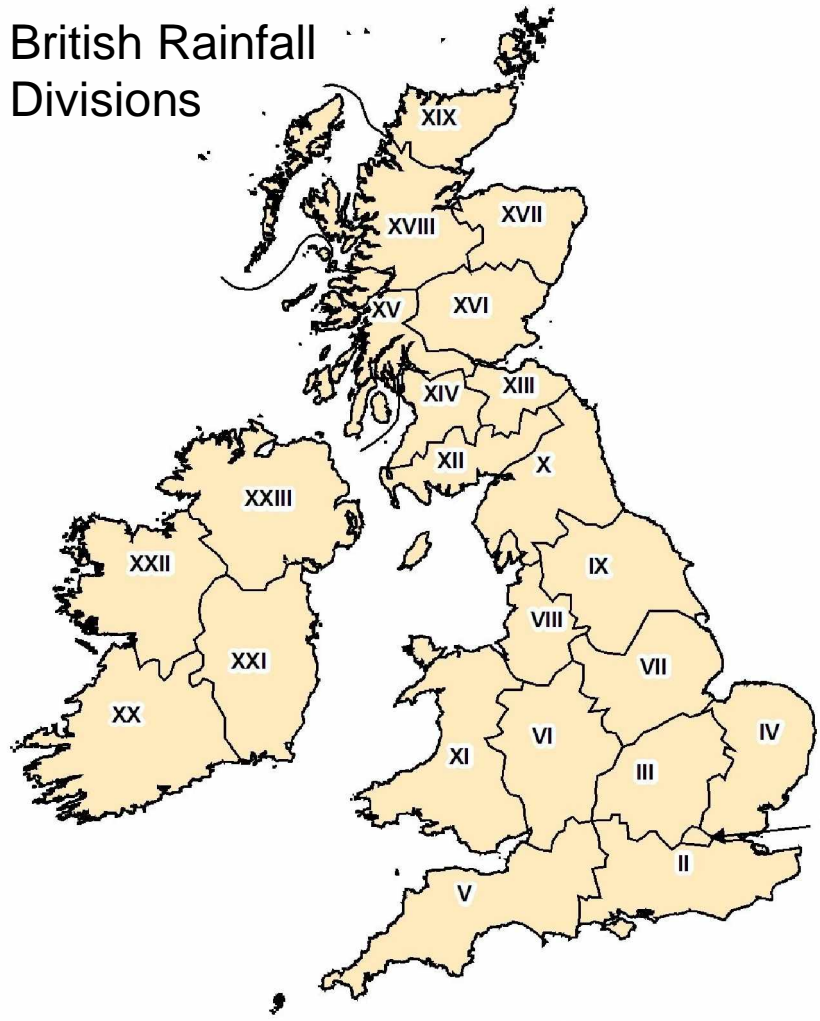


Observations > 150mm

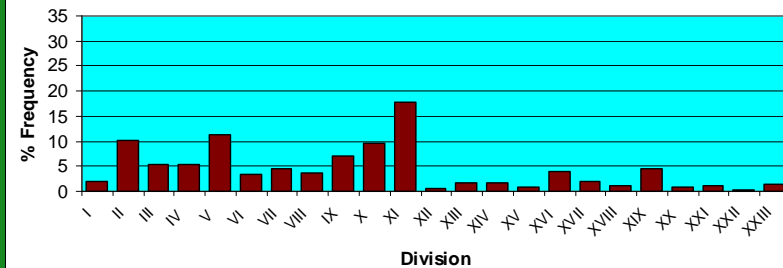


## Spatial Distribution of Extreme Rainfalls

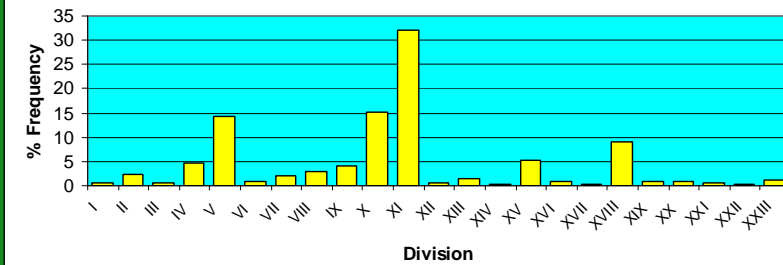
British Rainfall Divisions



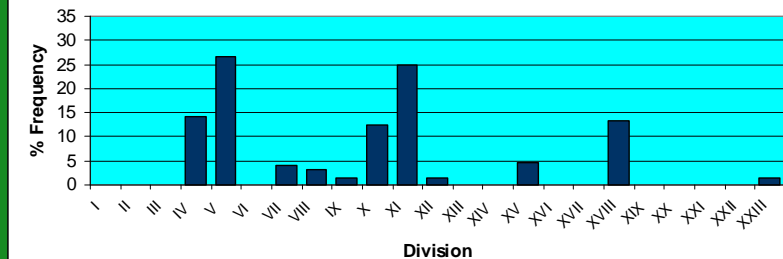
All Observations

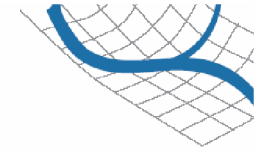


> 100mm

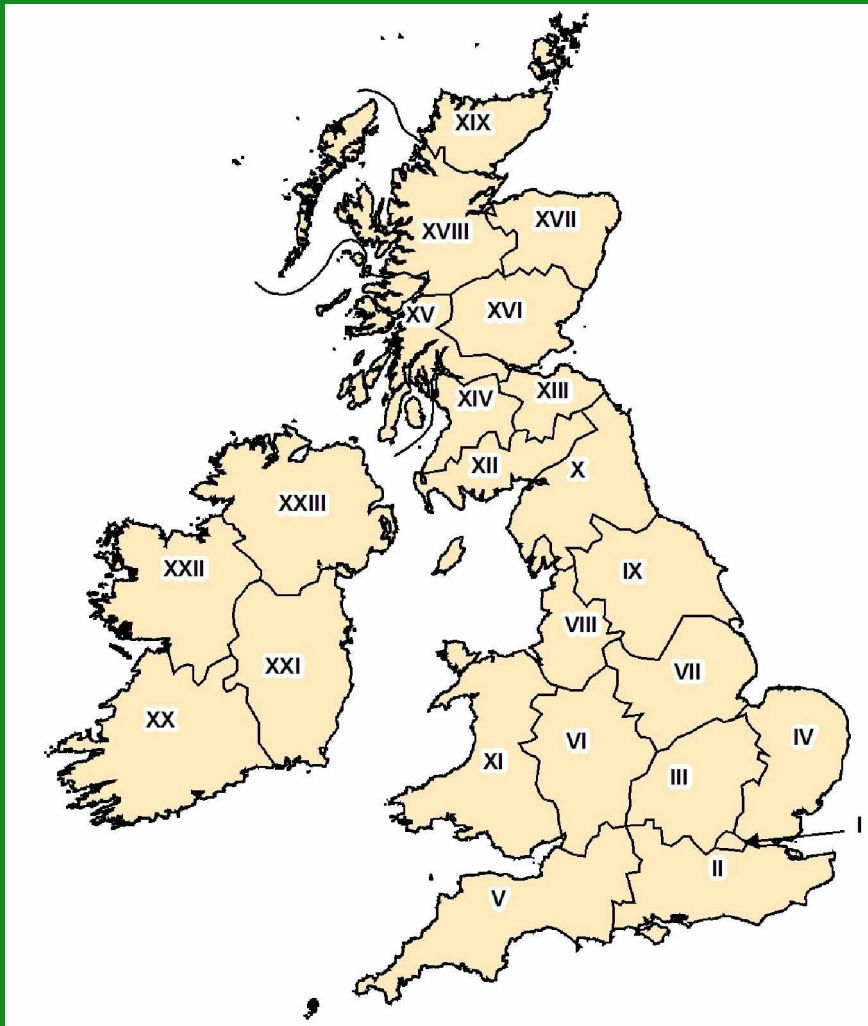


> 150mm





## Spatial Distribution of Extreme Rainfalls



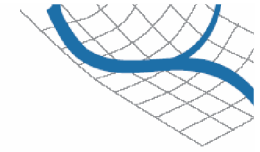
All observations were listed by division, not ideal for a proper spatial analysis

Distribution strongly affected by the numbers of gauges in each division.

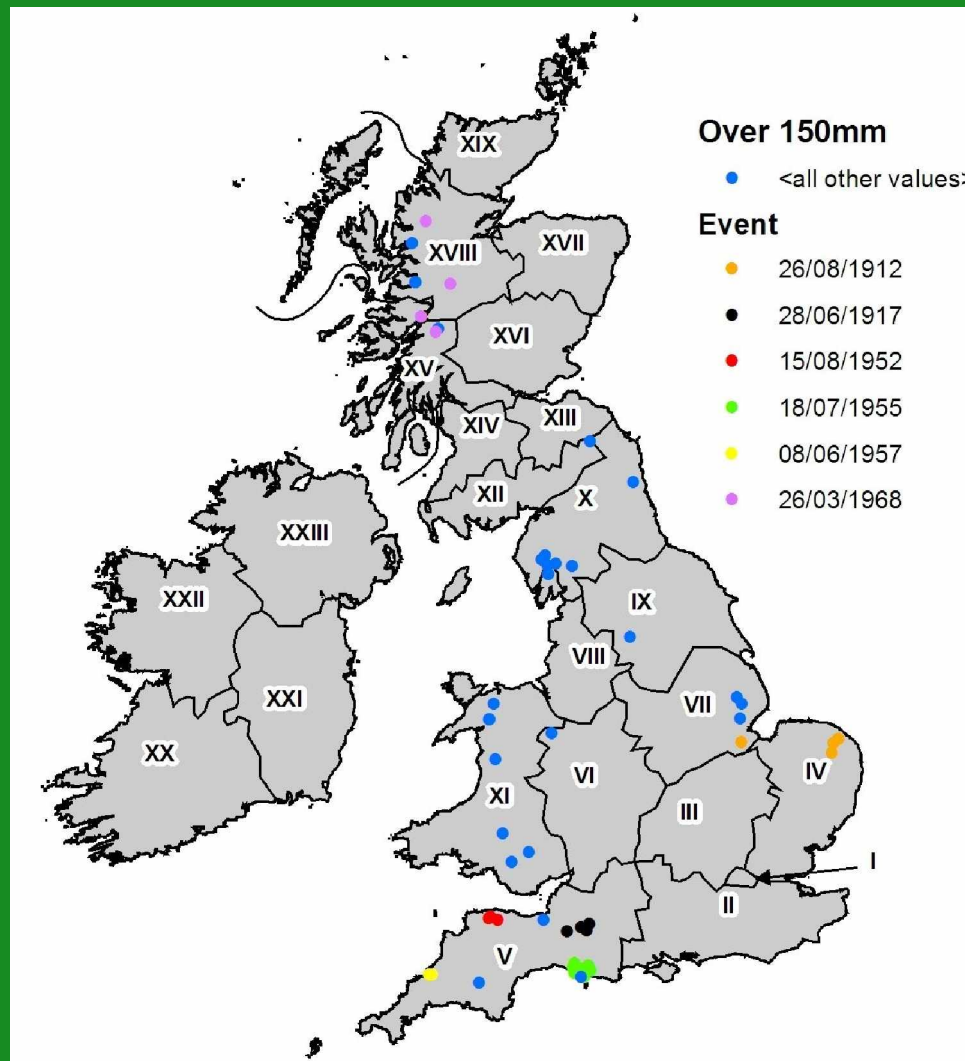
Fewer gauges in upland, sparsely populated areas.

E.g. 1899 had data from 3528 gauges only 446 in Scotland and 188 in Ireland

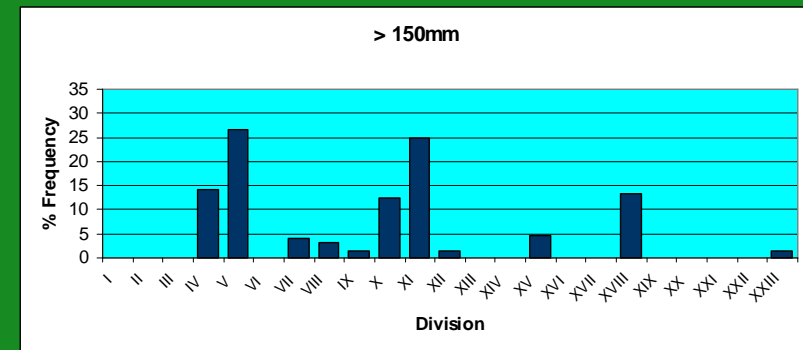
Observations from the Republic of Ireland stopped in 1939



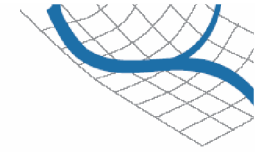
## Spatial Distribution of 24 hr Rainfalls Over 150mm



Some gauge grid references could be obtained from the Met Office



57 observations >150mm  
(45%) are from just six events



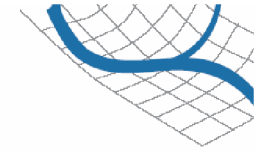
## Event Classification

A classification was required for more refined rainfall forecasting so that events with similar characteristics could be treated as specific set.

Classification based on information available in British Rainfall:

- Spatial distribution and patterns from maps
- Seasonality
- Maximum observed rainfall depths
- Information from observers such as descriptions of the rainfall intensity, duration presence of thunder

Initial classification applied to mapped events, further work will cover all events and include synoptic meteorology indices such as Lamb and GWL.



## Types of Events

**Mesoscale Convective Complexes (MCC)** – small depressions characterised by intense precipitation from convective cells within a larger area of continuous rain. Occur in summer affect S and SW Britain, falls of over 200mm in 24 hrs can be observed. Also known as Mesoscale convective systems (MCS).

**East Coast (EC)** – depressions where the eastwards progression stalls over the UK bringing moist air and rainfall from the North Sea to affect areas of the east coast. Occur in summer and can bring continuous rain for up to 4 days.

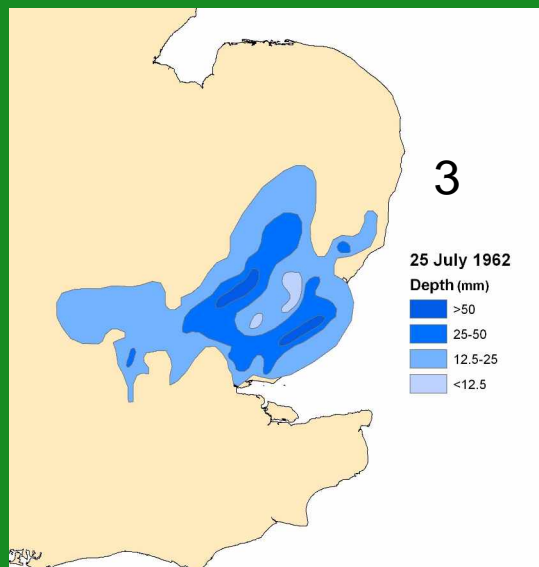
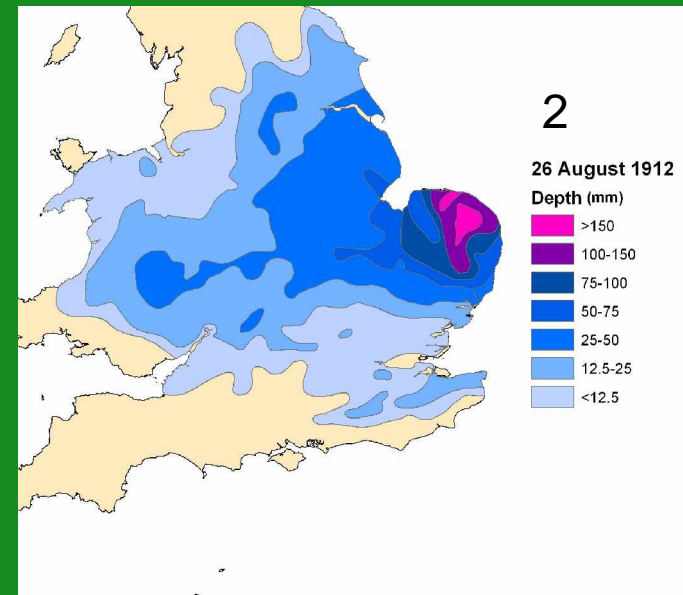
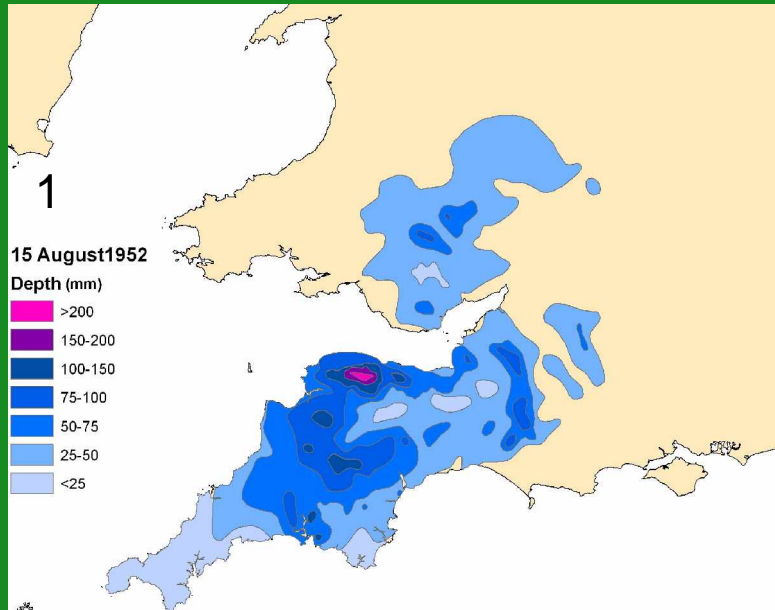
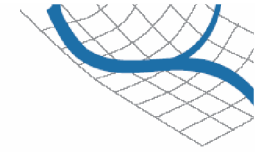
**Thunderstorms (T)** – isolated occurrences or progressions of convective cells, occur in summer but lacking the structure of an MCC.

**Orographic (O)** – rainfall associated with the normal west – east movement of Atlantic depressions which is enhanced over the mountainous areas and occur throughout the year.

**Depression (D)** – rainfall associated with a depression but not showing the features of the other classes. Can occur throughout the year.

# Event Classification

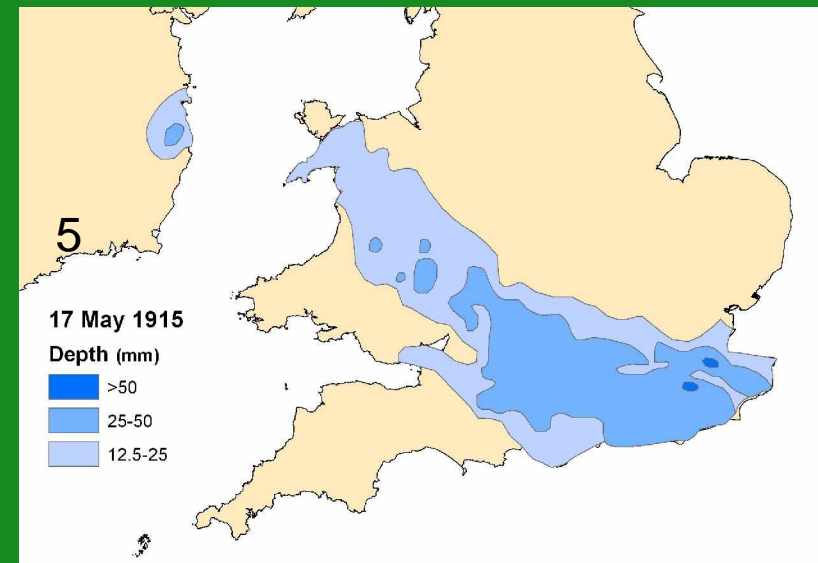
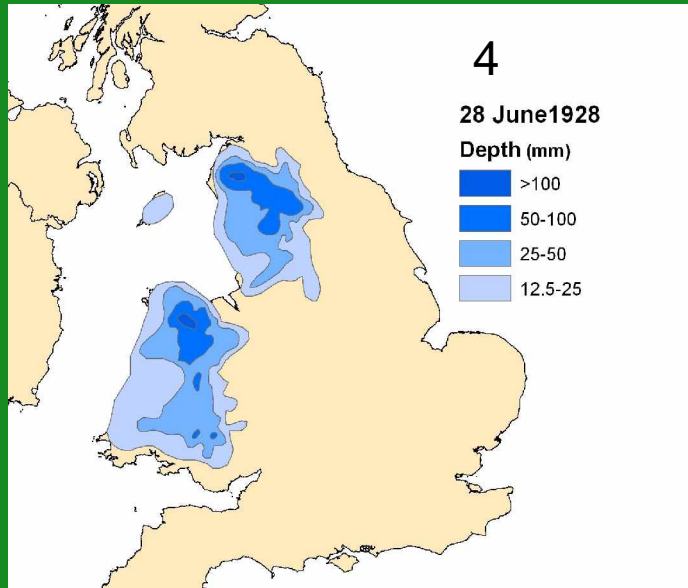
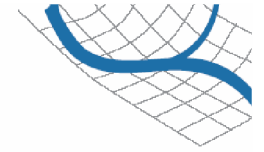
# Hydro-GIS Ltd



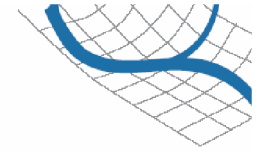
- 1) MCC
- 2) East Coast
- 3) Thunderstorm

# Event Classification

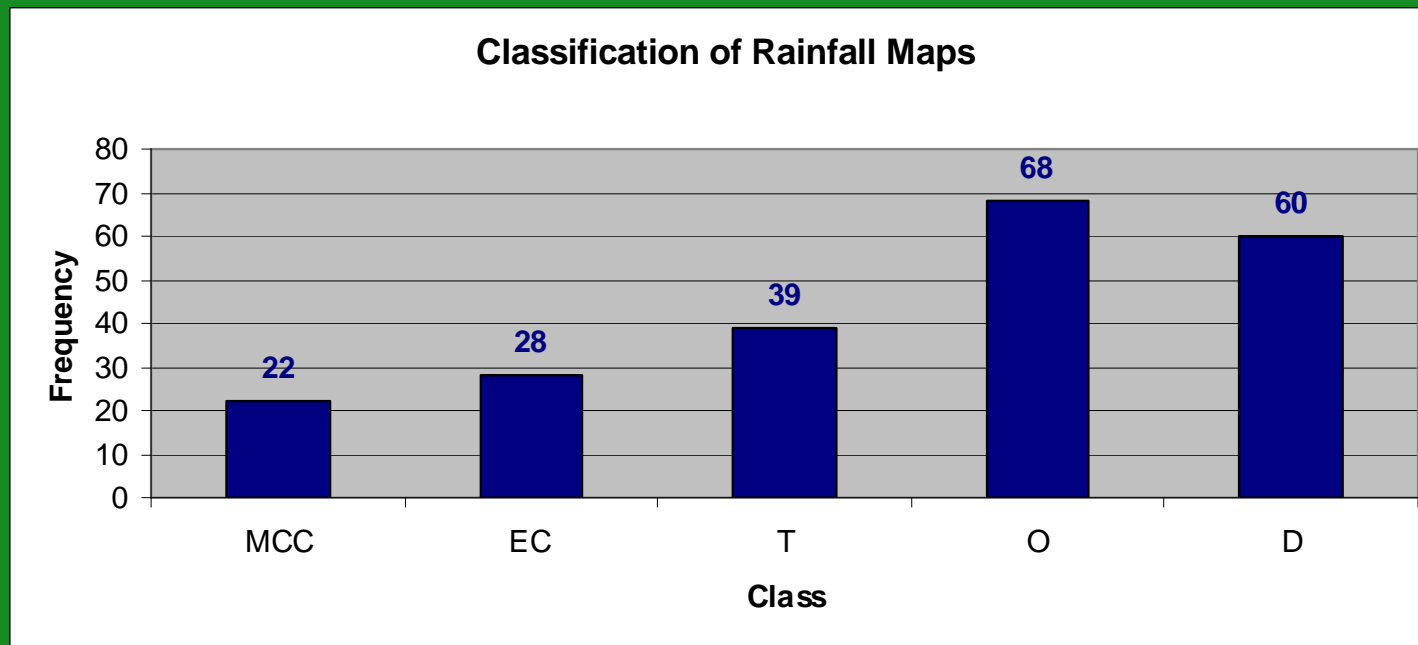
Hydro-GIS Ltd

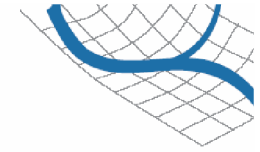


- 4) Orographic
- 5) Depression / other

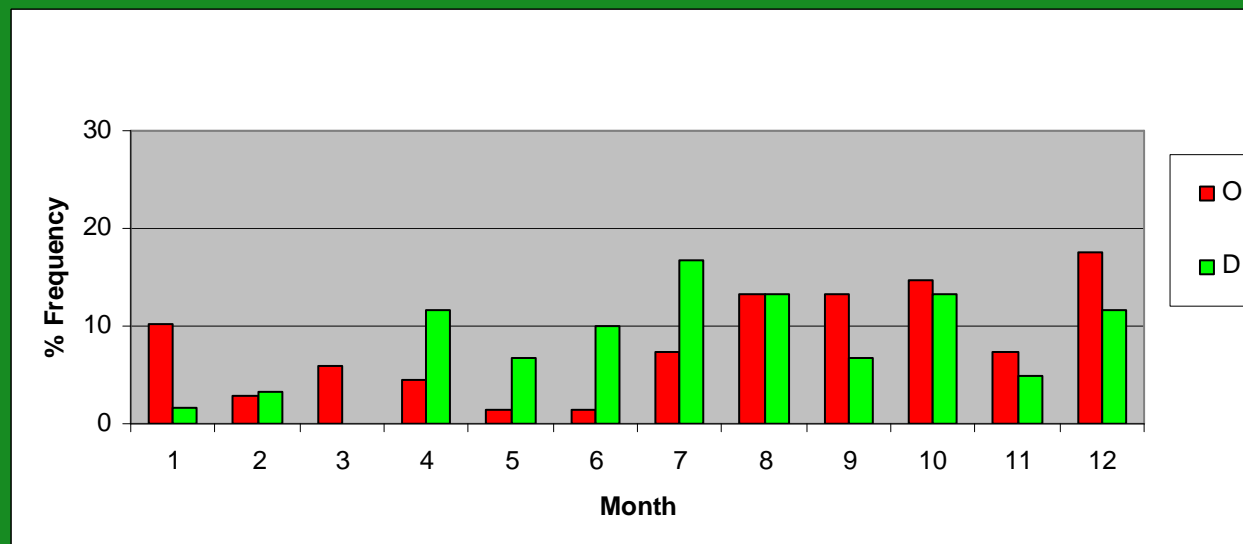
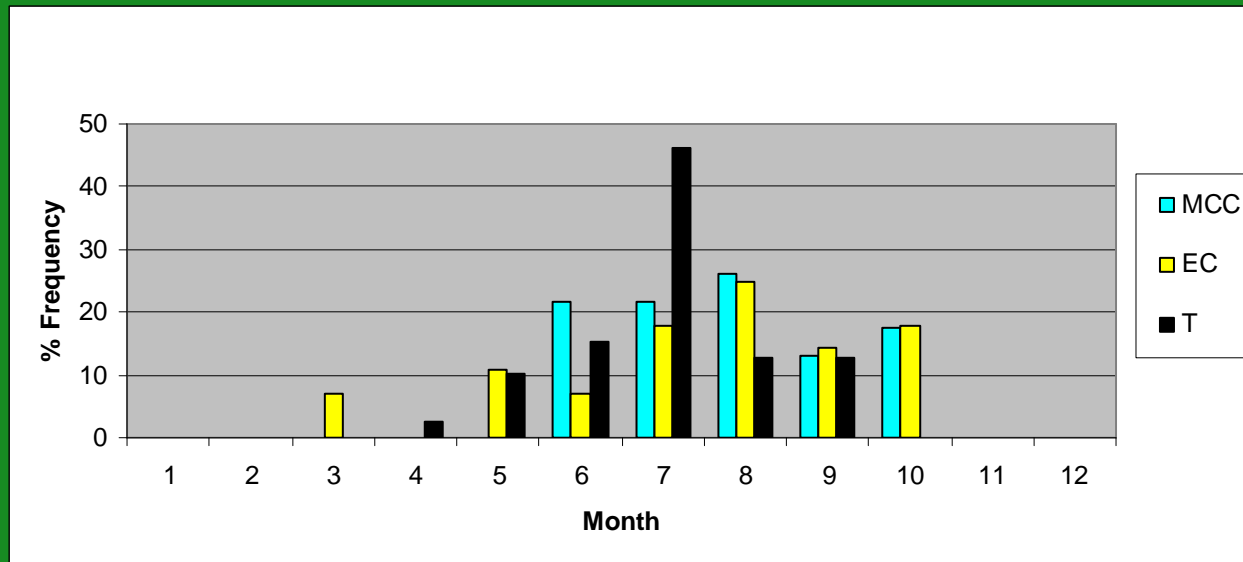


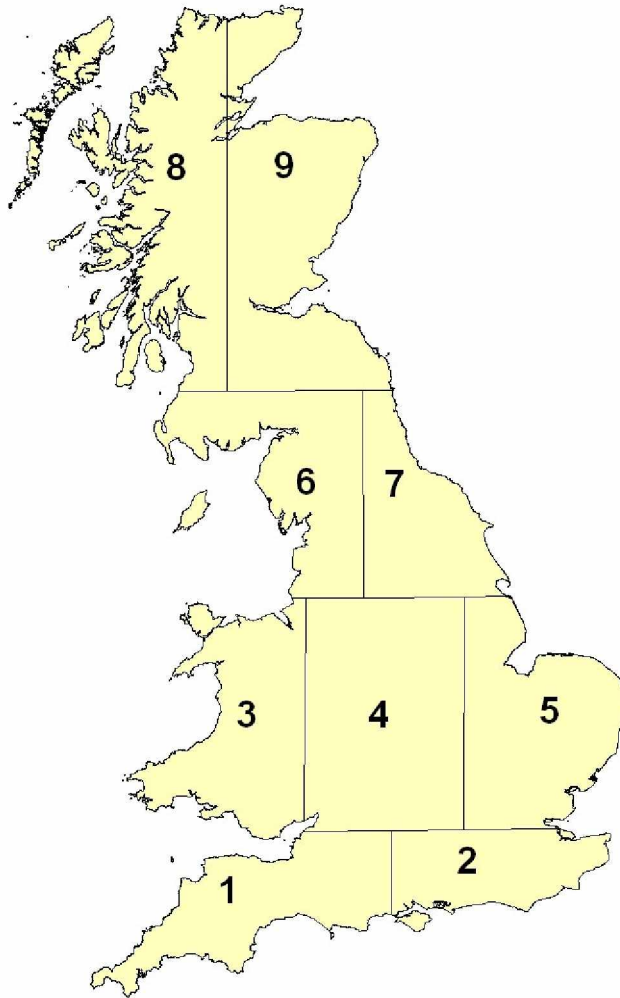
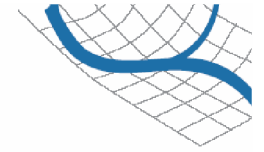
## Class Frequency





## Class Seasonality





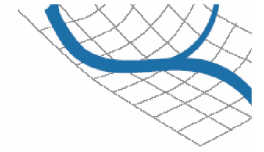
Required a revision of British Rainfall Divisions

Simple E/W split

Ireland not included due to lack of maps

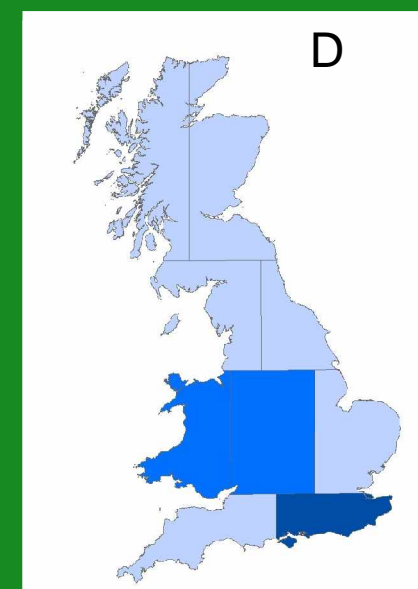
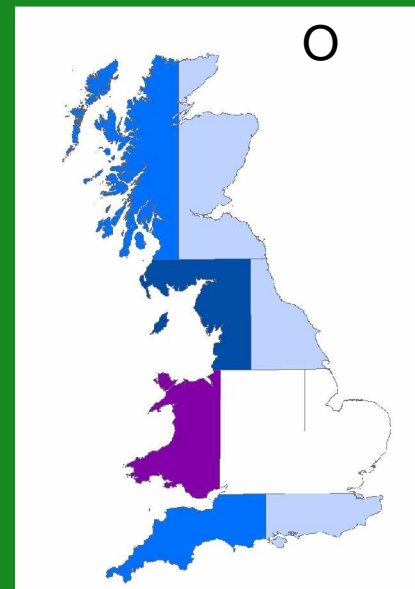
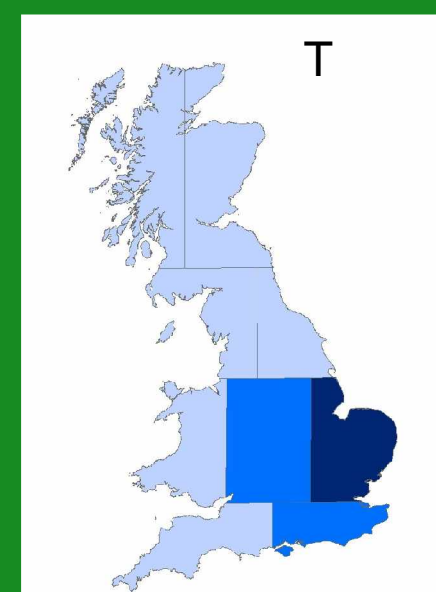
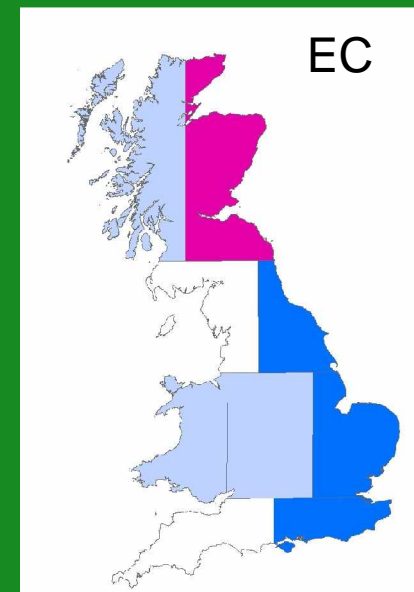
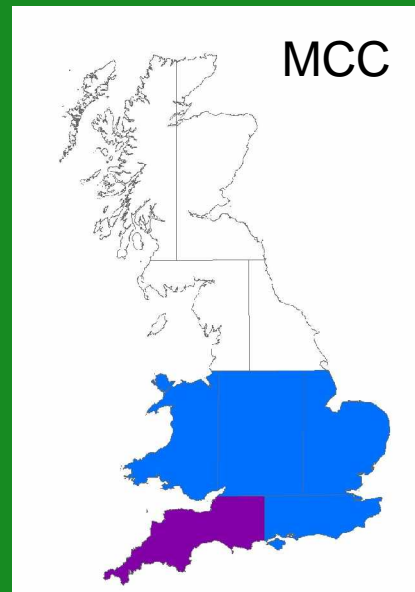
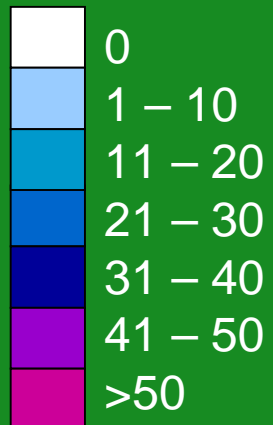
# Spatial Patterns

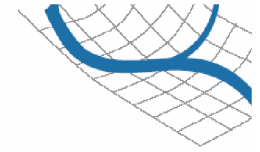
Hydro-GIS Ltd



Divisional location  
of maximum isohyet

% Events



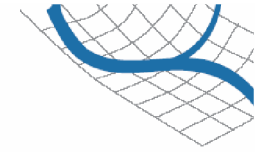


## Potential Uses of the British Rainfall Archive

There are a wide range of research applications in meteorology, climatology, hydrology and other fields:

- Studies of extreme weather;
- Design rainfall estimation;
- Long term climatic trends;
- Flood studies;
- Drainage design

**The digital archive will be made freely available for research purposes in the UK**



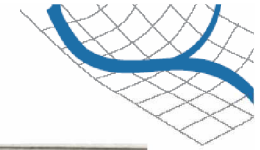
## Applications

**Information compiled in the digital archive is being used in the current study:**

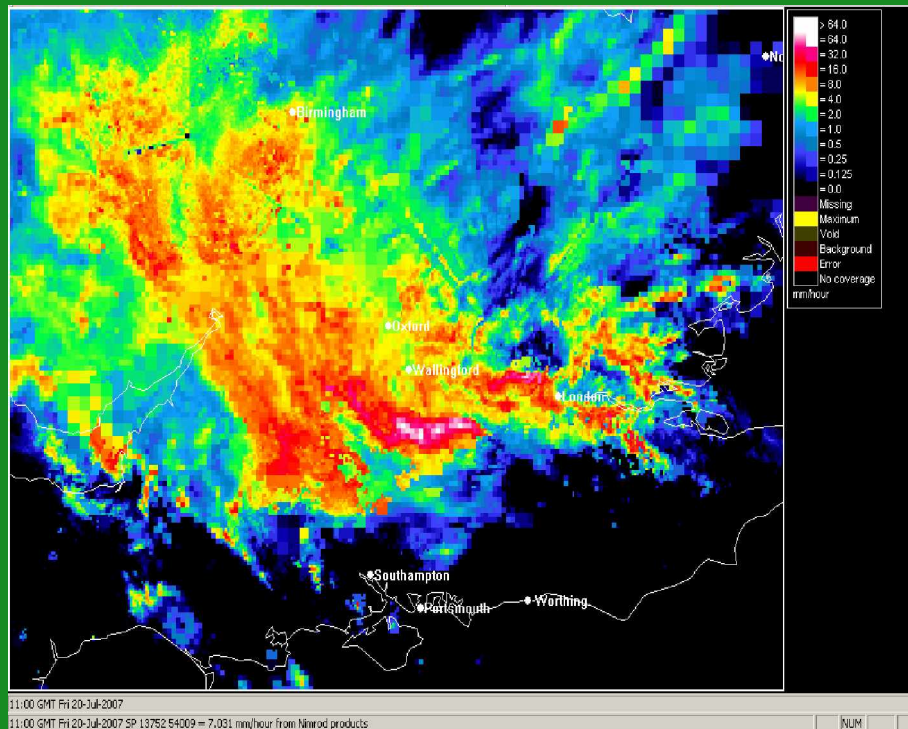
- As input, calibration and verification data for extreme rainfall forecasting;
- The classifications enable analysis to be undertaken for specific event types;
- Spatial prediction of rainfall;
- Application of computer learning and shape recognition for an automated classification.

**Other practical uses include:**

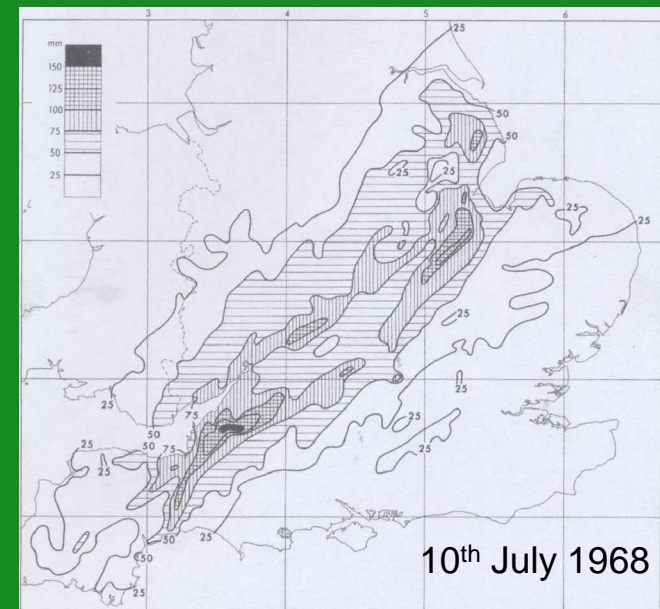
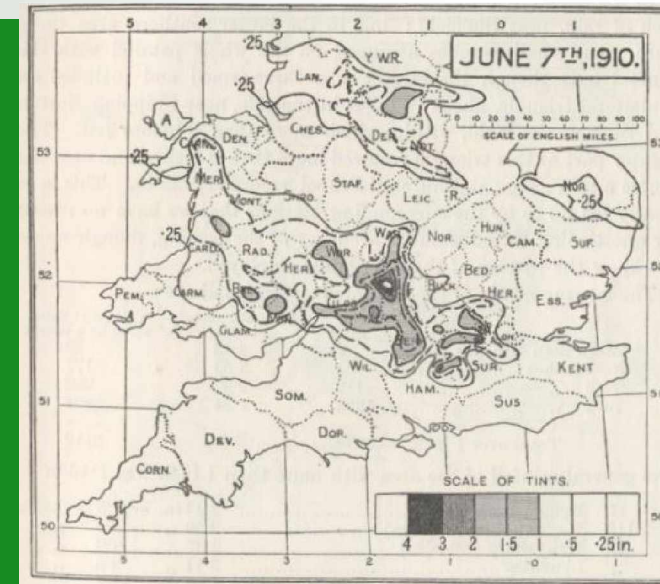
- Scenarios for flood forecasting;
- Emergency management planning;
- Assessments of historical flood risk;
- Thames EA GIS interface.



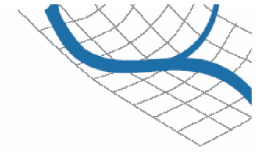
## Comparison of 20th July 2007 with events from BR archive



20<sup>th</sup> July 2007



200+ rainfall maps – potential scenarios for flood forecasting/emergency planning



## Historical Flood Records

DAMAGE DONE BY FLOODS AT FIDDINGTON.



AT EDBROOK FARM



Flood damage in Somerset following the Cannington storm, 18th August 1924.

Photos, descriptive text and rainfall observations are useful for historical flood studies and flood risk assessments

# Hydro-GIS Ltd

