Analysis of drought characteristics from 1880s to 2012 for an improved understanding of a water resource system

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Background

- Drought is a reoccurring feature of the UK climate
- It has multi-faceted impacts- both socio-economic and environmental
- Recent events in the UK have highlighted our vulnerability to hydrological extremes (both floods and droughts)
- There is currently a limited understanding of past drought events across the UK
- NERC-CASE funded- research collaboration between University of Liverpool and Severn Trent Water
- Improved understanding of drought risk and drought severity to inform water resource management

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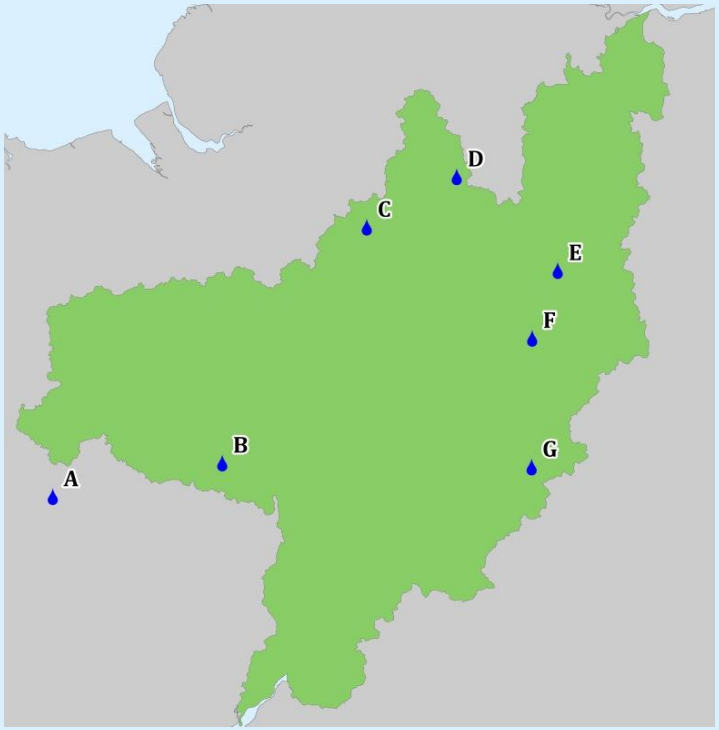
Long series rainfall data

- 7 long series records dating back to the mid-19th Century
- Data accessed from British Atmospheric Data Centre (BADC)
- Fairly complete records- site selection included checks for percentage of missing data more then 20% missing site rejected
- Data infilling used linear regression techniques from nearby stations (within 10km)



A- 1858
B- 1899
C- 1882
D- 1878
E- 1888
F-1887
G-1872

Drought characteristics

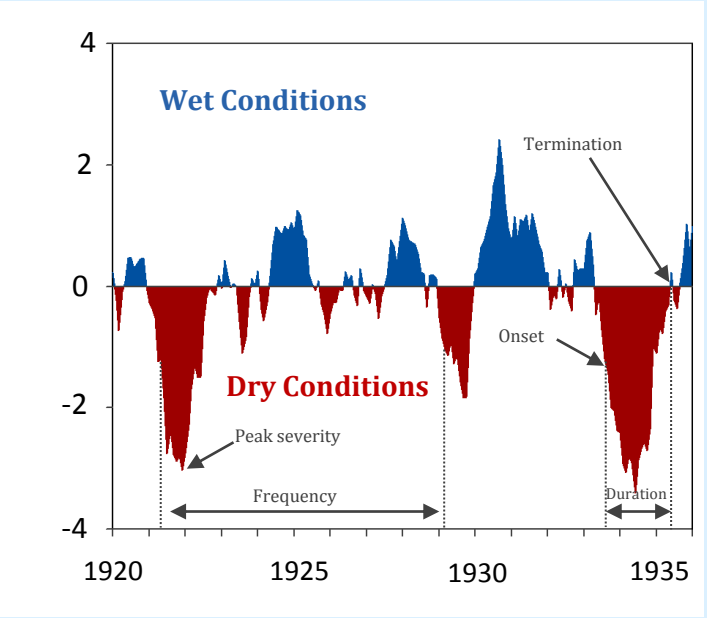
Number of ways to define, characterise and monitor meteorological droughts-

Drought indices-

- Palmer Drought Severity Index (PDSI)
- Standardised Precipitation Index (SPI)
- Standardised Precipitation Evapotranspiration Index (SPEI)

Drought characteristics include-

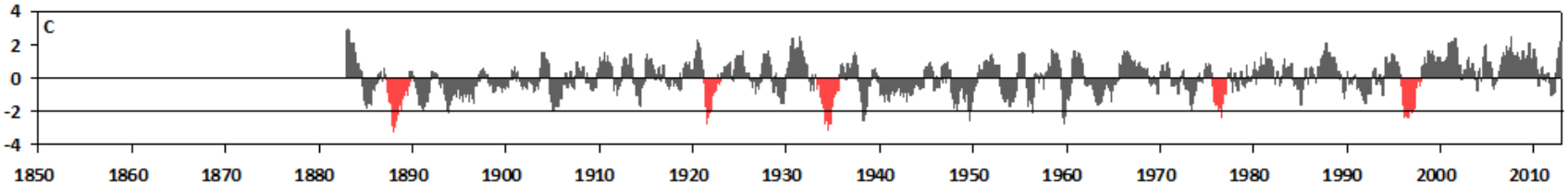
- Severity
- Frequency
- Duration
- Onset
- Termination



Standardised Precipitation Index

- SPI is used to characterise and monitor droughts.
- Developed by McKee et al., 1993 to define and monitor droughts.
- Standardised nature of the SPI allows for the determination of the rarity of a drought or anomalously wet event at various timescales for any location with available precipitation data.
- Monthly rainfall data is fitted to a probability distribution function.
- Transformed into a normal distribution to give a mean SPI of zero.
- SPI values represent number of standard deviations from the mean (negative values indicate dry conditions, positive values indicate wet conditions).

SPI Values	Classification
2.00 or more	Extremely wet
1.50 to 1.99	Very wet
1.00 to 1.49	Moderately wet
-0.99 to 0.99	Near normal
-1.00 to -1.49	Moderate drought
-1.50 to -1.99	Severe drought
-2.00 or less	Extreme drought



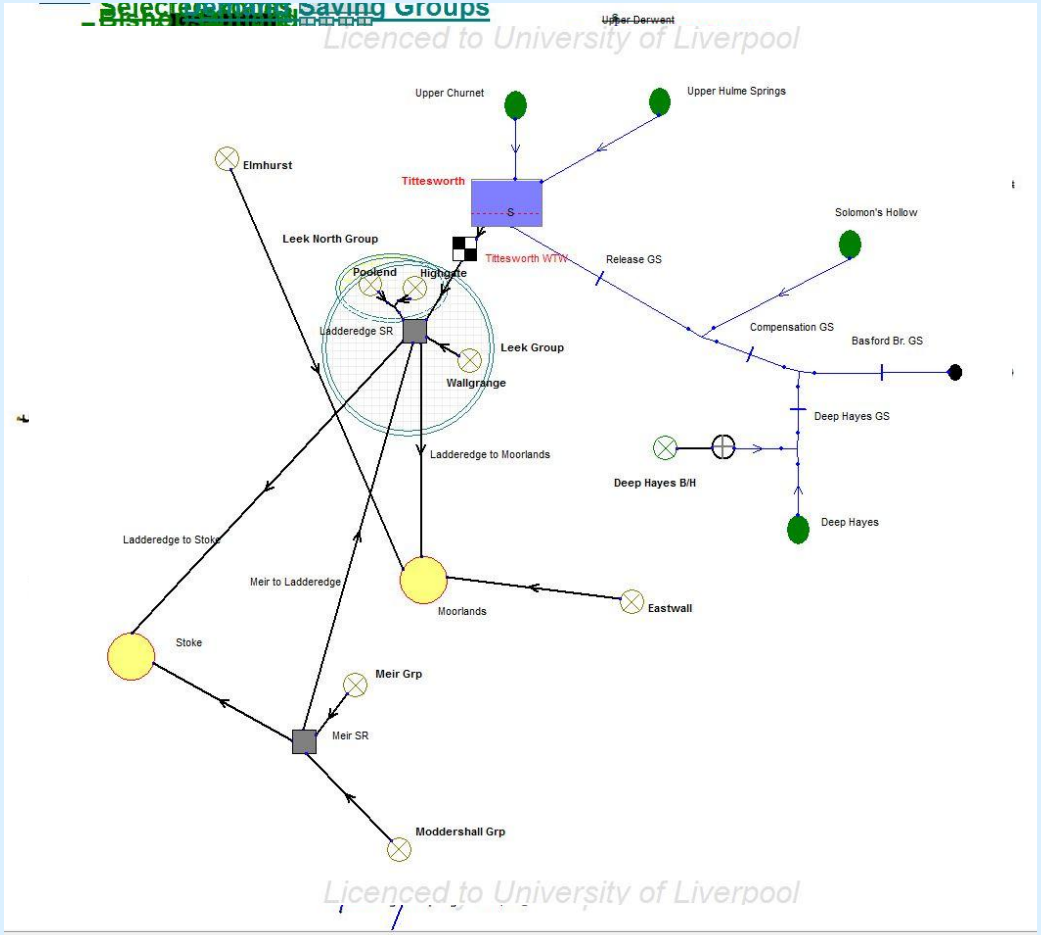
Date	Months in drought	Rank	Months in extreme drought	Rank	Max Severity	Rank
1887-1888	27	2	7	2	-3.2	1
1893-1897	45	1	1	5*	-2.02	6
1921-1922	16	5*	4	4	-2.38	4
1934-1935	25	3	10	1	-3.13	2
1975-1975	16	5*	1	5*	-2.33	5
1995-1997	24	4	7	3	-2.35	3
2010-2012	5	6	0	6	-1.12	7

Application of long series data I

- Severn Trent use Aquator water resource system model to simulate the water supply network
- Model used for water resource management plans and drought plans- legally required by DEFRA
- Water resource management plans sets out how water companies ensure sufficient water availability for the next 25 years
- Drought plans set out how water companies will manage water supplies and water demand during a drought
- Data used in modelling from 1920-2010 but this period misses droughts during the 1880s and 1890s
- The UK has a wealth of long series climate data that is under used in water resource management

Application of long series data II

- Aquator model simulates the entire Severn Trent water resource supply network
- This includes reservoirs, rivers, groundwater boreholes, water treatment works and demand centres
- What is the impact of using a longer dataset on deployable output (DO)?- **the maximum rate at which a system can supply water continuously through a dry period with a known or assumed severity**



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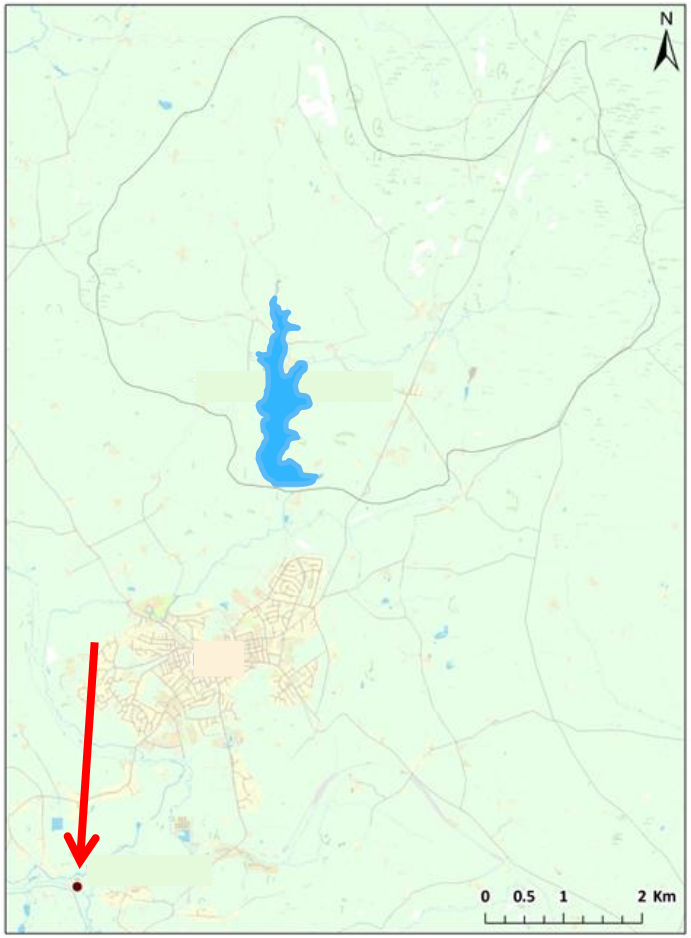
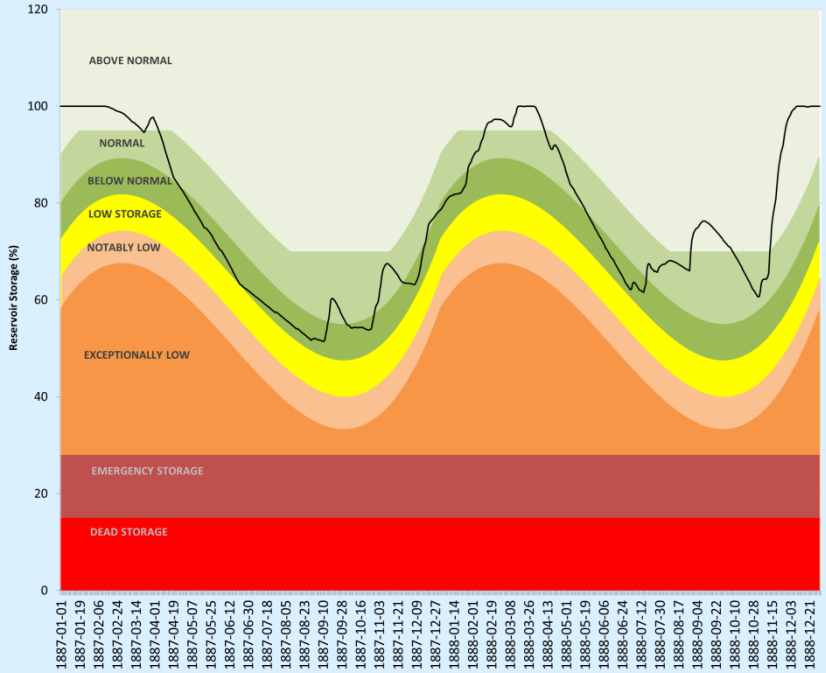
Water Resource Zone Mini Model

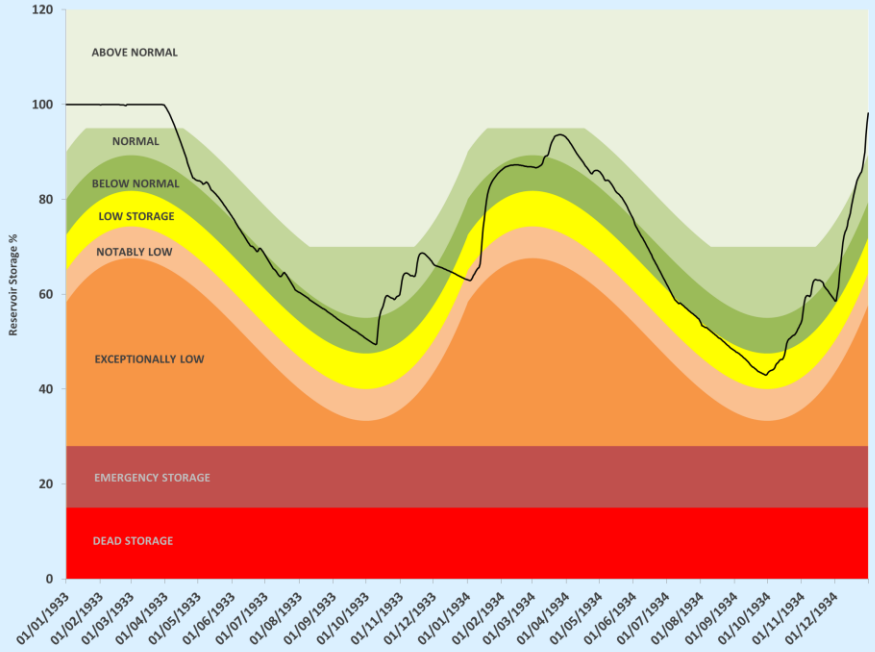
- Severn Trent Water divide their supply region in water resource zones (7 in total)
- Mini model represents one water resource zone including strategic reservoir
- Rainfall data used to model inflow into the reservoir
- Rainfall-runoff model (HYSIM) used to simulate daily inflow into the reservoir (1884-2013)
- What is the impact of using a longer rainfall data set?
- Simulated inflow used in the mini model to calculate DO



Results

- Deployable output calculation for the water resource zone- insignificant change
- Modelled reservoir levels show ‘critical drought’ is still 1933-1934
- ‘Critical drought’ drought event which reaches a reservoir level to trigger a hosepipe ban





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Implications

- Extended data series only used for small part of the whole water resource system
- May be beneficial to use long series approach for other water resource zones to investigate any changes in deployable output
- Would provide a more robust water resource management plan from the Severn Trent Water perspective
- The SPI indicated that the late 19th century drought events could be more severe than droughts in the 1920-2010 modelling period
- Water resource modelling has shown these events would not have any greater impact than events currently modelled
- Further investigation into the links between the SPI and impacts needed

Summary

- Wealth of long series climate data available for the UK
- SPI provides a useful drought monitoring and characterisation tool
- Use of longer series rainfall data to capture more droughts for water resources modelling has little impact in this case

Work produced a lot of questions

- Is there a need to increase data length in water resource modelling?
- How can drought indices be used to inform decision makers?
- How suitable is the SPI for decision making?
- What indices would be most appropriate for water resource management?

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Thank You
Any Questions?
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