

A multi-proxy reconstruction of millennial scale drought history for Northern England



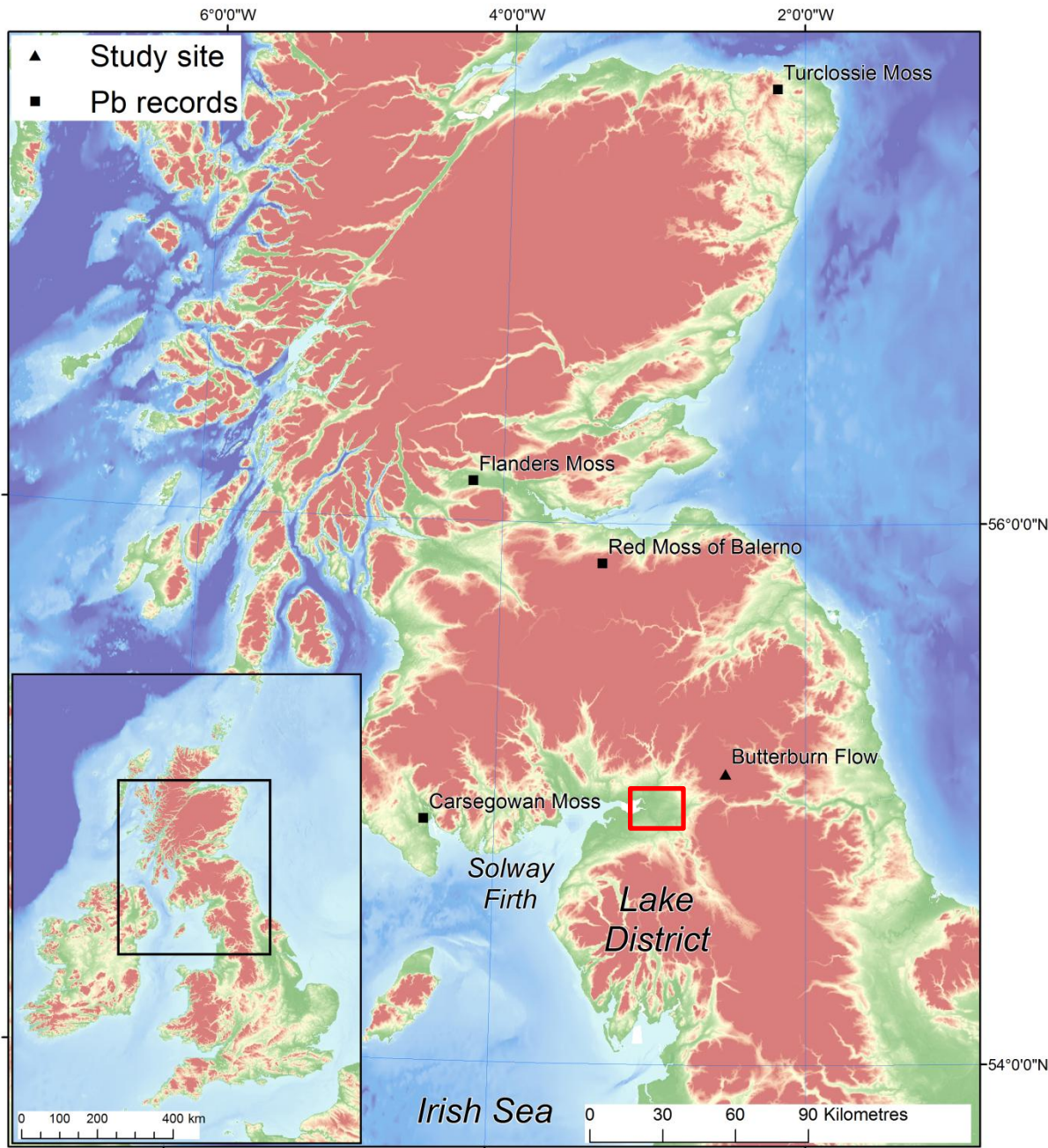
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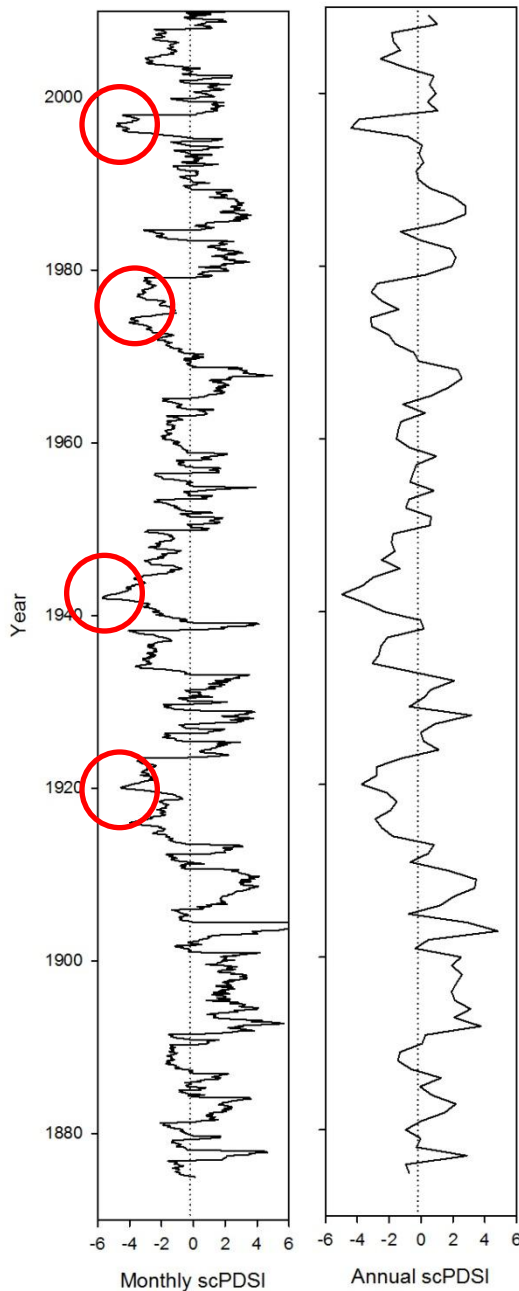
- Instrumental (T & P) series reconstructed from around Carlisle.
- Peat core extracted from Butterburn Flow



Reconstruction of the historic droughts

- Instrumental temperature and precipitation data since 1875
- PDSI generated using the long instrumental series
- The testate amoebae analyses undertaken at 3mm sampling resolution, providing a sub-decadal (2-5 year) sample resolution from an ombrotrophic peat bog.
- Age depth model based on chronological control provided by air fall pollutants (Pb & Zn) histories and radiocarbon dating
- Calibration of the sedimentary sequences to the PDSI (instrument series) over the last c.150 years

PDSI



- Instrumental temperature and precipitation data since 1875
- Series reconstructed for locations near Carlisle, ~35 km away.
- Several known droughts are clearly presented
 - 1995/96
 - 1974 & 1976/77
 - 1941/42
 - 1920/21

(Fowler & Kilsby, 2002)

Core sampling

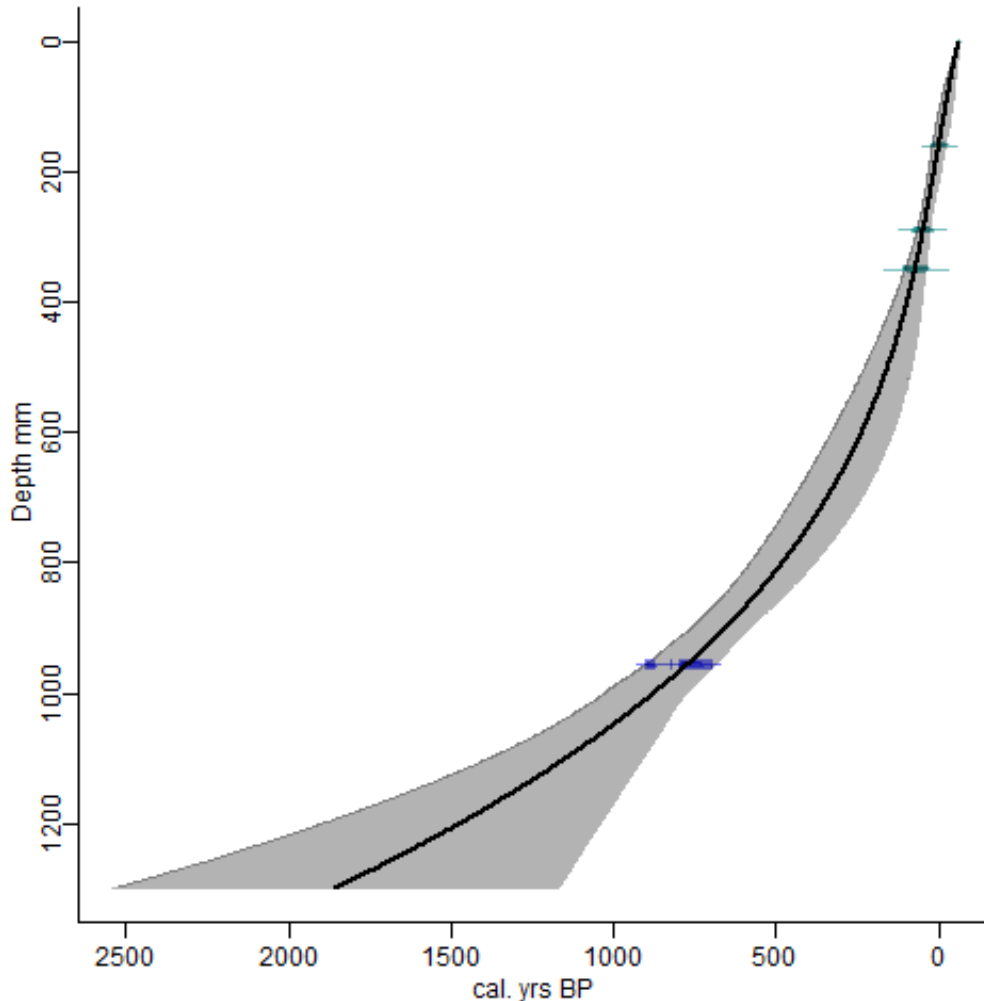
- Three 500mm cores, with 100mm overlap
- Sampled at 3mm of the first 500mm of core, then at 10mm thereafter.



Geochemistry

- The slices were geochemically examined using non-destructive X-ray fluorescence spectrometry (XRF)
- These were compared to a chronologically constrained sample set, to identify geochemical markers.

Age depth model



- The geochemical markers were then supplemented by a ^{14}C date, in generating an age depth model
- Awaiting a further two ^{14}C dates at 650mm & 1280mm

Testate Amoebae

- Testate amoebae are protists (unicellular animals) which form external shells (tests) and live in freshwaters and wet soils
- They are known to be good indicators of soil moisture levels
- *Sphagnum* mosses provide the normal living space for testate amoebae in the northern hemisphere
- Used to reconstruct changes in hydrological condition in peatlands
- Ratios of species present differ under wet, normal and dry conditions



Testate Amoebae distribution down core.

A water table reconstruction was undertaken using the Charman et al. (2007) training set, applied as in Sillasoo et al. (2007)

DRY

WET

PDSI & WT

Good general agreement
between WT depth and
PDSI

WT indicates phases of
wetter weather 1600-
1995, thought this may be
broken down as wetter
1905-1985
1600-1805

Generally drier before
1600

Discussion

- The wet phase between 1600-1800 and dry phase around the 1900 are identified within other texts (Swindles, 2010).
- The high resolution records provide greater ability to interrogate the variability in records at site, but also provide a clearer depiction of phases or shifts in climatic conditions.
- Localised topographic variations in instrumental site records and core extraction site may explain some of the poor fit between WT and PDSI.
- There are clear differences between dry phases and drought events, with severe droughts occurring during wet phases.

Conclusions

- The PDSI closely reflects well documented droughts.
 - Importance on localised temperature records
- There is general agreement, between PDSI and testate amoebae.
- The role of site/catchment antecedence is difficult to quantify, and missed with current analysis approaches.



The wettest drought project?

Research Questions

- Greater need for more long series analysis from instrumental data, greater density of sites analysed.
- Can this high resolution approach be undertaken on large scale areas, or spatially sensitive sites?
- Value and importance of wet/dry phases relative to drought events - relationship?
- Approaches to quantifying antecedence and incorporating into the analysis.