Supplement of

Have river flow droughts become more severe? A review of the evidence from the UK – a data-rich, temperate environment
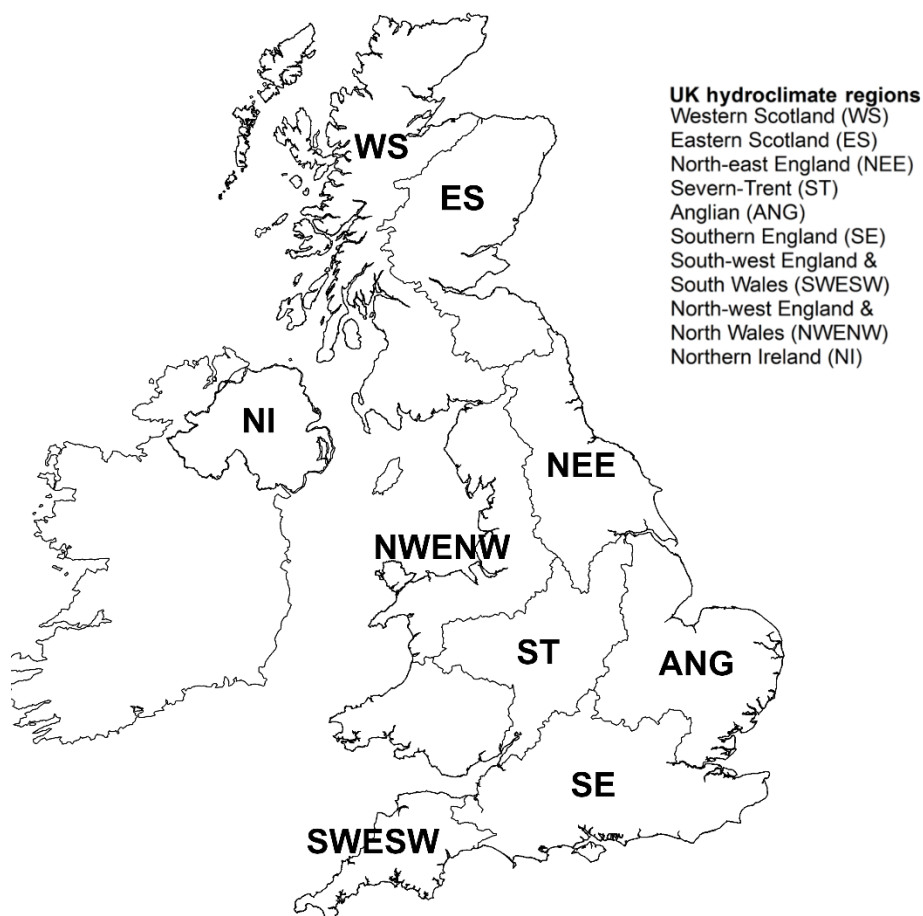
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Additional Figures and Tables

UK hydroclimate regions
Western Scotland (WS)
Eastern Scotland (ES)
North-east England (NEE)
Severn-Trent (ST)
Anglian (ANG)
Southern England (SE)
South-west England &
South Wales (SWESW)
North-west England &
North Wales (NWENW)
Northern Ireland (NI)

Figure S1: location map showing the hydroclimate regions (after Barker et al. 2019) used in Figure 5 and S2, as well as the trend results tables (Tables S1 – S4)
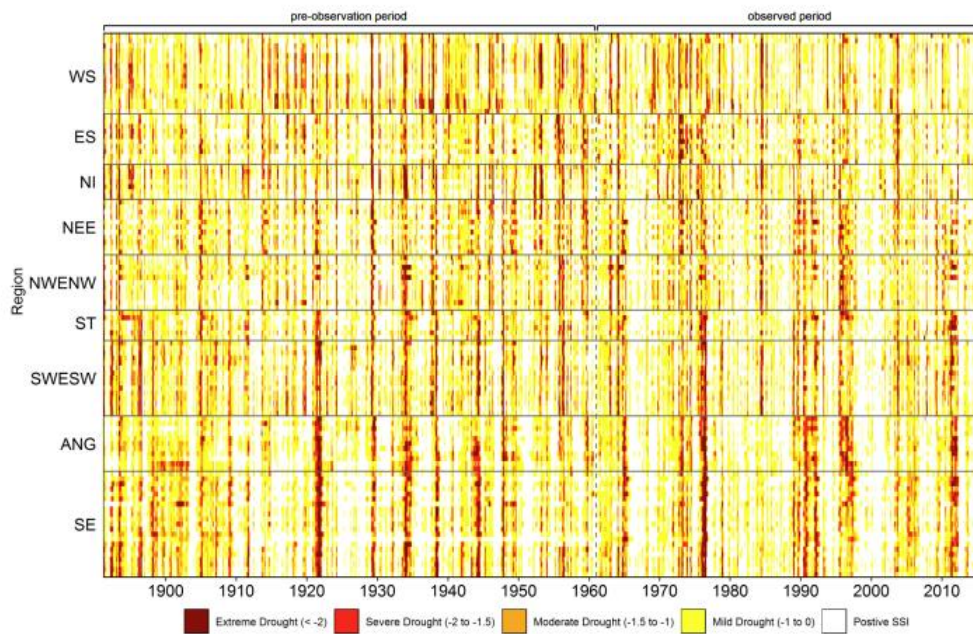
Figure S2: Heatmap of SSI-3 for LFBN catchments (arranged roughly from north to south on the y-axis with one row per catchment and regions marked for clarity) from 1891 to 2015.

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Figure S2 – Heat map of 3-month Standardised Streamflow Index (SSI-12) for Low Flows Benchmark Network (LFBN) catchments from 1891 to 2015 (catchments arranged roughly from north to south on the y axis, with one row per catchment and hydro-climatic regions marked for clarity) with colours according to SSI12 category in key. 'Observed period' highlights typical maximum record coverage of most gauging stations. 'pre-observation' the period with most added value from the reconstructions. Reproduced with permission from Barker et al. 2019. For equivalent results with SSI-3 see Figure 5.
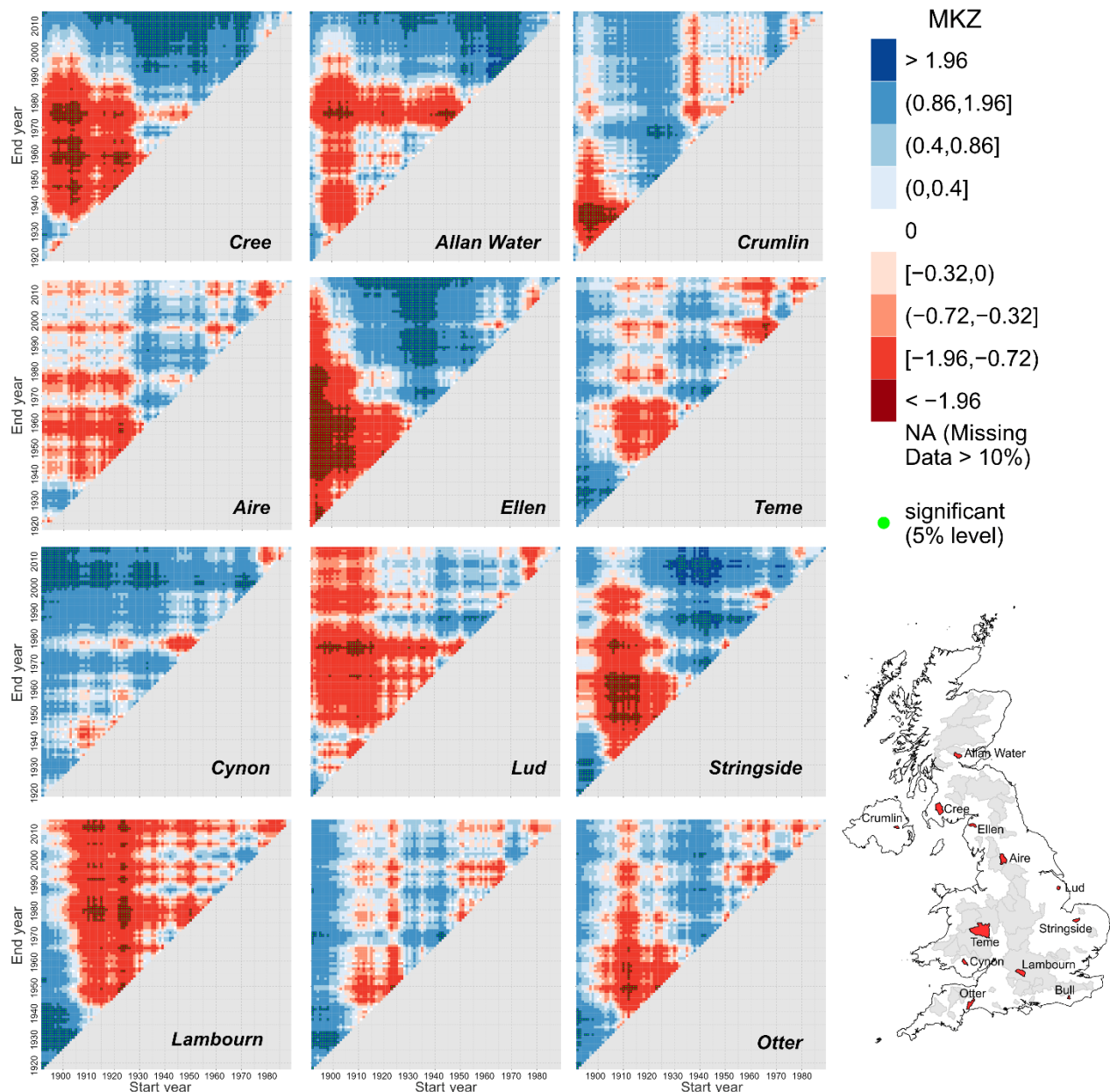
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Figure S3: Multitemporal trend analysis applied to time series of accumulated drought deficit using SSI-3 for nine selected long reconstructed records from Barker et al. 2019, and three additional catchments (Stringside, Bull and Otter). The colour ramp denotes values of the MK Z statistic (blue = positive, red = negative) with green dots denoting significant cases. As with previous figures blue = ameliorating drought, red = worsening drought). For equivalent results for SSI-12, see Figure 6.

Supplementary Tables

Table S1: Summary of trend results per region of river flow indicators relevant for water resources/drought (Q95, Q70, Q50) for the period 1965 – 2022. Regions are shown in Figure S1.

Region	No. of stations	Q95				Q70				Q50			
		Positive (%)	Sign. pos. at 5% (%)	Negative (%)	Sign. neg. at 5% (%)	Positive (%)	Sign. pos. at 5% (%)	Negative (%)	Sign. neg. at 5% (%)	Positive (%)	Sign. pos. at 5% (%)	Negative (%)	Sign. neg. at 5% (%)
WS	24	66.67	25.00	33.33	16.67	91.67	37.50	8.33	4.17	91.67	29.17	8.33	0.00
ES	41	95.12	19.51	4.88	0.00	85.37	24.39	14.63	0.00	87.80	34.15	12.20	0.00
NEE	30	53.33	23.33	46.67	3.33	33.33	13.33	66.67	3.33	40.00	10.00	60.00	6.67
ST	20	30.00	0.00	70.00	15.00	15.00	0.00	85.00	15.00	0.00	0.00	100.00	0.00
ANG	69	44.93	13.04	55.07	15.94	50.72	13.04	49.28	14.49	34.78	7.25	65.22	13.04
SE	66	48.48	21.21	51.52	13.64	42.42	9.09	57.58	7.58	43.94	6.06	56.06	6.06
SWESW	39	71.79	17.95	28.21	7.69	41.03	0.00	58.97	2.56	56.41	0.00	43.59	0.00
NWENW	22	68.18	18.18	31.82	13.64	63.64	9.09	36.36	9.09	63.64	13.64	36.36	4.55

Table S2: Summary of trend results per region of seasonal mean river flows for the period 1965 - 2022

Region	No. of stations	Seasonal Mean - Autumn				Seasonal Mean - Winter				Seasonal Mean - Spring				Seasonal Mean - Summer			
		Positive (%)	Sign. pos. at 5% (%)	Negative (%)	Sign. neg. at 5% (%)	Positive (%)	Sign. pos. at 5% (%)	Negative (%)	Sign. neg. at 5% (%)	Positive (%)	Sign. pos. at 5% (%)	Negative (%)	Sign. neg. at 5% (%)	Positive (%)	Sign. pos. at 5% (%)	Negative (%)	Sign. neg. at 5% (%)
WS	24	75.00	0.00	25.00	0.00	100.00	83.33	0.00	0.00	33.33	0.00	66.67	0.00	87.50	4.17	12.50	0.00
ES	41	95.12	0.00	4.88	0.00	95.12	75.61	4.88	0.00	36.59	0.00	63.41	2.44	97.56	14.63	2.44	0.00
NEE	30	60.00	0.00	40.00	0.00	90.00	30.00	10.00	0.00	3.33	0.00	96.67	23.33	40.00	6.67	60.00	3.33
ST	20	45.00	0.00	55.00	0.00	80.00	5.00	20.00	0.00	0.00	0.00	100.00	10.00	15.00	0.00	85.00	5.00
ANG	69	63.77	2.90	36.23	2.90	71.01	1.45	28.99	0.00	21.74	0.00	78.26	8.70	40.58	5.80	59.42	17.39
SE	66	62.12	7.58	37.88	0.00	84.85	6.06	15.15	0.00	21.21	3.03	78.79	9.09	30.30	9.09	69.70	9.09
SWESW	39	100.00	7.69	0.00	0.00	76.92	0.00	23.08	0.00	15.38	0.00	84.62	0.00	58.97	2.56	41.03	0.00
NWENW	22	54.55	4.55	45.45	4.55	90.91	45.45	9.09	0.00	27.27	4.55	72.73	9.09	68.18	13.64	31.82	4.55

Table S3: trend results comparing all analysed UK catchments to the UKBN2 network for river flow indicators relevant for water resources/drought (Q95, Q70, Q50) and seasonal mean river flows for the period 1965 – 2022. Please note the different numbers of sites used between the 'ALL' and 'UKBN2' catchments.

Indicator	Number of sites		Positive (%)		Sign. pos. at 5% (%)		Negative (%)		Sign. neg. at 5% (%)	
	All	UKBN2	All	UKBN2	All	UKBN2	All	UKBN2	All	UKBN2
Q95	311	17	58.84	51.92	17.68	5.77	41.16	48.08	10.93	0.00
Q70			52.41	51.92	12.86	5.77	47.59	48.08	7.40	3.85
Q50			51.13	53.85	11.58	7.69	48.87	46.15	3.22	5.77
SeasMeanA			70.74	78.85	3.54	1.92	29.26	21.15	0.96	0.00
SeasMeanW			83.92	90.38	24.44	25.00	16.08	9.62	0.00	0.00
SeasMeanSP			20.90	21.15	0.96	0.00	79.10	78.85	7.72	5.77
SeasMeanSU			52.09	46.15	7.40	0.00	47.91	53.85	6.75	3.85

48 Table S4: Summary of trend results for the UKBN2 network for hydrological drought indicators calculated from SSI3 for the period 1965 – 2022. Please note
49 that the numbers of stations are significantly lower than the numbers for the full network shown in Tables S1 and S2.
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Region	No. of stations	Max. intensity				Total deficit				Duration			
		Positive (%)	Sign. pos. at 5% (%)	Negative (%)	Sign. neg. at 5% (%)	Positive (%)	Sign. pos. at 5% (%)	Negative (%)	Sign. neg. at 5% (%)	Positive (%)	Sign. pos. at 5% (%)	Negative (%)	Sign. neg. at 5% (%)
WS	6	83.3	16.7	16.7	0.0	83.3	33.3	0.0	0.0	0.0	0.0	100.0	83.3
ES	8	75.0	12.5	25.0	0.0	87.5	25.0	0.0	0.0	0.0	0.0	100.0	12.5
NEE	4	25.0	0.0	75.0	0.0	25.0	0.0	25.0	0.0	25.0	0.0	75.0	25.0
ST	7	0.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	100.0	0.0	0.0	0.0
ANG	5	40.0	0.0	60.0	20.0	40.0	0.0	60.0	0.0	40.0	0.0	60.0	0.0
SE	16	37.5	0.0	62.5	0.0	25.0	0.0	75.0	6.3	68.8	0.0	31.3	0.0
SWESW	11	36.4	0.0	63.6	0.0	72.7	0.0	27.3	0.0	54.5	0.0	45.5	0.0
NWENW	5	40.0	0.0	60.0	0.0	60.0	0.0	40.0	0.0	40.0	0.0	60.0	20.0

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