Hydrological Summary

for the United Kingdom

July 2013

General

July was a month of contrasts – with the Jet Stream tracking to the north of the country, hot, arid conditions dominated throughout the most notable heatwave since June/July 2006. With evaporation demands and soil moisture deficits increasing steeply through the first three weeks, the countryside – verdant in the early summer – took on a very parched complexion. Woodland and heathland fires were widely reported together with substantial increases in both spray irrigation and domestic demand – reportedly rising by 30% in some localities. Seasonal river flow recessions steepened with a corresponding contraction in the stream network and associated ecological stress. Reservoir replenishment was very meagre until the fourth week when a dramatic change in synoptic patterns heralded a very unsettled episode with intense downpours and localised, mostly urban, flooding. Runoff rates recovered rapidly in most, but not all, areas – helping to ensure that early August reservoir stocks were within 10% of the long term average in all index impoundments (excepting a few where maintenance work is ongoing) and, notwithstanding steep recessions since January, groundwater levels in most major aquifers are also within the normal late-summer range, albeit below average in some areas. Although rainfall deficiencies for 2013 thus far are notable in some, mostly western, areas, the legacy of the exceptional 2012 rainfall has ensured that the general water resources outlook remains healthy.

Rainfall

Early in July the Azores high pressure cell extended north-eastwards across almost all of the UK – bringing warm and very dry weather conditions which lasted throughout most of the month. Parts of north-west Britain aside, many areas reported 20, or more, days without a trace of rain (but there were some observations of virga – precipitation that evaporates before reaching the ground). Weather patterns were rapidly transformed on the 22nd/23rd and rainfall in many localities over the last 10 days of the month exceeded the July average. The Midlands was particularly wet: Nottingham recorded a rainfall total of 67.8mm in 24 hrs (22nd/23rd) and nearby Market Bosworth registered 21mm in less than an hour. In Cumbria, 79.8mm of rain fell at Carlisle in the 24 hours ending at 09:00 GMT on the 28th (with 97.4mm in 48 hrs). The intensity of much of the late-July rainfall overwhelmed local drainage capacities in some areas; flash flooding was common and transport disruption considerable (the rail link between Edinburgh and Berwick was interrupted). Nationally, the July rainfall total was around 80% of average but spatial variations in rainfall anomalies were very substantial – reflecting the convective nature of much of the late-July precipitation. Some areas missed by the storms reported less than a quarter of the July average rainfall (e.g. coastal areas of Hampshire) and parts of northern Scotland and the South West registered less than 50%. The Western Isles recorded their driest June/July since 1982 (the third successive notably dry early summer) and substantial medium-term rainfall deficiencies extend across much of the country. Provisional February-July rainfall totals are the lowest for 10 years for Scotland, and 30 years for Wales. However, the significance of these deficiencies for water resources is considerably moderated by the exceptional 2012 rainfall.

River flows

Some spring-fed streams aside, river flows in July spanned a seasonally very wide range. Recessions were steep throughout much of the month and, by the fourth week, flows in some responsive rivers, including the South Tyne and Clyde (both with records of around 50 years) were approaching long term minima. Depressed flow rates affected most of the country and, with oxygen levels also declining, ecological stress became increasingly evident; in the fourth week, the Environment Agency rescued fish isolated in headwater reaches of the River Teme (Herefordshire). Locally, the intensity of the late-July rainfall exceeded the infiltration capacity of the dry soils; correspondingly flash flooding was common (e.g. at Todmorden on the 30th), and runoff rates picked up sharply in most catchments. Spate conditions were widespread in late July; the Dover Beck and Lune both reported their 2nd highest July flows on record and flood alerts extended across large parts of northern Britain during the final week. Nonetheless, July runoff totals were depressed in a number of responsive western and northern catchments: The Taw (Devon) and Nevis (Scottish Highlands) recorded their lowest July runoff since the 1984 drought. In contrast, flows remained modestly above average in a number of groundwater-fed rivers (e.g. the Lambourn, Itchen and Mimram). Notable runoff deficiencies have built up through 2013 thus far in some western catchments (e.g. the Ribble) but the extreme runoff in the late autumn and early winter of 2012 has ensured that 12-month runoff accumulations are healthy across almost all of the UK (north-west Scotland is an exception).

Groundwater

The great majority of the heavy late-July rainfall served to moderate soil moisture deficits rather than recharge aquifers but some isolated replenishment will have occurred. Generally the steep 2013 recessions, from exceptionally high groundwater levels early in the year, have returned levels to well within the normal range for the late summer – but the influence of the differing characteristics of individual aquifers is also evident in many of the hydrographs. For example in the Carboniferous Limestone levels are low in South Wales and have fallen 35 metres since the turn of the year at Alstonfield (Derbyshire). In contrast, levels are still rising (in response to the 2012 rainfall) in the much slower-responding Permo-Triassic sandstone at Nuttalls Farm (West Midlands). Here, as across much of the outcrop, levels are above the late summer average – notably so at Skirwith in north-west England. In the Magnesian Limestone, levels have fallen but remain seasonally high, particularly further north (Swan House) whilst in the Jurassic Limestone, levels are well within the normal range. This is also true of the Chalk, the UK's primary aquifer, but a distinction can still be drawn between the more responsive wells (e.g. Tilshead) where levels have fallen a little below the late-summer average and the slower-responding Stonor Park and Therfield wells where levels remain appreciably above average.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
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Rainfall . . . Rainfall . . .

Met Office

Rainfall accumulations and return period estimates

Percentages are from the 1971-2000 average.

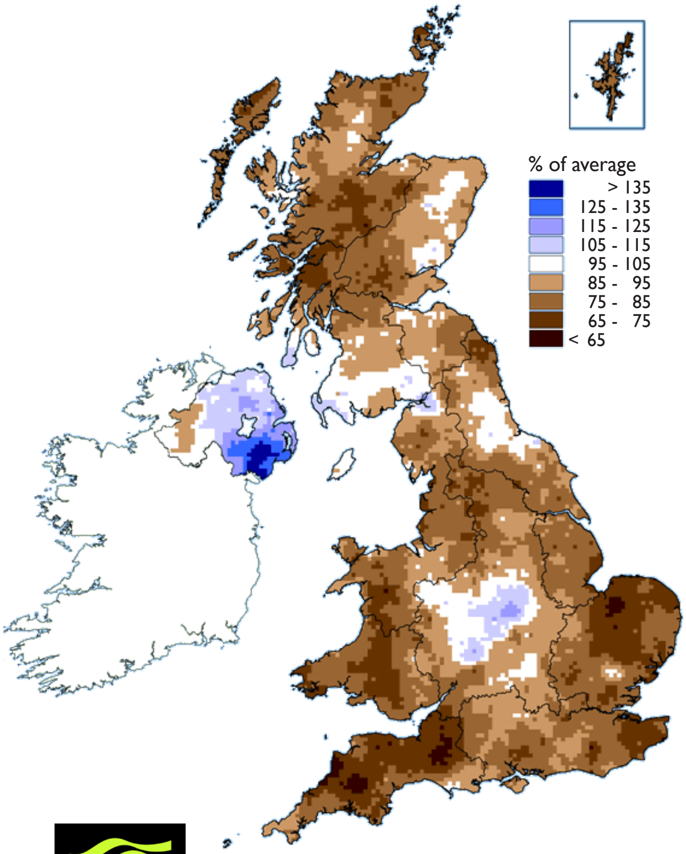
Area	Rainfall	Jul 2013	Jun13 – Jul13	RP	May13 – Jul13	RP	Feb13 – Jul13	RP	Aug12 – Jul13	RP
United	mm	**64**	111		201		390		1166	
Kingdom	%	**97**	82	5-10	101	2-5	88	5-10	108	2-5
England	mm	**52**	87		157		295		927	
	%	**100**	76	5-10	93	2-5	85	5-10	114	2-5
Scotland	mm	**83**	139		257		512		1471	
	%	**96**	84	5-10	108	2-5	90	2-5	102	2-5
Wales	mm	**58**	115		223		438		1458	
	%	**79**	74	5-10	96	2-5	82	5-10	107	2-5
Northern	mm	**78**	166		276		516		1219	
Ireland	%	**105**	114	2-5	130	2-5	111	2-5	110	5-10
England &	mm	**53**	91		166		314		1001	
Wales	%	**96**	76	5-10	94	2-5	84	5-10	113	2-5
North West	mm	**107**	167		254		411		1346	
	%	**137**	107	2-5	114	2-5	86	5-10	115	5-10
Northumbria	mm	**74**	112		203		339		1036	
	%	**130**	95	2-5	115	2-5	93	2-5	126	10-20
Midlands	mm	**66**	105		186		316		873	
	%	**134**	94	2-5	113	2-5	95	2-5	116	2-5
Yorkshire	mm	**59**	99		181		303		944	
	%	**112**	86	2-5	106	2-5	86	5-10	117	2-5
Anglian	mm	**33**	57		108		216		624	
	%	**74**	58	10-15	74	5-10	79	5-10	104	2-5
Thames	mm	**36**	59		120		263		764	
	%	**84**	59	8-12	79	5-10	86	2-5	110	2-5
Southern	mm	**27**	48		100		252		841	
	%	**60**	48	15-25	67	8-12	80	5-10	109	2-5
Wessex	mm	**43**	73		134		278		1015	
	%	**91**	68	5-10	82	5-10	78	5-10	118	5-10
South West	mm	**27**	70		148		356		1381	
	%	**44**	53	10-20	73	5-10	75	8-12	116	5-10
Welsh	mm	**57**	112		217		426		1415	
	%	**79**	74	5-10	96	2-5	82	5-10	108	2-5
Highland	mm	**62**	123		271		589		1636	
	%	**65**	67	20-30	103	2-5	89	2-5	95	2-5
North East	mm	**82**	125		206		385		980	
	%	**124**	95	2-5	106	2-5	96	2-5	104	2-5
Tay	mm	**86**	123		222		451		1328	
	%	**116**	86	5-10	103	2-5	89	2-5	105	2-5
Forth	mm	**98**	136		216		400		1217	
	%	**137**	97	2-5	104	2-5	87	2-5	108	2-5
Tweed	mm	**96**	140		213		385		1152	
	%	**149**	108	2-5	109	2-5	95	2-5	122	8-12
Solway	mm	**112**	182		310		568		1643	
	%	**128**	110	2-5	128	2-5	102	2-5	118	10-20
Clyde	mm	**106**	177		314		588		1794	
	%	**99**	90	2-5	114	2-5	88	2-5	104	2-5

% = percentage of 1971-2000 average *RP = Return period*

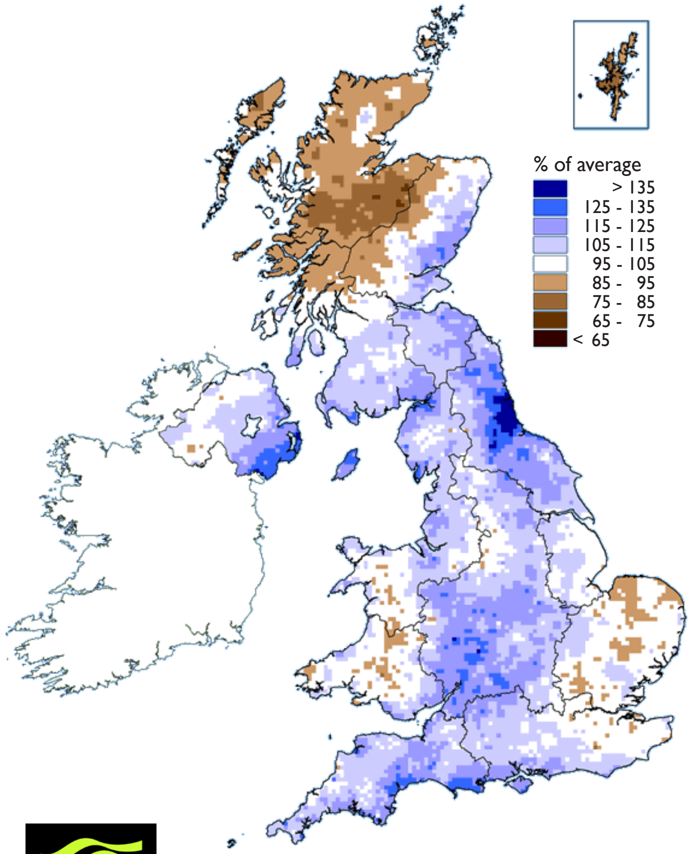
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability since 1910; they also assume a stable climate. The quoted RPs relate to the specific timespans only; for the same timespans, but beginning in any month the RPs would be substantially shorter. The timespans featured do not purport to represent the critical periods for any particular water resource management zone. For hydrological or water resources assessments of drought severity, river flows and/or groundwater levels normally provide a better guide than return periods based on regional rainfall totals. Note that precipitation totals in winter months may be underestimated due to snowfall undercatch. All monthly rainfall totals since March 2013 are provisional.

Rainfall . . . Rainfall . . .

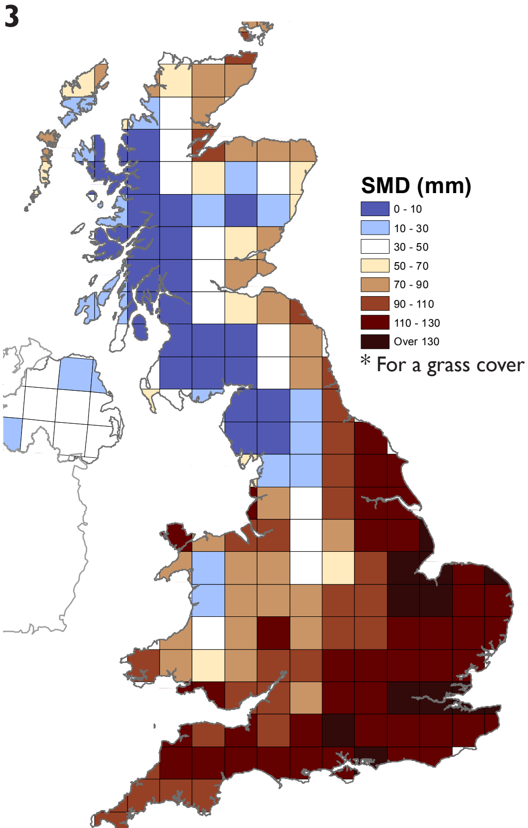
February 2013 - July 2013 rainfall as % of 1971-2000 average



August 2012 - July 2013 rainfall as % of 1971-2000 average



MORECS Soil Moisture Deficits* July 2013



Met Office 3-month outlook Updated: July 2013

The balance of probabilities suggests that the dry, settled conditions experienced through much of July may not persist through August; currently near-to-above-average rainfall is slightly favoured. For August-September-October as a whole the signal is largely indistinguishable from climatology.

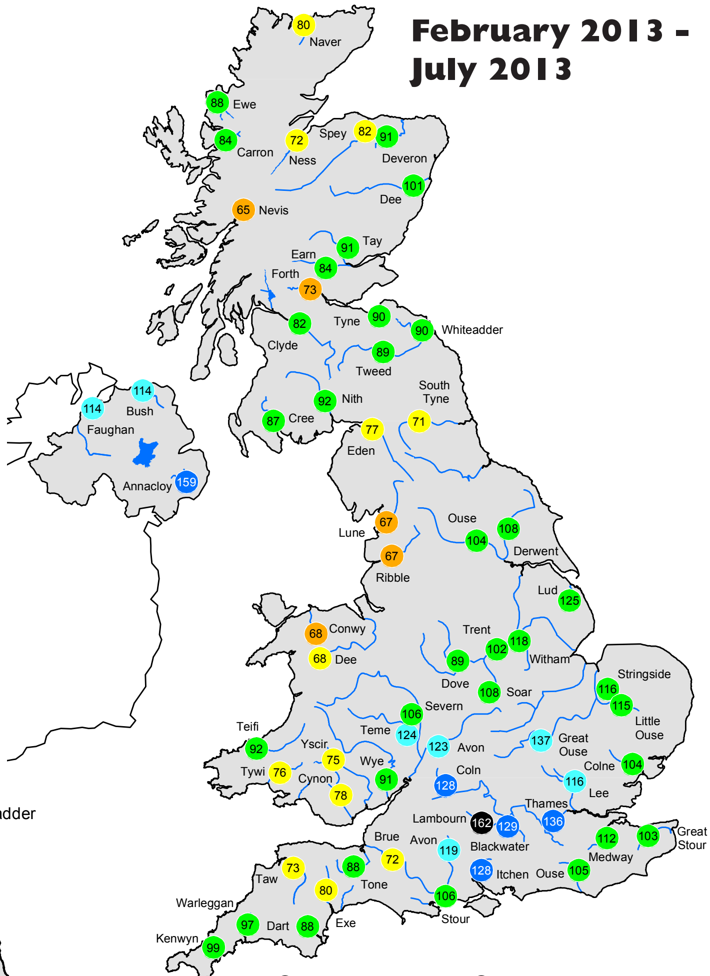
The probability that UK precipitation for August-September-October will fall into the driest of our five categories is around 20% and the probability that it will fall into the wettest category is around 20% (the 1981-2010 probability for each of these categories is 20%).

The complete version of the 3-month outlook may be found at:
http://www.metoffice.gov.uk/publicsector/contingency-planners
This outlook is updated towards the end of each calendar month.

The latest shorter-range forecasts, covering the upcoming 30 days, can be accessed via:
http://www.metoffice.gov.uk/weather/uk/uk_forecast_weather.html
These forecasts are updated very frequently.

River flow . . . River flow . . .

February 2013 - July 2013



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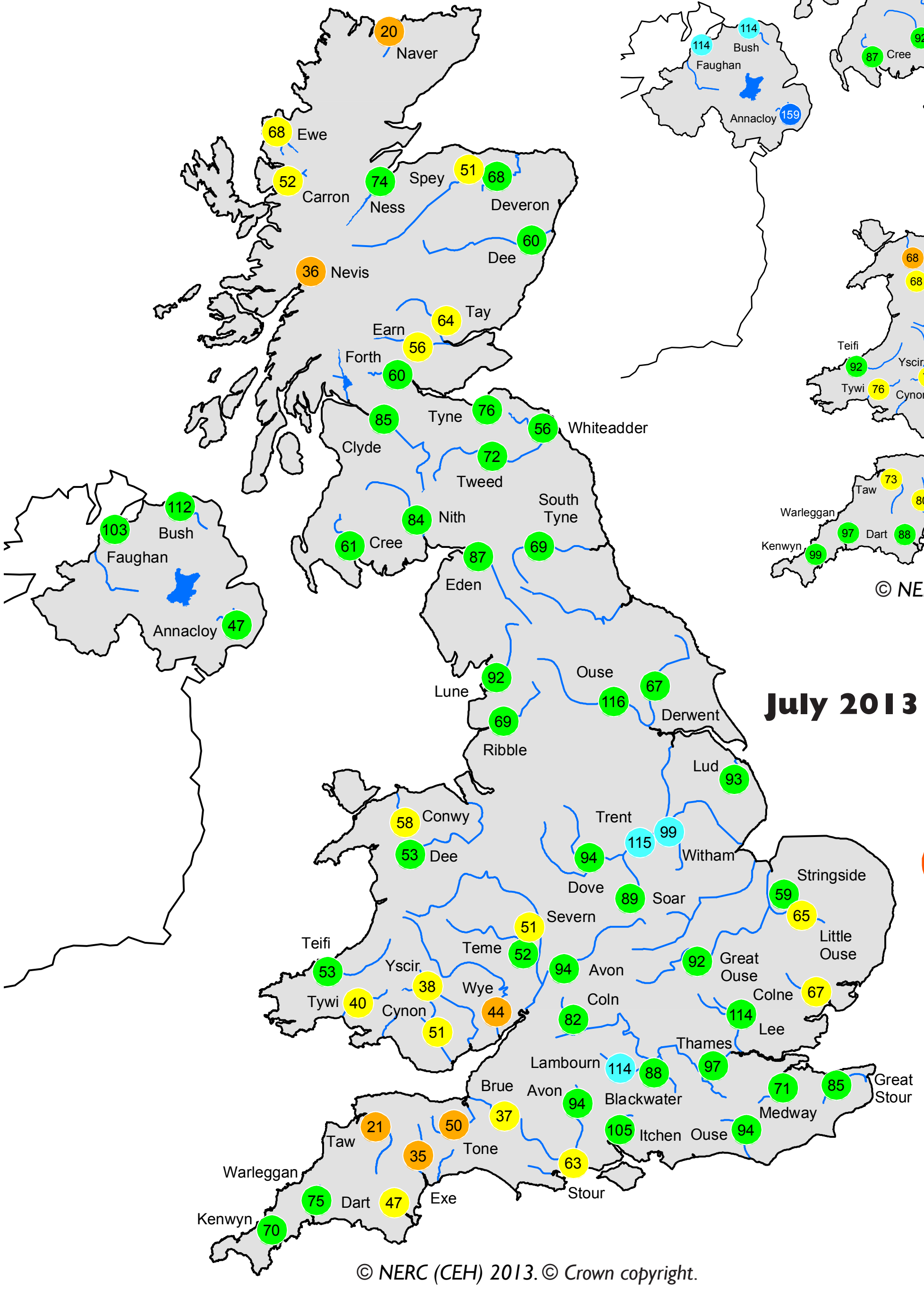
July 2013



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Key

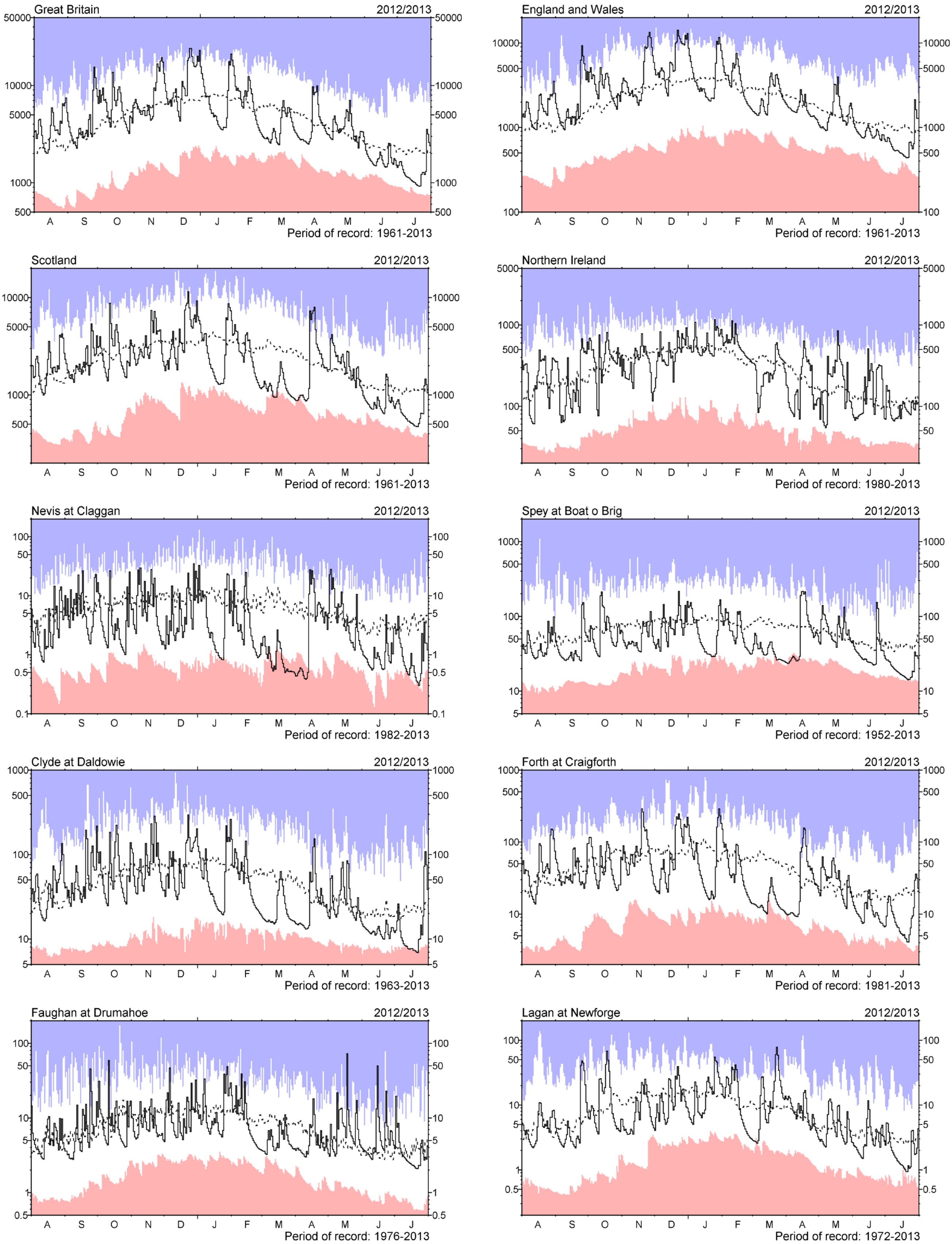
- 25 — % of long-term average (record figure when circled)
- Exceptionally high flow
- Notably high flow
- Above normal
- Normal range
- Below normal
- Notably low flow
- Exceptionally low flow

*Based on ranking of the monthly flow**

River flows

*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much greater. Note: the period of record on which these percentages are based varies from station to station. Percentages may be omitted where flows are under review.

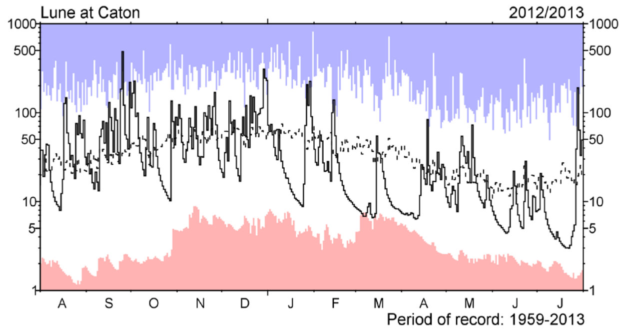
River flow . . . River flow . . .

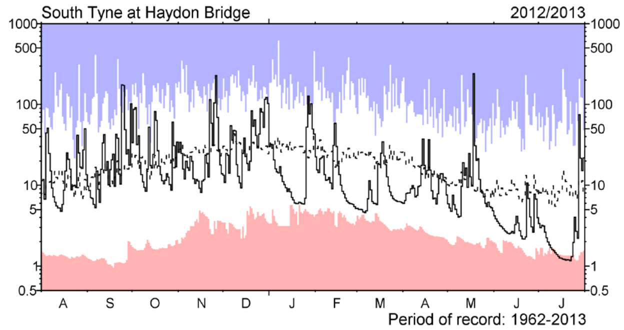


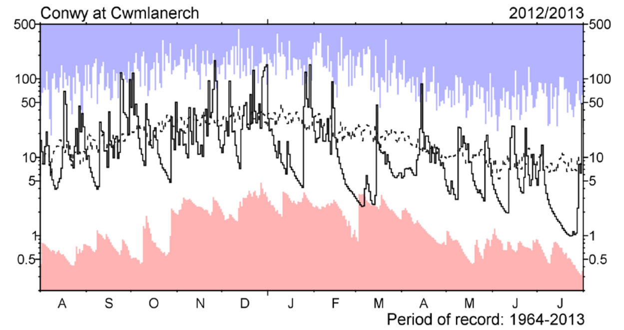
River flow hydrographs

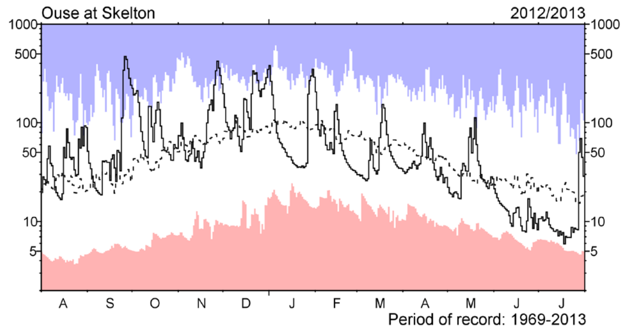
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to August 2012 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. Mean daily flows are shown as the dashed line.

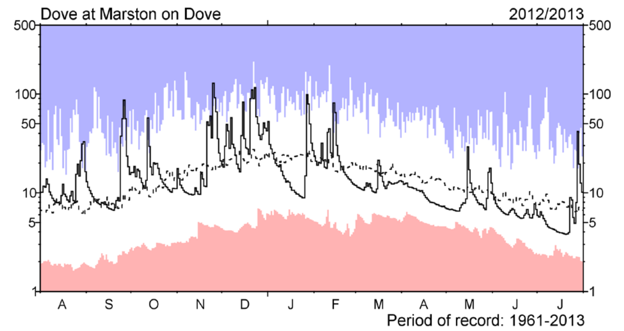
River flow . . . River flow . . .

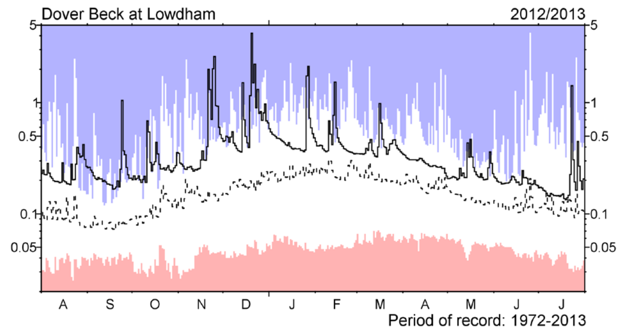


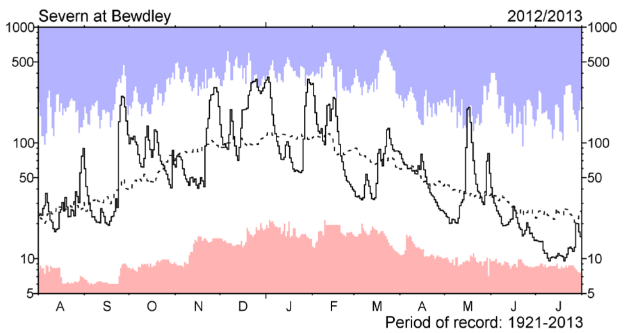


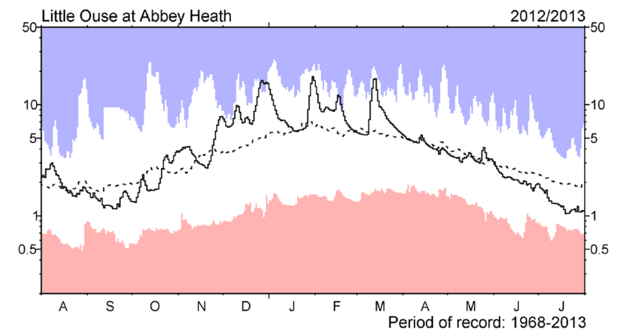


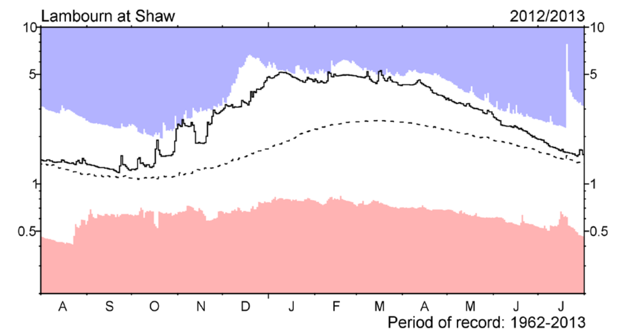


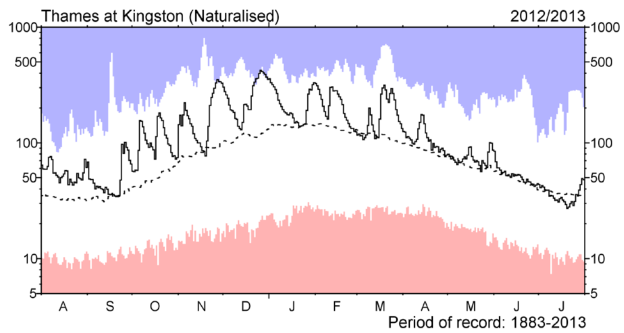


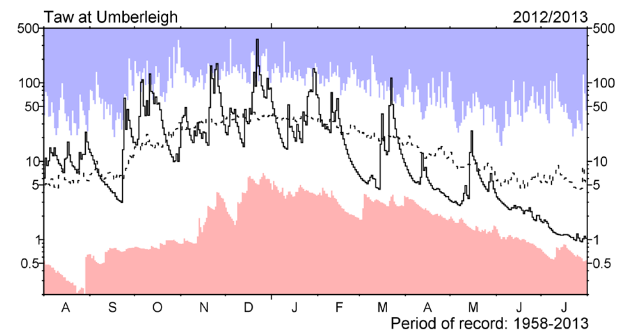


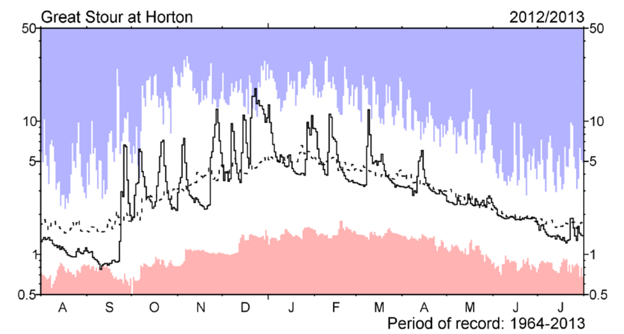




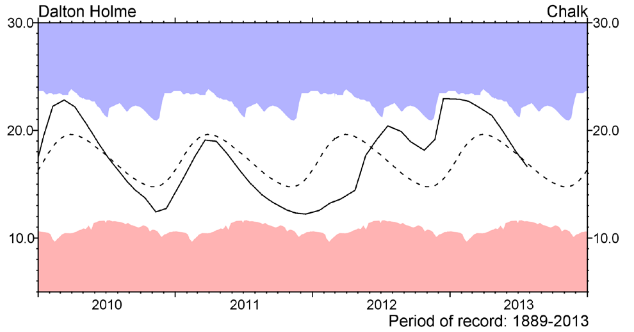


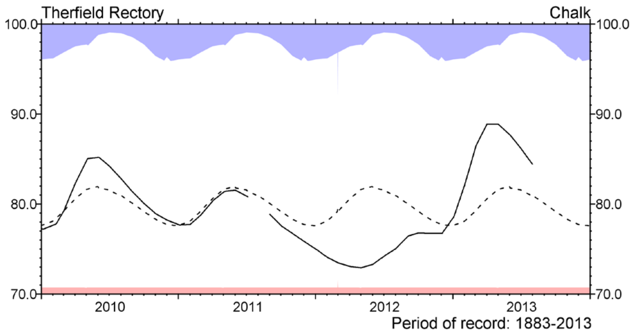


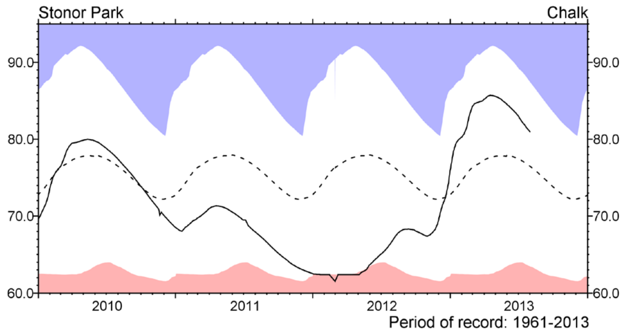


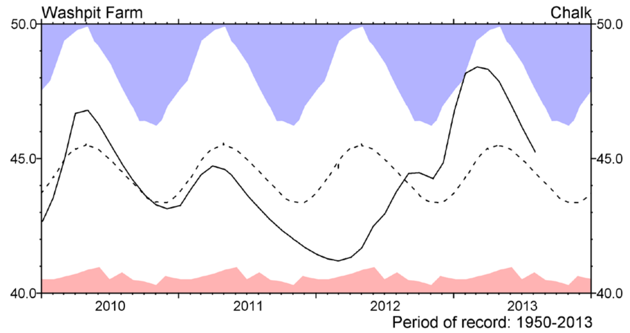


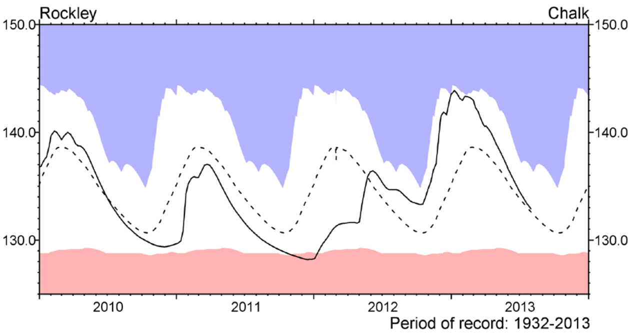
Groundwater . . . Groundwater

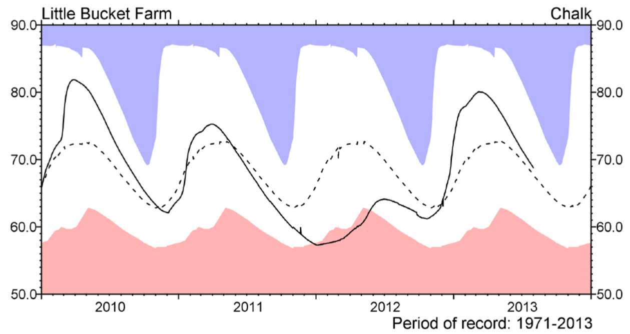


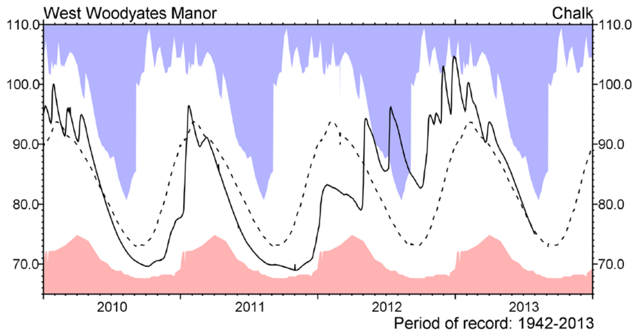


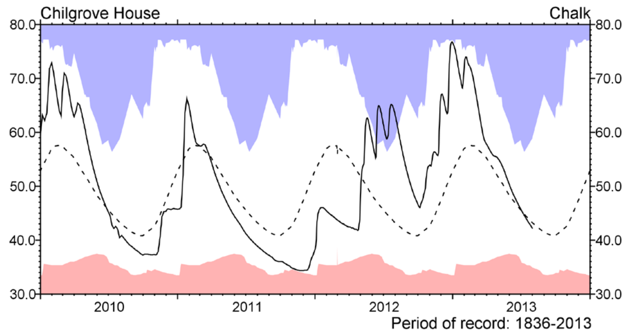


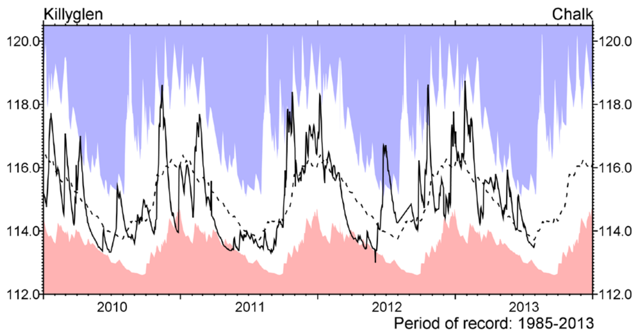


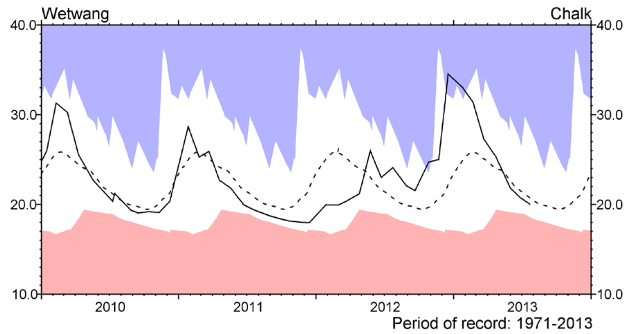






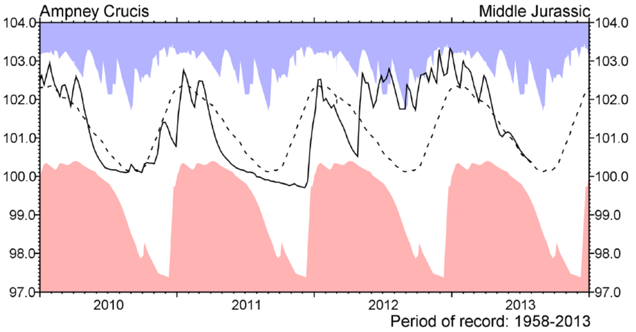


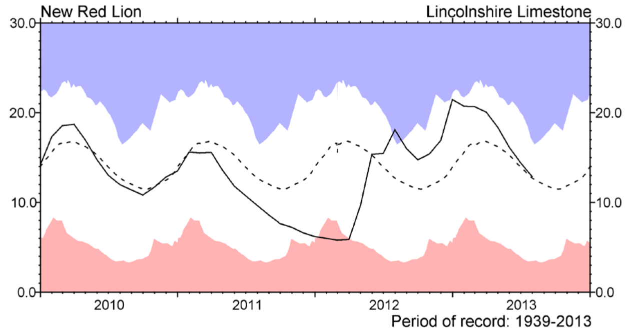


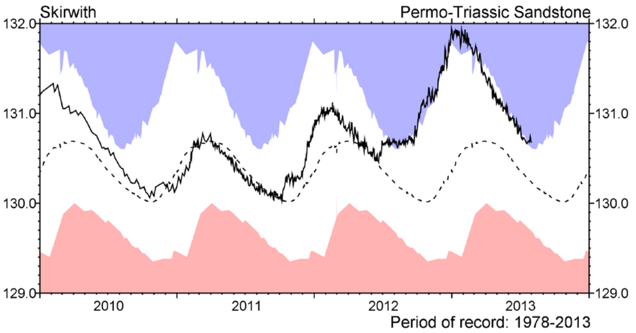


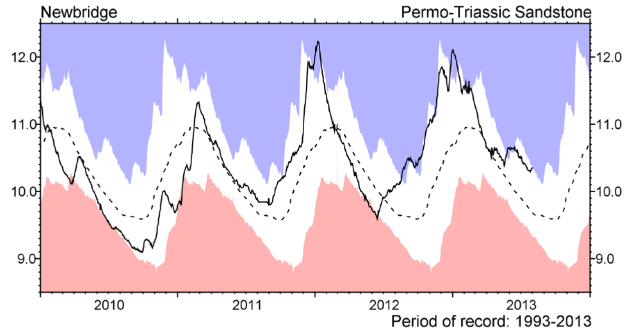
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined below overlying impermeable strata. The monthly mean and the highest and lowest levels recorded for each month are displayed in a similar style to the river flow hydrographs. Note that most groundwater levels are not measured continuously and, for some index wells, the greater frequency of contemporary measurements may, in itself, contribute to an increased range of variation. The latest recorded levels are listed overleaf.

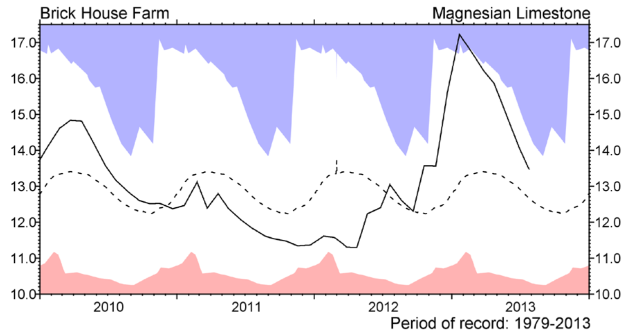
Groundwater ... Groundwater

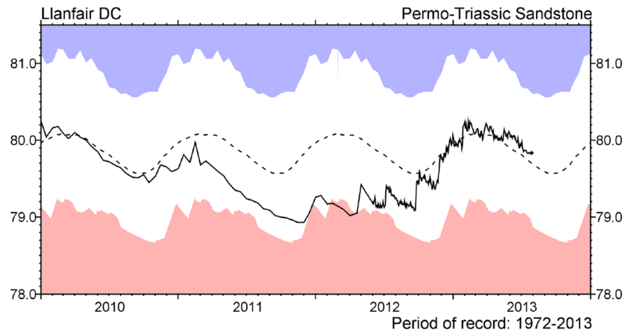


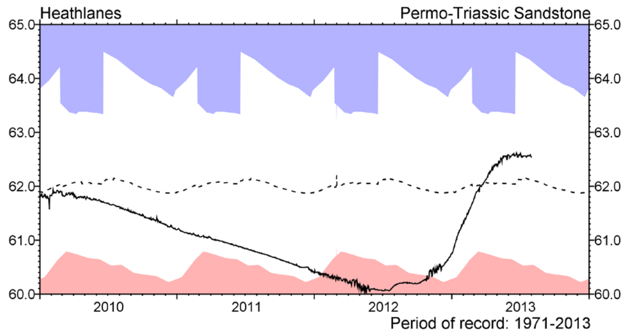


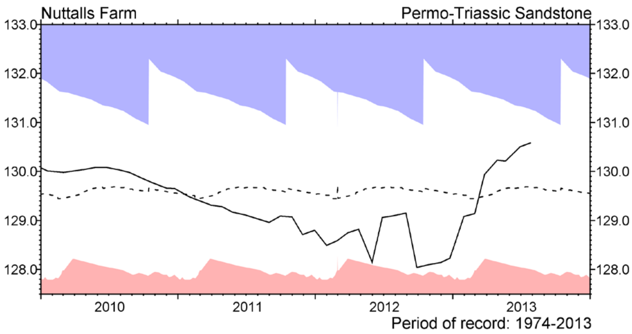


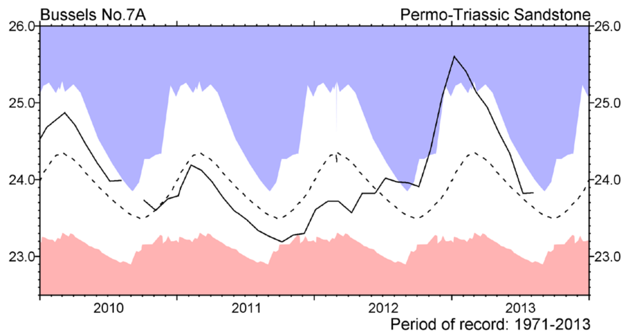


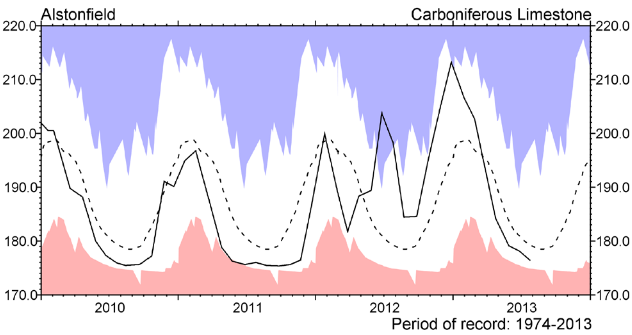










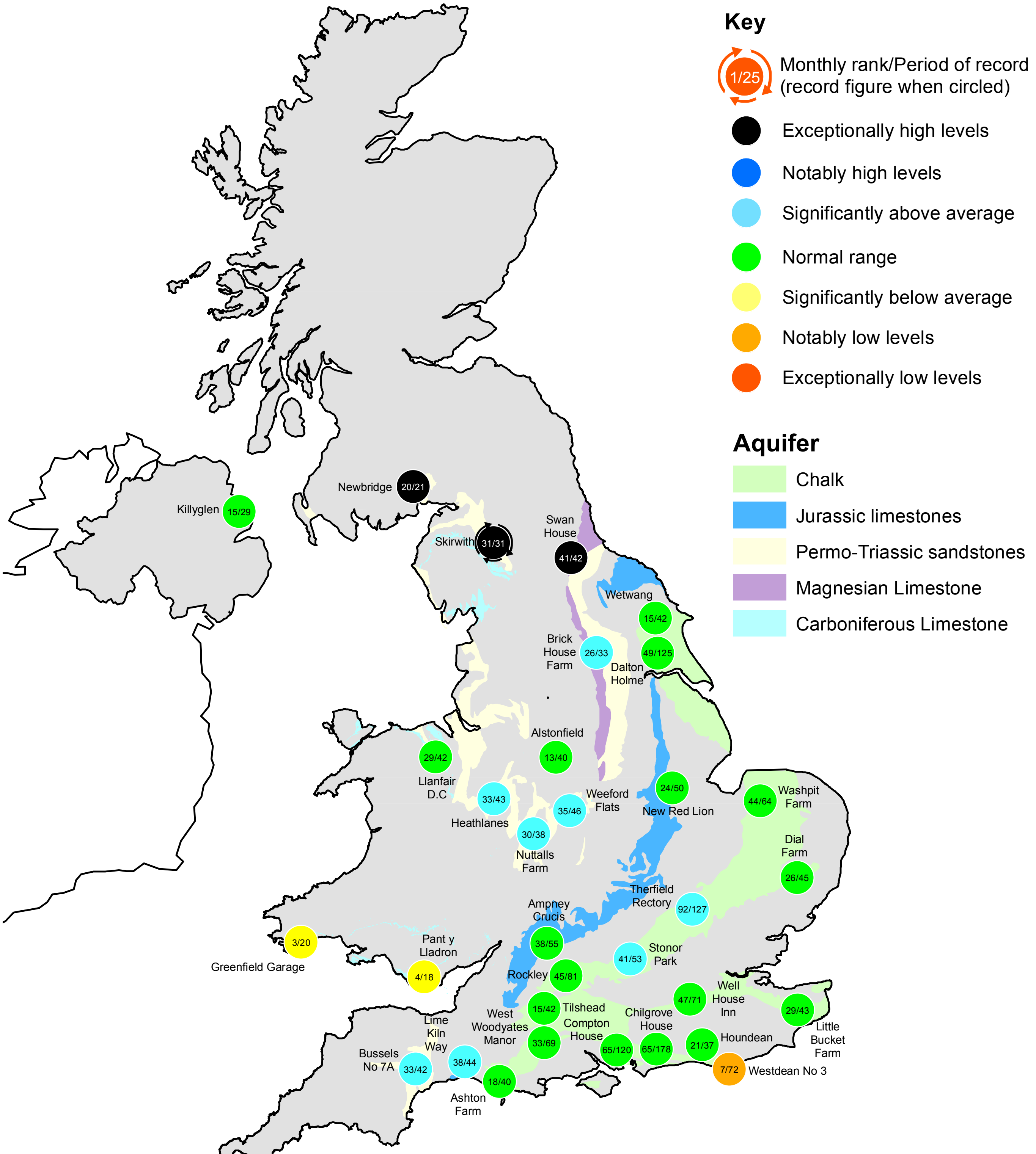


Groundwater levels July / August 2013

Borehole	Level	Date	Jul av.	Borehole	Level	Date	Jul av.	Borehole	Level	Date	Jul av.
Dalton Holme	16.66	24/07	17.23	Chilgrove House	42.16	31/07	43.66	Brick House Farm	13.47	25/07	12.81
Therfield Rectory	84.42	31/07	81.43	Killyglen (NI)	113.60	31/07	113.89	Llanfair DC	79.84	01/08	79.74
Stonor Park	81.00	31/07	76.81	Wetwang	20.02	22/07	20.99	Heathlanes	62.54	31/07	62.04
Tilshead	82.94	31/07	85.01	Ampney Crucis	100.37	31/07	100.50	Nuttalls Farm	130.58	26/07	129.62
Rockley	132.91	31/07	133.22	New Red Lion	12.85	31/07	13.23	Bussels No.7a	23.83	05/08	23.73
Well House Inn	97.32	31/07	95.71	Skirwith	130.70	31/07	130.31	Alstonfield	176.43	24/07	179.24
West Woodyates	75.00	31/07	77.14	Newbridge	10.35	31/07	9.79				

Levels in metres above Ordnance Datum

Groundwater . . . Groundwater



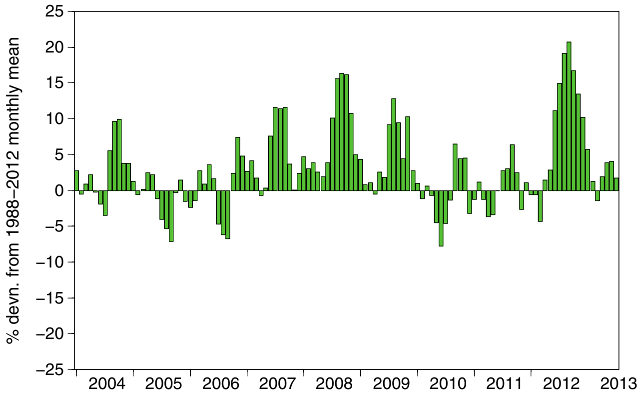
Groundwater levels - July 2013

The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. The rankings are designed as a qualitative indicator, and ranks at extreme levels, and when levels are changing rapidly, need to be interpreted with caution.

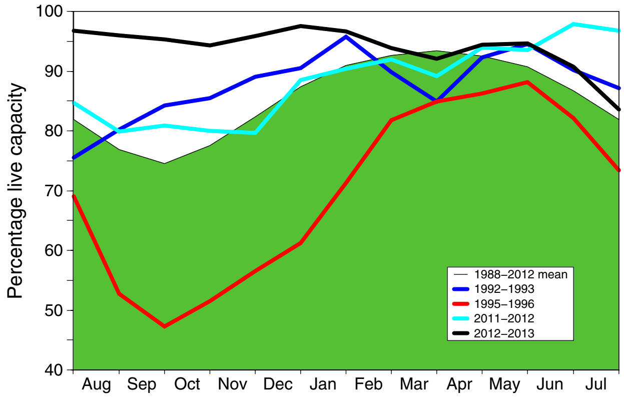
Notes:
i. The outcrop areas are coloured according to British Geological Survey conventions.
ii. Yew Tree Farm levels are now received quarterly.

Reservoirs . . . Reservoirs . . .

Guide to the variation in overall reservoir stocks for England and Wales



Comparison between overall reservoir stocks for England and Wales in recent years



These plots are based on the England and Wales figures listed below.

Percentage live capacity of selected reservoirs at end of month

Area	Reservoir		Capacity (Ml)	2013 May	2013 Jun	2013 Jul	Jul Anom.	Min Jul	Year* of min	2012 Jul	Diff 13-12
North West	N Command Zone	•	124929	83	73	64	0	23	1984	92	-28
	Vyrnwy		55146	98	94	82	7	45	1984	98	-16
Northumbrian	Teesdale	•	87936	95	90	83	9	45	1989	95	-12
	Kielder		(199175)	92	90	89	0	66	1989	100	-11
Severn Trent	Clywedog		44922	99	99	87	2	50	1976	94	-7
	Derwent Valley	•	39525	85	76	69	-5	43	1996	97	-28
Yorkshire	Washburn	•	22035	91	83	72	-2	50	1995	93	-21
	Bradford supply	•	41407	91	77	63	-9	38	1995	97	-34
Anglian	Grafham		(55490)	96	94	92	3	66	1997	94	-2
	Rutland		(116580)	95	92	86	1	74	1995	97	-11
Thames	London	•	202828	97	97	93	6	73	1990	98	-5
	Farmoor	•	13822	97	98	93	-3	84	1990	97	-4
Southern	Bewl		28170	99	93	82	6	45	1990	90	-8
	Ardingly		4685	100	98	86	0	65	2005	100	-14
Wessex	Clatworthy		5364	85	78	70	-5	43	1992	100	-30
	Bristol WW	•	(38666)	90	83	71	-5	53	1990	98	-27
South West	Colliford		28540	97	91	82	4	47	1997	86	-5
	Roadford		34500	88	86	76	-1	46	1996	93	-17
	Wimbleball		21320	94	85	74	-4	53	1992	100	-26
	Stithians		4967	86	82	72	1	39	1990	98	-27
Welsh	Celyn and Brenig	•	131155	100	99	90	2	65	1989	100	-9
	Brianne		62140	100	99	94	4	67	1995	100	-6
	Big Five	•	69762	96	95	83	6	41	1989	98	-15
	Elan Valley	•	99106	100	95	84	2	53	1976	97	-13
Scotland(E)	Edinburgh/Mid Lothian	•	97639	96	92	82	-1	51	1998	100	-18
	East Lothian	•	10206	100	98	88	-1	72	1992	100	-12
Scotland(W)	Loch Katrine	•	111363	92	78	66	-9	53	2000	88	-22
	Daer**		22412	77	65	56	-26	56	2013	100	-44
	Loch Thom	•	11840	91	85	85	1	59	2000	95	-10
Northern Ireland	Total+	•	55540	95	91	85	8	54	1995	95	-11
	Silent Valley	•	20634	96	93	82	9	42	2000	97	-15

( ) figures in parentheses relate to gross storage
• denotes reservoir groups
*last occurrence
** stocks affected by maintenance in 2013
+ excludes Lough Neagh

Details of the individual reservoirs in each of the groupings listed above are available on request. The percentages given in the Average and Minimum storage columns relate to the 1988-2012 period except for West of Scotland and Northern Ireland where data commence in the mid-1990s. In some gravity-fed reservoirs (e.g. Clywedog) stocks are kept below capacity during the winter to provide scope for flood attenuation purposes; hydro-power generation may also influence reservoir stocks. Monthly figures may be artificially low due to routine maintenance or water quality issues.

Location map...Location map

National Hydrological Monitoring Programme

The National Hydrological Monitoring Programme (NHMP) was instigated in 1988 and is undertaken jointly by the Centre for Ecology & Hydrology (CEH) and the British Geological Survey (BGS) – both are component bodies of the Natural Environment Research Council (NERC). The National River Flow Archive (maintained by CEH) and the National Groundwater Level Archive (maintained by BGS) provide the historical perspective within which to examine contemporary hydrological conditions.

Data Sources

River flow and groundwater level data are provided by the Environment Agency (EA), Natural Resources Wales - Cyfoeth Naturiol Cymru, the Scottish Environment Protection Agency (SEPA) and, for Northern Ireland, the Rivers Agency and the Northern Ireland Environment Agency. In all cases the data are subject to revision following validation (high flow and low flow data in particular may be subject to significant revision).

Reservoir level information is provided by the Water Service Companies, the EA, Scottish Water and Northern Ireland Water.

Most rainfall data are provided by the Met Office (address opposite).

To allow better spatial differentiation the monthly rainfall data for Britain are presented for the regional divisions of the precursor organisations of the EA and SEPA.

The monthly, and n-month, rainfall figures have been produced by the Met Office, National Climate Information Centre (NCIC) and are based on gridded data from raingauges. They include a significant number of monthly raingauge totals provided by the EA and SEPA. The Met Office NCIC monthly rainfall series extends back to 1910 and forms the official source of UK areal rainfall statistics which have been adopted by the NHMP. The gridding technique used is described in Perry MC and Hollis DM (2005) available at http://www.metoffice.gov.uk/climate/uk/about/Monthly_gridded_datasets_UK.pdf

The regional figures for the current month are based on limited raingauge networks so these (and the return periods associated with them) should be regarded as a guide only.

The Met Office NCIC monthly rainfall series are Crown Copyright and may not be passed on to, or published by, any unauthorised person or organisation.

From time to time the Hydrological Summary may also refer to evaporation and soil moisture figures. These are obtained from MORECS, the Met Office services involving the routine calculation of evaporation and soil moisture throughout the UK.

08/2013

For further details please contact:

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The National Hydrological Monitoring Programme depends on the active cooperation of many data suppliers. This cooperation is gratefully acknowledged.

Enquiries

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A full catalogue of past Hydrological Summaries can be accessed and downloaded at:
http://www.ceh.ac.uk/data/nrfa/nhmp/nhmp.html

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