Hydrological Summary for the United Kingdom

September 2013

General

Synoptic patterns across most of the country during September were typically autumnal but monthly rainfall totals were generally modest, mostly 50-80% of average, contributing to significant rainfall deficiencies in the June-September timeframe. There were a few notable storm events and some isolated flood alerts, mostly in mid-month, but with recessions then re-established, runoff rates in many catchments were seasonally depressed entering October. Reservoir replenishment since May has been below average and late-September stocks were notably below average in a number of, mostly southern, impoundments. For England & Wales as a whole reservoir stocks remain healthy (albeit substantially below the record levels of September 2012) but spatial variations are considerable. Seasonally modest stocks characterise parts of southern England and western Scotland. Despite groundwater recessions now extending for at least seven months in the most responsive aquifers, groundwater levels generally remain close to the early autumn average. Whilst the overall water resources situation is healthy, the notably high soil moisture deficits at month-end (reflecting similar conditions in 2009 and 2011) across much of Lowland England (and extending into eastern Scotland) imply a significant delay in the seasonal recovery of river flows and aquifer recharge rates. Even with average rainfall over the coming three months, it is unlikely that soils will approach saturation before mid-December in some regions. As a consequence there is an increased likelihood of notably low late autumn river flows and a restriction in the length of the 2013/14 aquifer recharge season.

Rainfall

After a dry and warm start to September, cyclonic conditions brought locally torrential downpours late in the first week; on the 6th, 24-hour rainfall totals of 62.8mm at Durham and 71.2mm at Nunraw Abbey (East Lothian) were reported, and more extensive heavy rainfall occurred around mid-month. Driven by a vigorous Jet Stream, a sequence of active frontal systems crossed the UK from the 15th-17th; in north-west Scotland, Cluaunie Inn reported a two-day rainfall total of 82mm. Thereafter, persistent high pressure, centred on Scandinavia, restricted the eastern penetration of further low pressure systems and dry weather predominated; precipitation was largely restricted to fog drip in many localities. Many regions registered September rainfall totals within the 70-80% range but parts of Wales and eastern Britain (Lincolnshire and the Cairngorms in particular) were notably dry – precipitation totals fell below 20mm in parts of Humberside and Lincolnshire. Convective storms contributed to the few areas registering substantially above average September rainfall (e.g. parts of north-east England). For much of the country, September was the fourth successive month registering below average rainfall and, at the national scale, the June-September period was the driest since 2003; particularly notable rainfall deficiencies characterise parts of eastern and southern England (in Anglian region it was the driest for 23 years). Rainfall deficiencies for 2013 thus far are moderate across most of the UK but water year (October-September) rainfall totals are close to the long-term average.

River flows

In most catchments, the late summer river flow recessions continued into early-September but the majority were interrupted by, mostly minor, spate conditions around the 7th/8th; a few flood alerts were in operation in north-east England (in Redcar flash flooding required the evacuation of 60 homes) and southern Scotland. The third week witnessed more extensive spates; nonetheless, estimated outflows from Great Britain remained below the long-term daily average throughout September (with the exception of the 16th). With few exceptions, September runoff totals were below average but within the normal range. Importantly, however, sustained recessions over the latter half of the month, and continuing into October, saw flows in responsive rivers approach the lowest on record, for the time of year; examples include the Dee (eastern Scotland), the Annacloy (Northern Ireland) and the Tone (Somerset). For such rivers, and extensively across Scotland, runoff totals for the June-September period were relatively depressed, and the third lowest since the 1984 drought for Scotland as a whole. An interesting exception is the Dover Beck (Nottinghamshire): the September runoff total was close to 150% of average and flows have remained well above average throughout a relatively dry 2013 – a consequence of sustained high baseflow, a legacy of the extreme recharge to the Permo-Triassic sandstones during 2012. Such rivers aside, current flows contrast sharply with the abundant runoff at the beginning of the year, and the seasonally very dry soil moisture conditions imply a continuation of recessions throughout the remainder of the autumn in some areas.

Groundwater

With relatively low rainfall and warm weather over much of Britain, combined with the seasonally high soil moisture deficits that have characterised the last few months, there has been, as yet, little sign of an onset of recharge across any aquifer. A year ago in September 2012, levels in many boreholes had established new monthly maxima. In contrast, across the majority of the Chalk, groundwater levels are currently still close to their seasonal average levels, and would have been lower were it not for the continued influence of the high recharge throughout much of last year. The exception to this pattern is in the south of England, where responsive Chalk aquifers are now below their normal range, and at Dalton Holme (Yorkshire), where a faster than expected recession has brought levels below their normal range. In the absence of a rapid onset of wetter weather, it is likely that recessions in the Chalk will continue, and levels in some aquifers may become notably low within the next two months. In the very responsive limestone in south Wales, levels are already depressed, the third lowest for the time of year at Greenfield Garage, albeit in a short 20-year record. In the generally slower responding Permo-Triassic sandstones and in the Magnesian Limestone, groundwater levels remain above their normal range, exceptionally so at Swan House. As in the Chalk, this is a legacy of last winter's recharge, and generally levels in these aquifers are declining gently.

Centre for Ecology & Hydrology
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Rainfall . . . Rainfall . . .

Met Office

Rainfall accumulations and return period estimates

Percentages are from the 1971-2000 average.

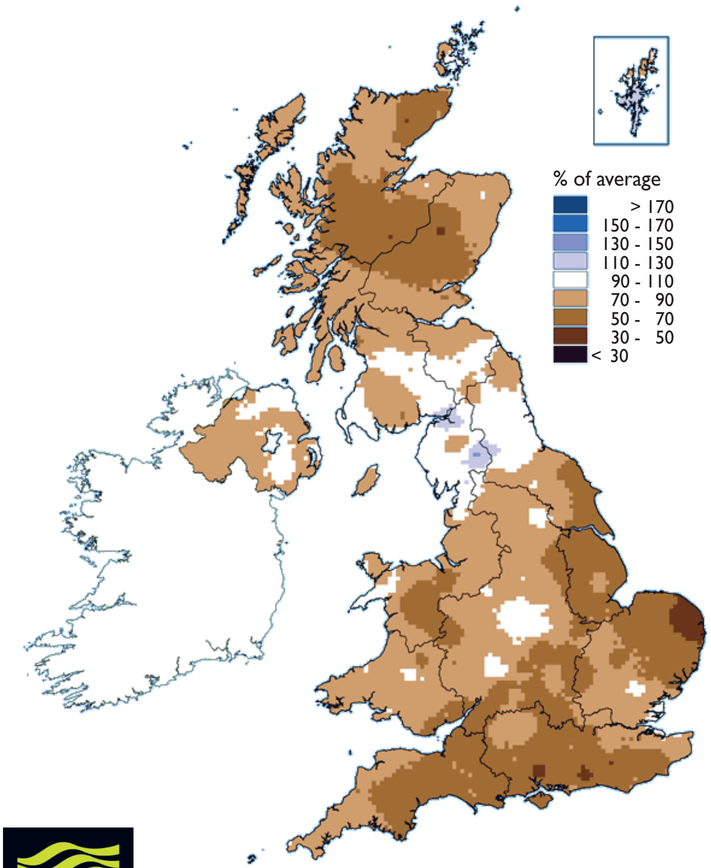
Area	Rainfall	Sep 2013	Jun 13 – Sep 13	RP	Apr 13 – Sep 13	RP	Jan 13 – Sep 13	RP	Oct 12 – Sep 13	RP
United	mm	**71**	253		408		643		1084	
Kingdom	%	**73**	81	8-12	92	5-10	87	5-10	101	2-5
England	mm	**55**	198		298		485		860	
	%	**76**	79	5-10	83	5-10	85	5-10	106	2-5
Scotland	mm	**95**	323		562		845		1372	
	%	**72**	81	8-12	102	2-5	88	5-10	96	2-5
Wales	mm	**80**	305		464		768		1361	
	%	**68**	82	5-10	87	5-10	85	5-10	100	2-5
Northern	mm	**69**	292		477		783		1121	
Ireland	%	**74**	88	2-5	102	2-5	102	2-5	101	2-5
England &	mm	**58**	213		321		524		929	
Wales	%	**74**	80	5-10	84	5-10	85	5-10	105	2-5
North West	mm	**85**	349		485		693		1197	
	%	**83**	99	2-5	99	2-5	87	5-10	102	2-5
Northumbria	mm	**68**	259		386		578		943	
	%	**97**	100	2-5	103	2-5	99	2-5	114	2-5
Midlands	mm	**40**	194		293		468		794	
	%	**60**	80	5-10	84	5-10	87	5-10	105	2-5
Yorkshire	mm	**45**	207		308		480		838	
	%	**65**	83	5-10	85	5-10	84	5-10	104	2-5
Anglian	mm	**36**	136		209		342		607	
	%	**66**	66	10-20	70	10-20	79	8-12	101	2-5
Thames	mm	**56**	153		248		421		746	
	%	**88**	70	5-10	77	5-10	86	5-10	107	2-5
Southern	mm	**53**	147		244		438		819	
	%	**74**	65	10-15	75	5-10	84	5-10	106	2-5
Wessex	mm	**59**	168		266		485		928	
	%	**77**	67	10-15	74	10-15	82	5-10	108	2-5
South West	mm	**85**	233		353		671		1300	
	%	**86**	74	5-10	77	8-12	84	5-10	109	2-5
Welsh	mm	**79**	299		452		748		1323	
	%	**70**	82	5-10	87	5-10	85	5-10	101	2-5
Highland	mm	**107**	343		658		966		1547	
	%	**67**	76	10-15	106	2-5	85	2-5	90	2-5
North East	mm	**49**	225		370		571		914	
	%	**55**	78	8-12	89	5-10	87	8-12	97	2-5
Tay	mm	**67**	241		440		718		1218	
	%	**59**	71	10-20	92	5-10	83	5-10	96	2-5
Forth	mm	**77**	262		423		657		1098	
	%	**73**	80	5-10	93	2-5	85	5-10	97	2-5
Tweed	mm	**70**	283		423		626		1039	
	%	**87**	100	2-5	103	2-5	95	2-5	109	2-5
Solway	mm	**109**	379		618		923		1491	
	%	**88**	96	2-5	112	2-5	98	2-5	107	2-5
Clyde	mm	**125**	406		678		1019		1670	
	%	**76**	83	5-10	103	2-5	88	2-5	97	2-5

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

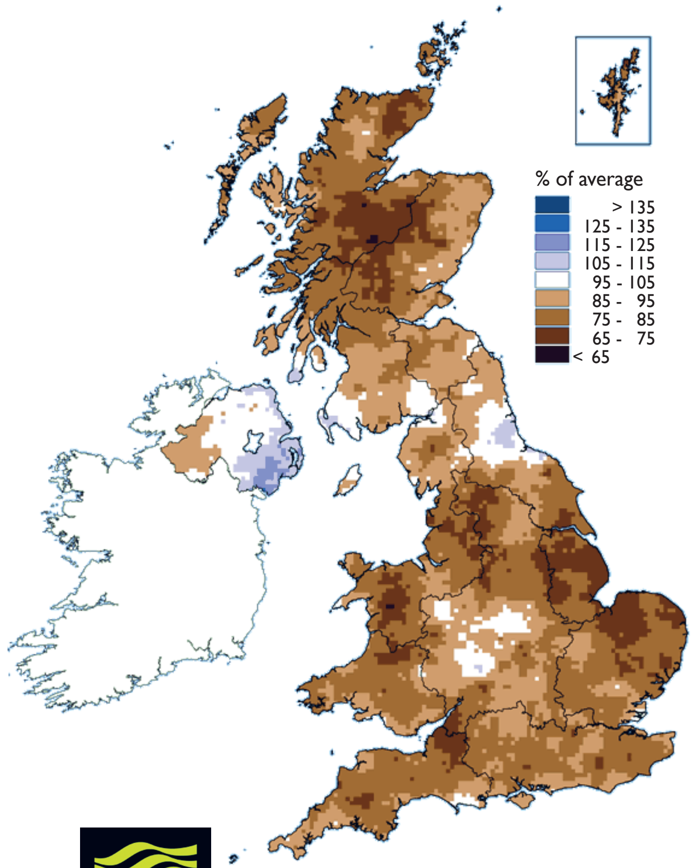
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic 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 April 2013 are provisional.

Rainfall . . . Rainfall . . .

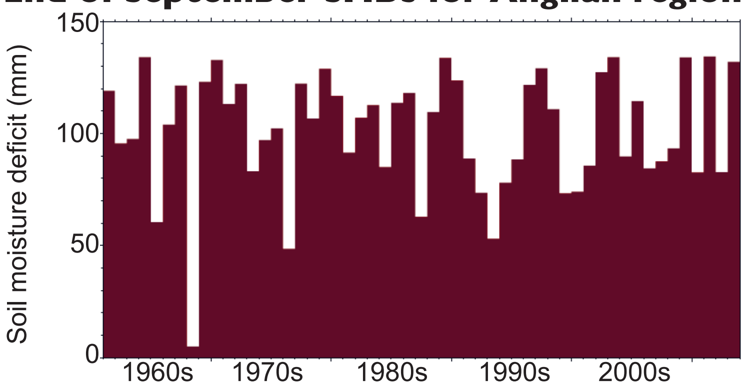
June 2013 - September 2013 rainfall as % of 1971-2000 average



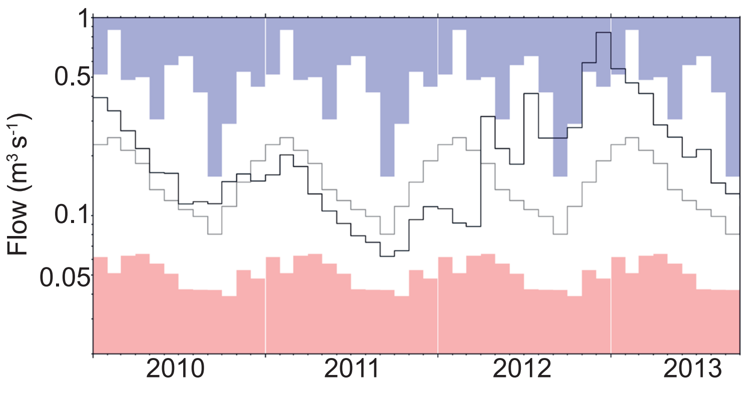
January 2013 - September 2013 rainfall as % of 1971-2000 average



End of September SMDs for Anglian region



Mean monthly flows for Dover Beck



Met Office 3-month outlook Updated: September 2013

Confidence in the forecast for precipitation across the UK over the next three months is low. There is a preference for near-to-below-average rainfall during October. For October-November-December as a whole the signal is similar to climatology, although with a slightly higher probability of above-average rainfall.

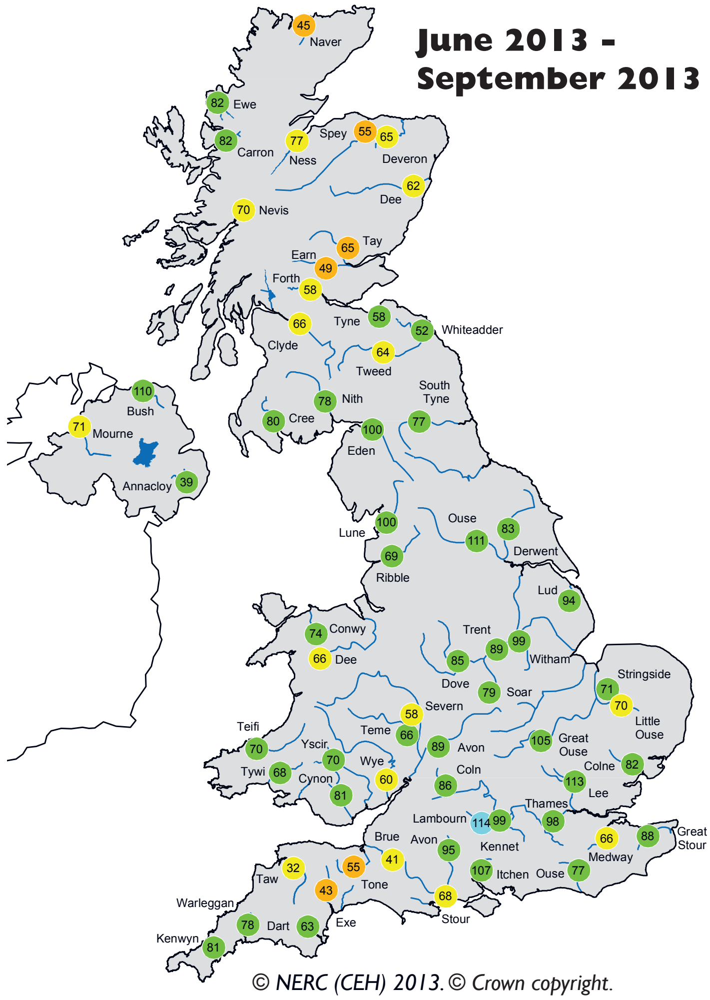
The probability that UK precipitation for October-November-December will fall into the driest of our five categories is around 20% and the probability that it will fall into the wettest category is around 20% (the 1981-2010 probability for each of these categories is 20%).

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.

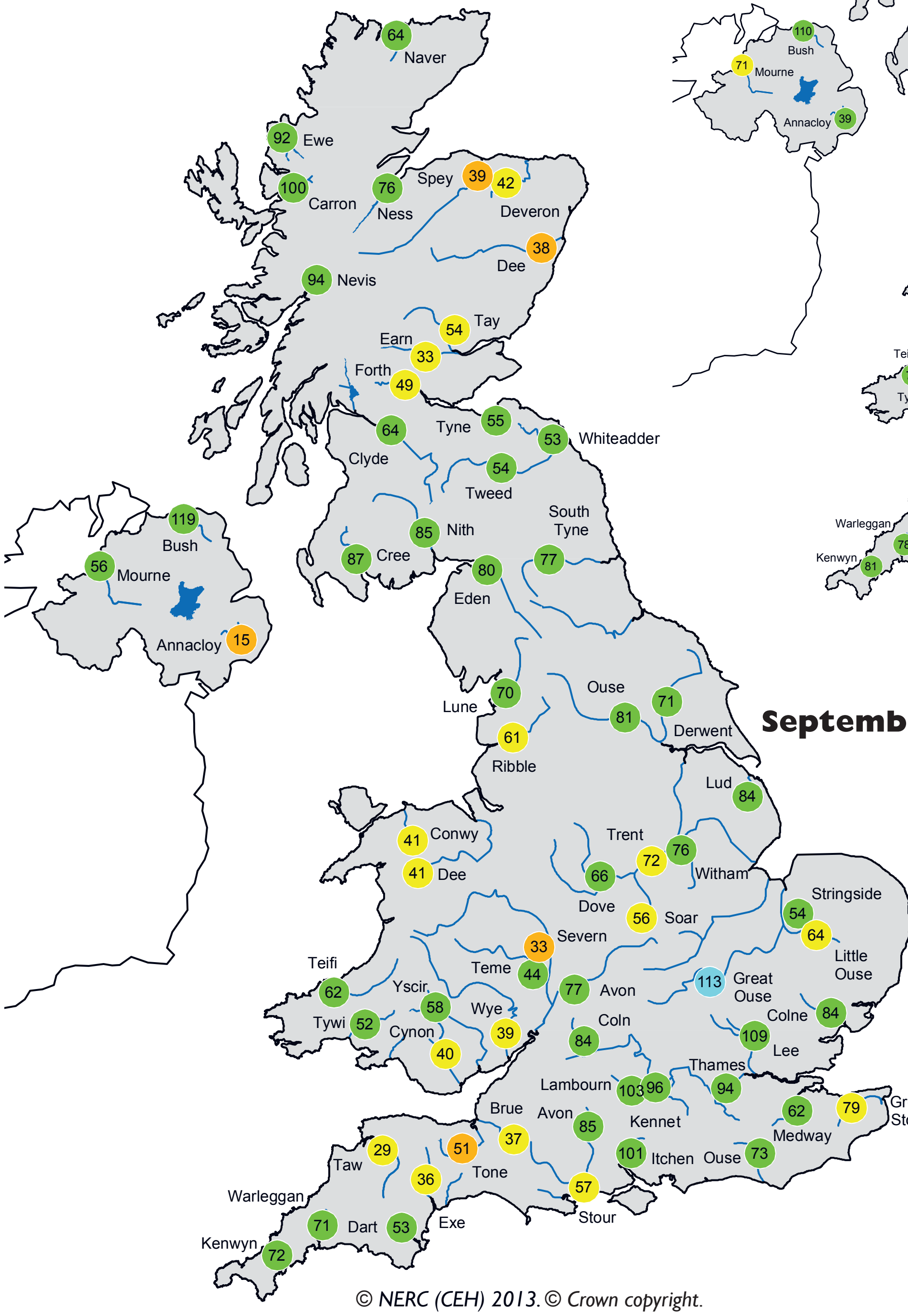
The latest shorter-range forecasts, covering the upcoming 30 days, can be accessed via:
http://www.metoffice.gov.uk/weather/uk/uk_forecast_weather.html
These forecasts are updated very frequently.

River flow . . . River flow . . .

June 2013 - September 2013



September 2013



Key

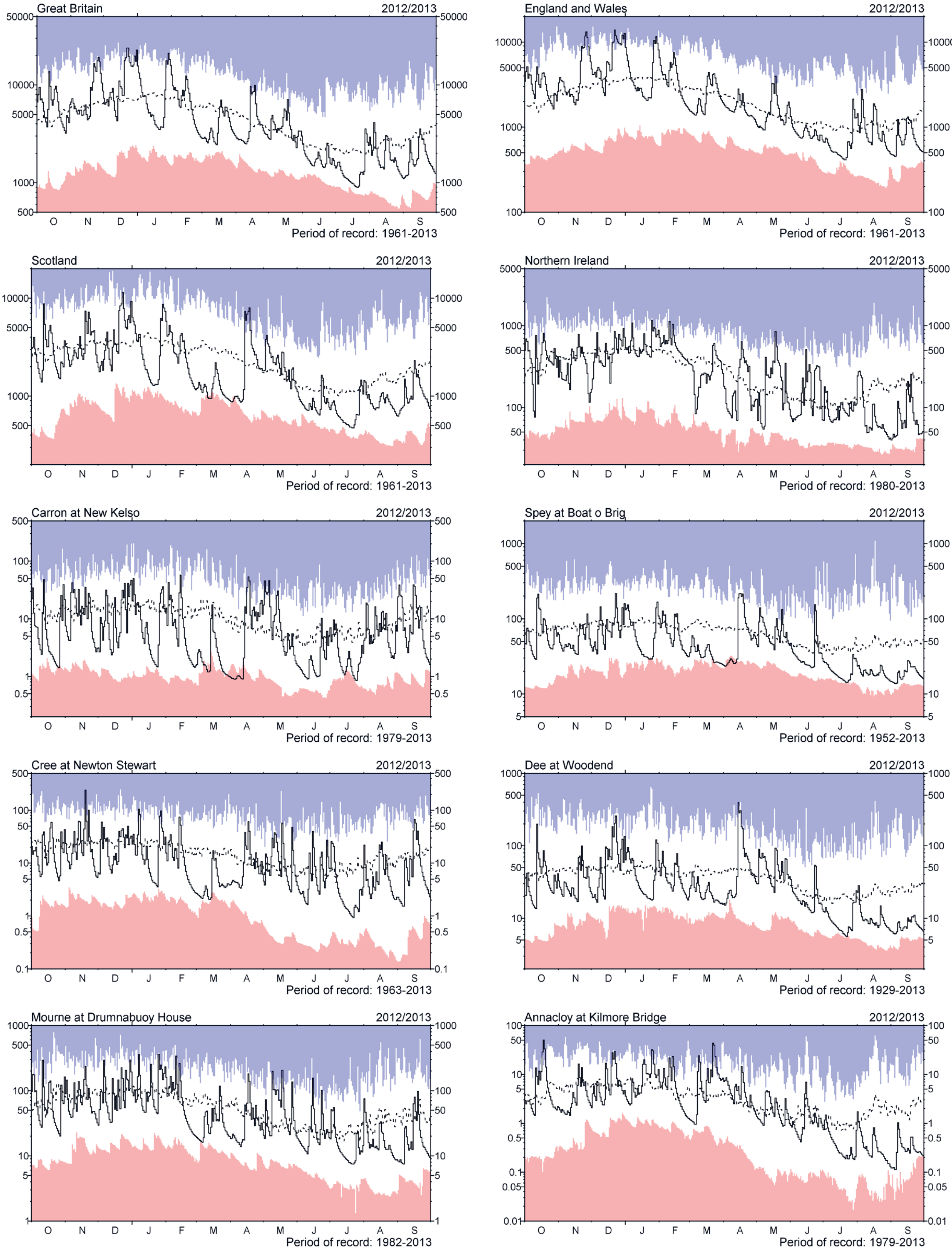
- (25) % of long-term average (record figure when circled)
- Exceptionally high flow
- Notably high flow
- Above normal
- Normal range
- Below normal
- Notably low flow
- Exceptionally low flow

*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.

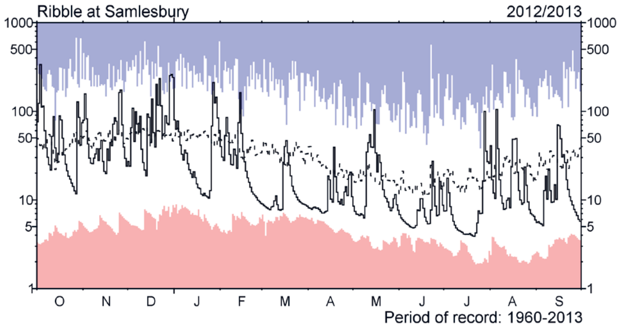
River flow . . . River flow . . .

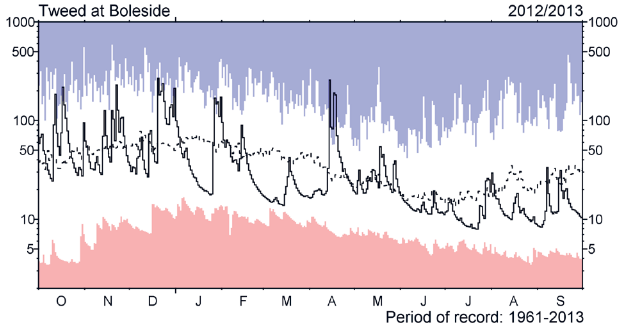


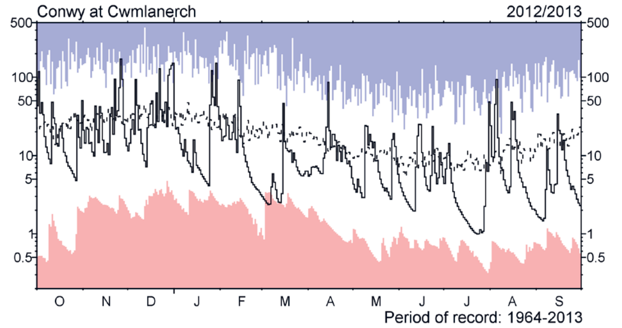
River flow hydrographs

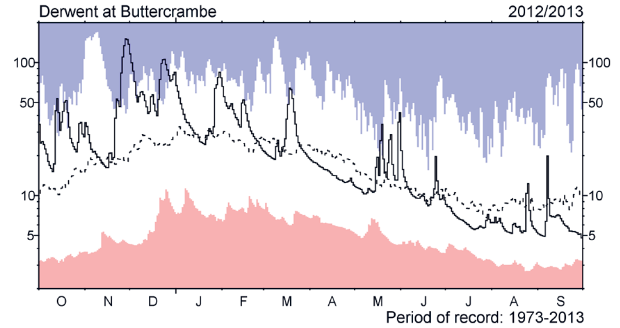
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to October 2012 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. Mean daily flows are shown as the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

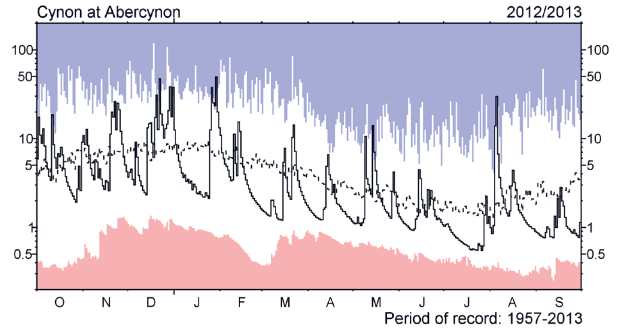
River flow . . . River flow . . .

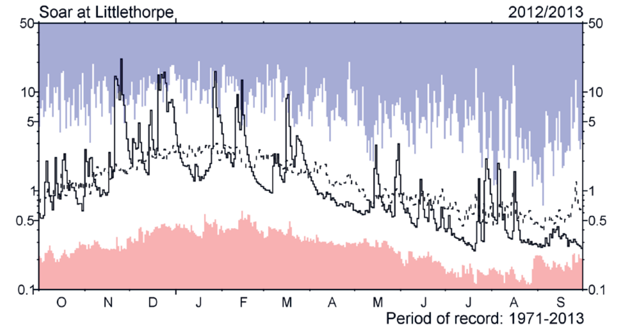


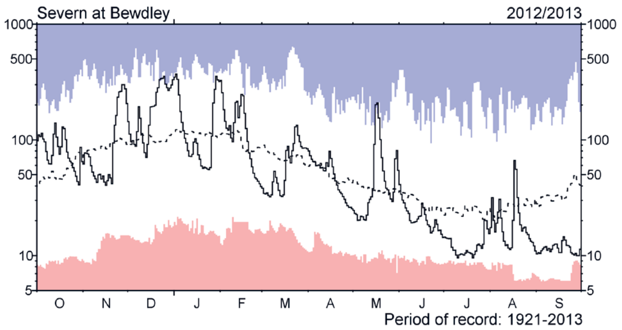


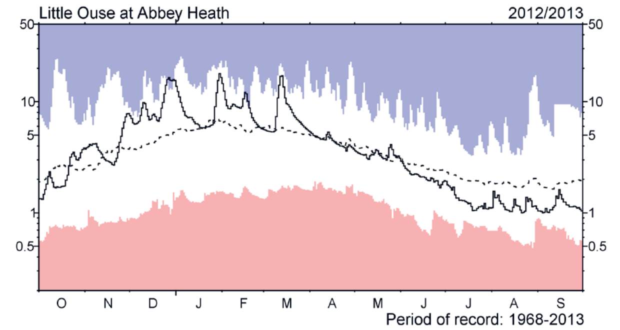


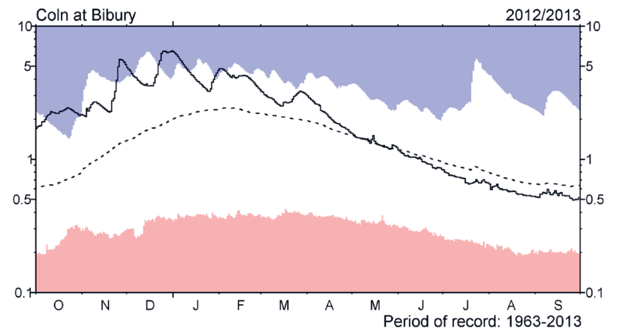


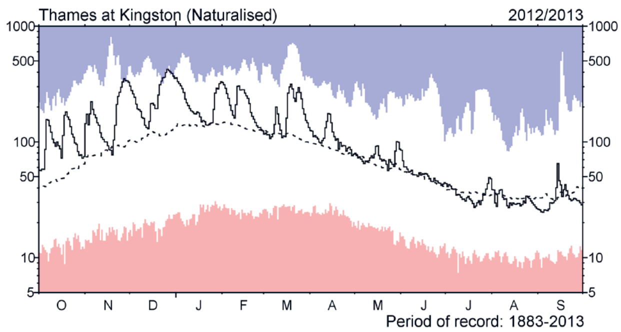


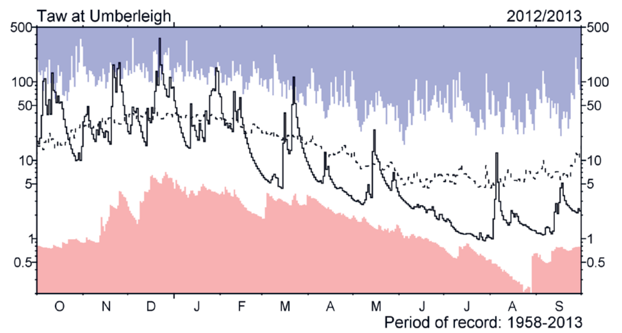


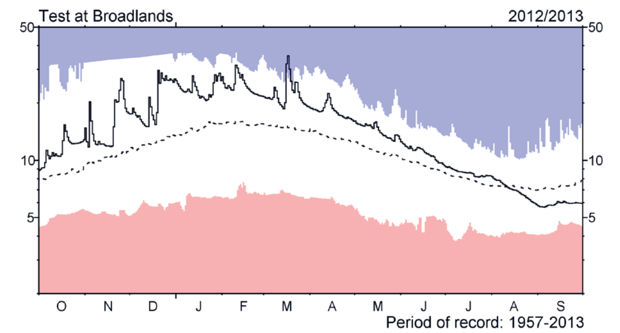




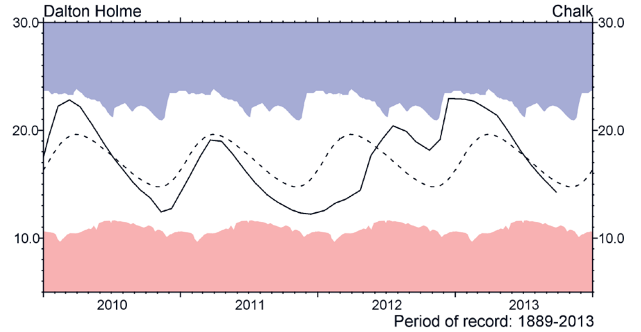


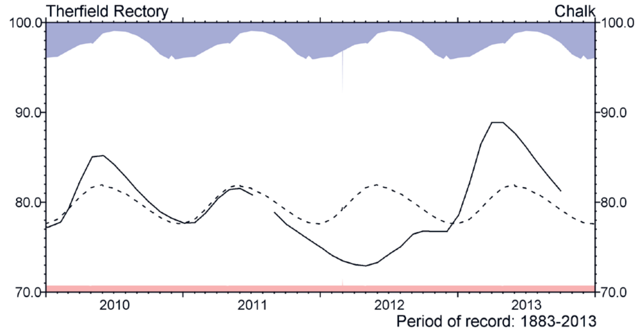


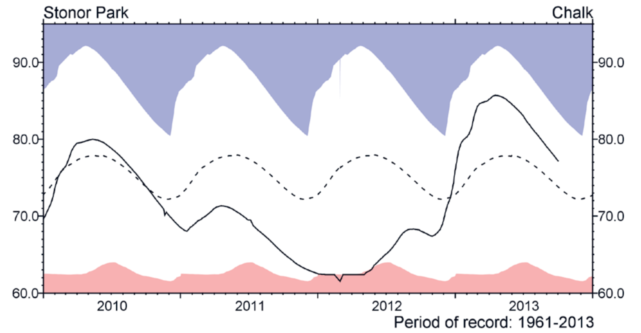


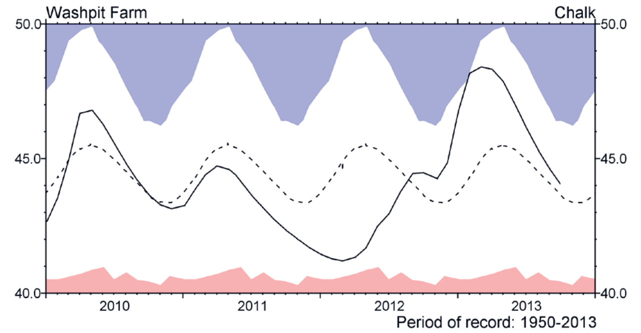


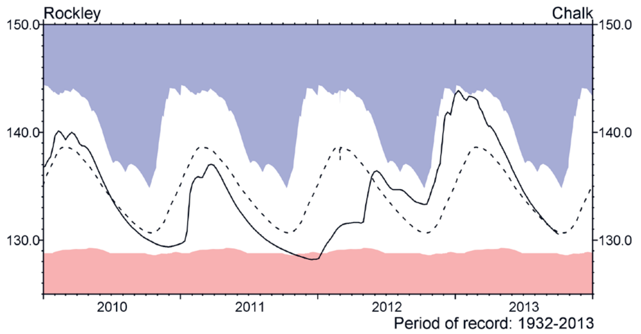
Groundwater . . . Groundwater

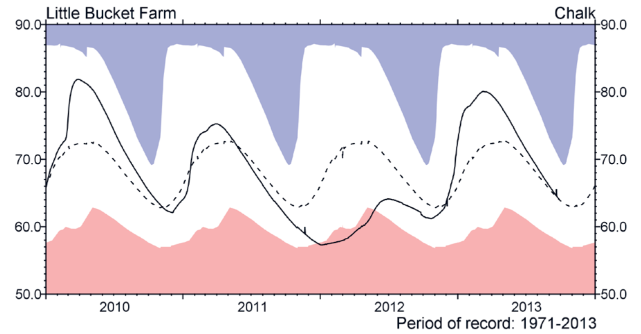


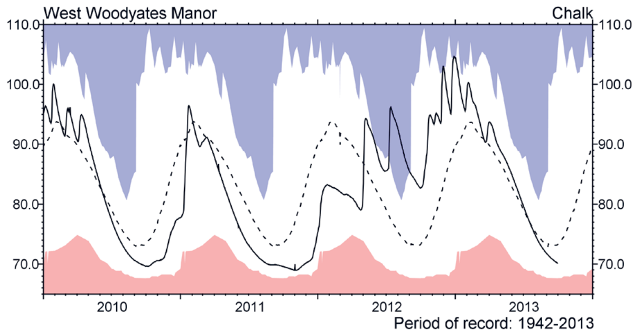


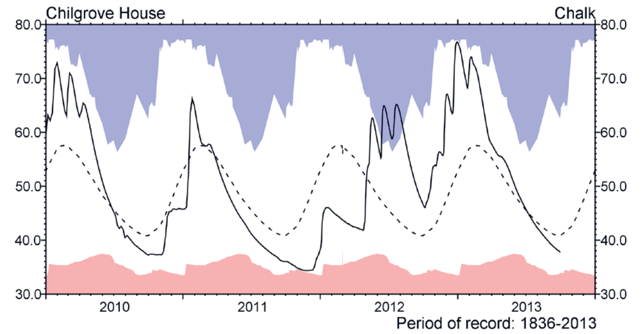


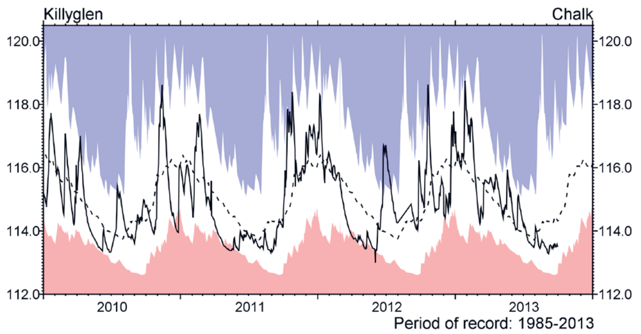


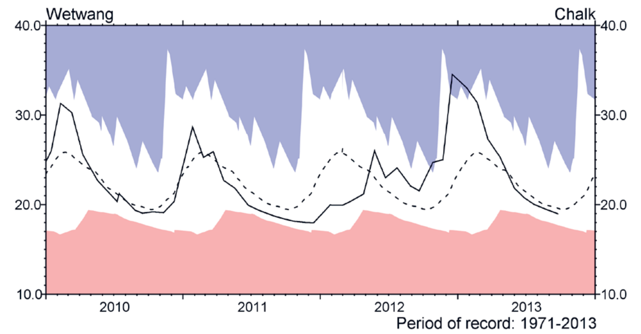






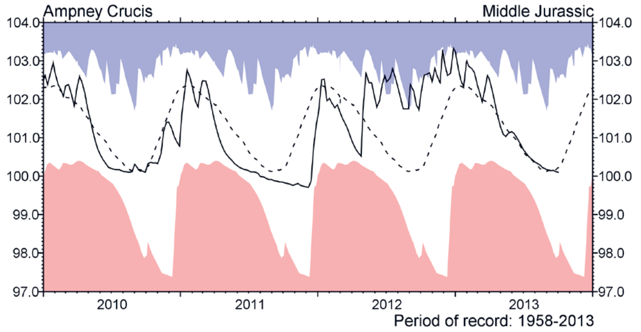


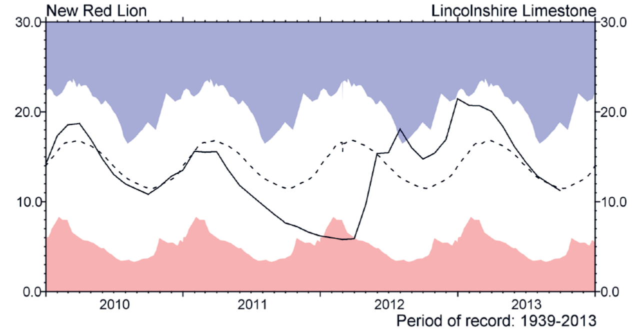


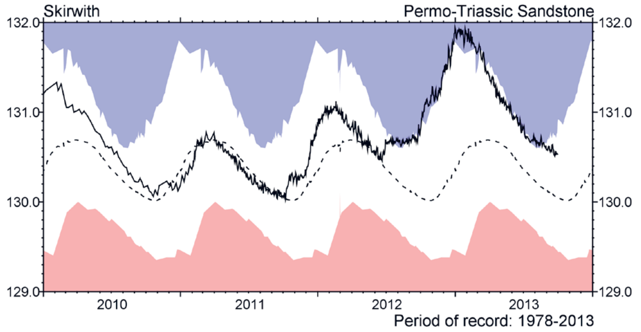


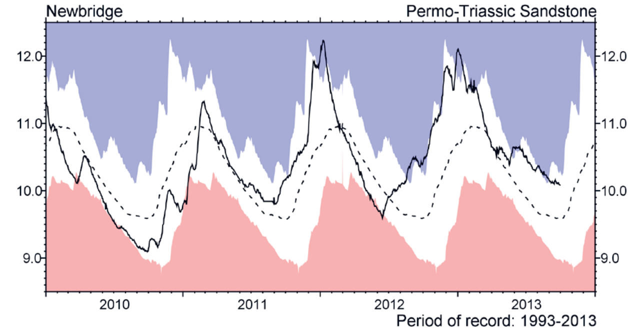
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined 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.

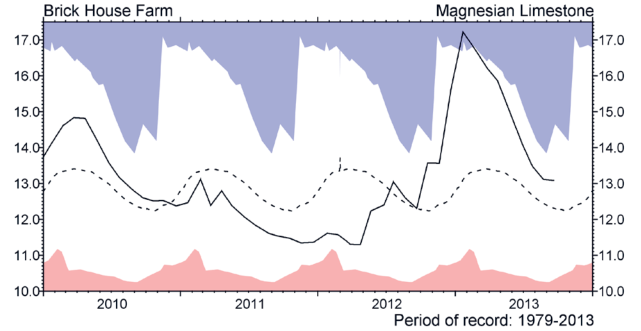
Groundwater ... Groundwater

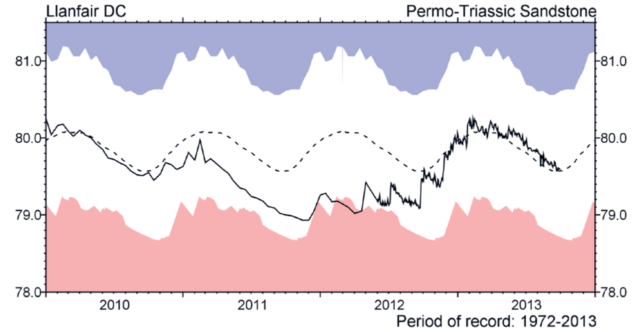


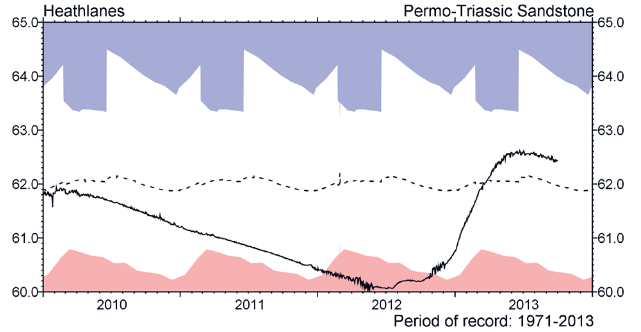


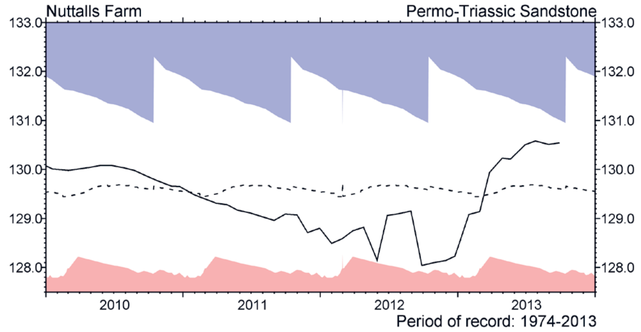


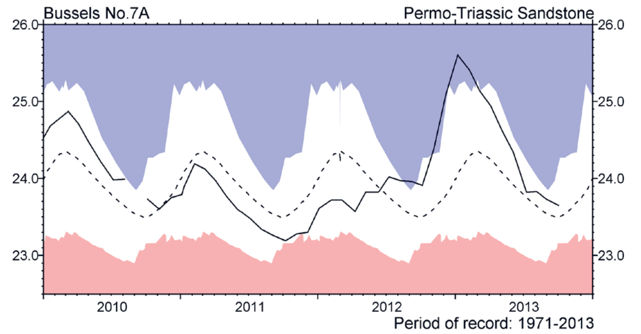


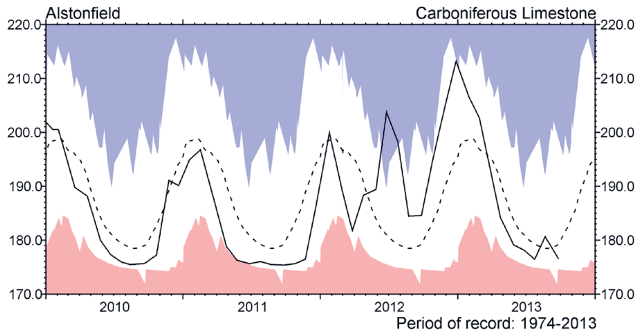










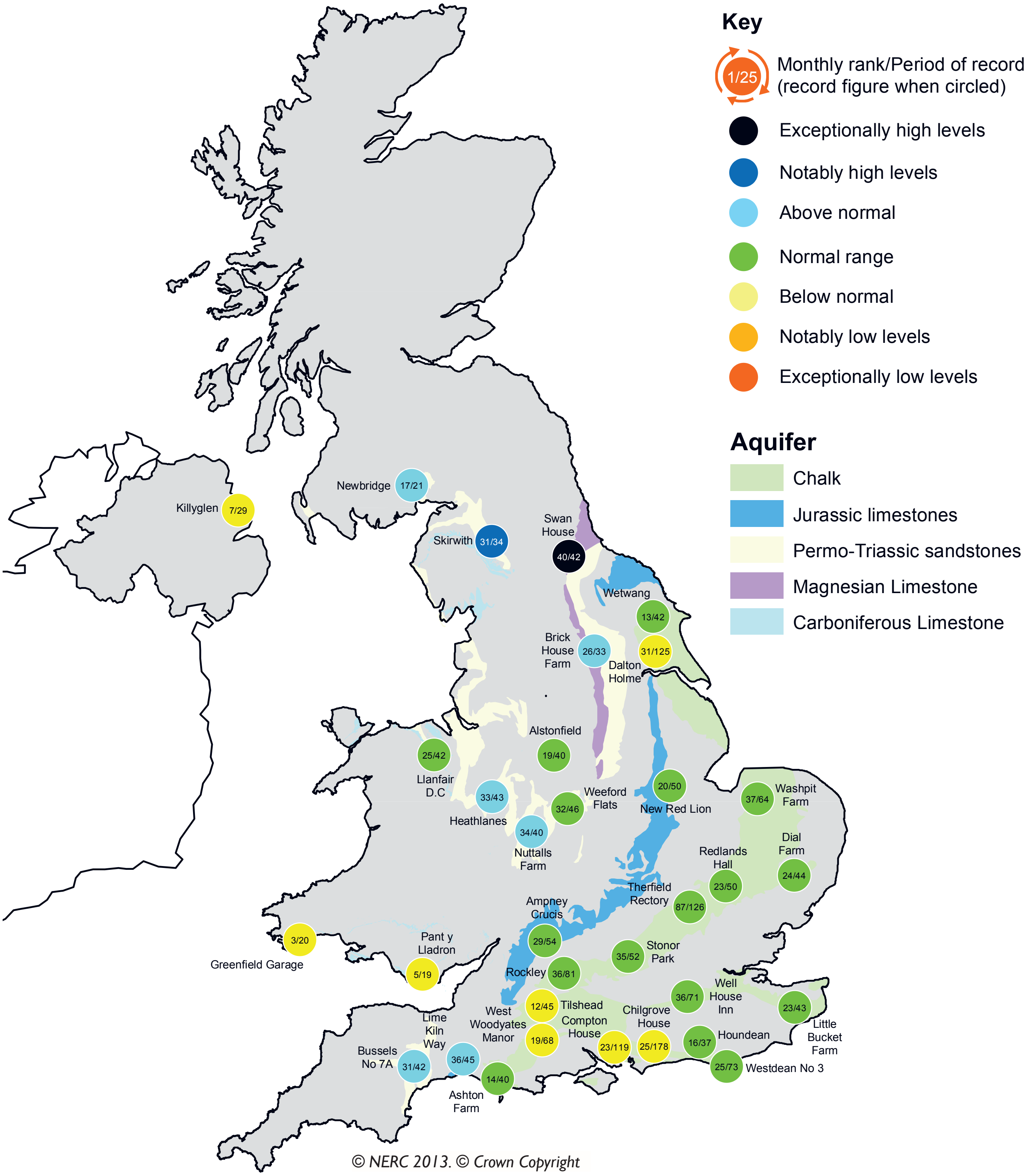


Groundwater levels September / October 2013

Borehole	Level	Date	Sep av.	Borehole	Level	Date	Sep av.	Borehole	Level	Date	Sep av.
Dalton Holme	14.27	26/09	15.46	Chilgrove House	37.75	30/09	40.75	Brick House Farm	13.08	19/09	12.33
Therfield Rectory	81.28	01/10	79.95	Killyglen (NI)	113.51	30/09	114.42	Llanfair DC	79.59	30/09	79.55
Stonor Park	77.18	01/10	74.22	Wetwang	18.96	24/09	19.74	Heathlanes	62.43	30/09	61.93
Tilshead	80.08	30/09	81.33	Ampney Crucis	100.10	01/10	100.17	Nuttalls Farm	130.54	27/09	129.57
Rockley	130.56	01/10	131.09	New Red Lion	11.22	30/09	11.67	Bussels No.7a	23.65	02/10	23.52
Well House Inn	93.99	01/10	93.91	Skirwith	130.52	30/09	130.13	Alstonfield	176.57	25/09	178.66
West Woodyates	70.14	30/09	73.21	Newbridge	10.08	30/09	9.64				

Levels in metres above Ordnance Datum

Groundwater...Groundwater

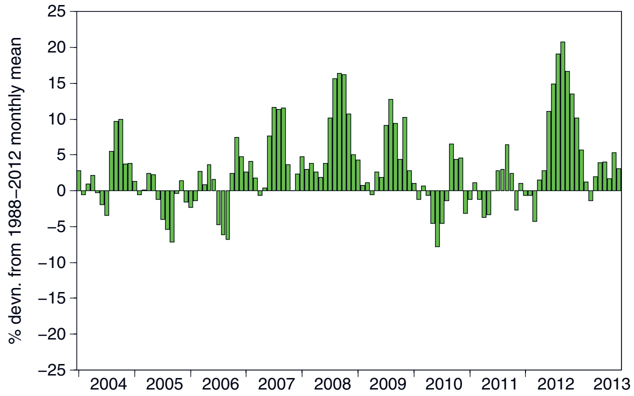


Groundwater levels - September 2013

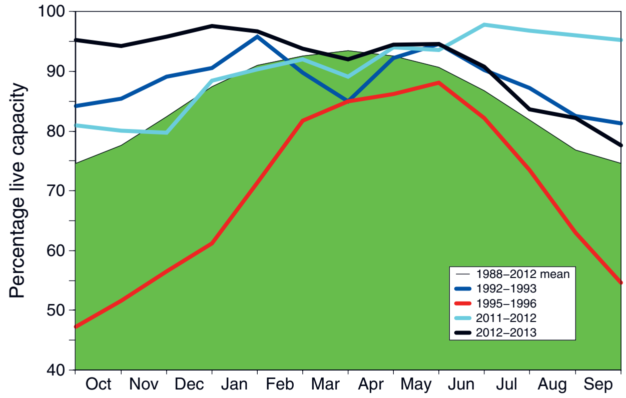
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated. 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.

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 Jul	2013 Aug	2013 Sep	Sep Anom.	Min Sep	Year* of min	2012 Sep	Diff 13-12
North West	N Command Zone	•	124929	64	67	63	4	13	1995	97	-34
	Vyrnwy		55146	82	80	70	2	26	1995	98	-28
Northumbrian	Teesdale	•	87936	83	93	91	22	31	1995	97	-6
	Kielder		(199175)	89	86	85	0	59	1989	93	-8
Severn Trent	Clywedog		44922	87	90	90	20	24	1989	90	0
	Derwent Valley	•	39525	69	65	55	-9	24	1989	100	-45
Yorkshire	Washburn	•	22035	72	69	62	-5	24	1995	98	-36
	Bradford Supply	•	41407	63	62	54	-14	15	1995	100	-46
Anglian	Grafham		(55490)	92	91	91	7	46	1997	95	-5
	Rutland		(116580)	86	80	78	-1	61	1995	98	-20
Thames	London	•	202828	93	90	86	9	53	1997	88	-2
	Farmoor	•	13822	93	96	98	8	54	2003	92	6
Southern	Bewl		28170	82	77	69	6	32	1990	79	-10
	Ardingly		4685	86	66	56	-11	32	2003	100	-44
Wessex	Clatworthy		5364	70	56	47	-10	25	2003	91	-44
	Bristol	•	(38666)	71	60	52	-11	31	1990	97	-45
South West	Colliford		28540	82	72	65	-4	38	2006	89	-24
	Roadford		34500	76	73	69	-1	26	1995	92	-23
	Wimbleball		21320	74	60	48	-17	30	1995	100	-52
	Stithians		4967	72	66	60	4	22	1990	93	-33
Welsh	Celyn & Brenig	•	131155	90	89	79	-2	39	1989	100	-20
	Brianne		62140	94	99	99	13	48	1995	100	-1
	Big Five	•	69762	83	84	76	7	19	1995	99	-23
	Elan Valley	•	99106	84	83	78	3	33	1976	100	-22
Scotland(E)	Edinburgh/Mid-Lothian	•	97639	82	67	74	-4	43	1998	100	-26
	East Lothian	•	10206	88	87	83	2	52	1989	100	-17
Scotland(W)	Loch Katrine**	•	111363	66	65	60	-15	43	1995	91	-31
	Daer**		22412	56	60	58	-21	32	1995	100	-42
	Loch Thom	•	11840	85	82	81	-1	56	1995	100	-19
Northern Ireland	Total+	•	55540	85	76	71	-2	29	1995	98	-27
	Silent Valley	•	20634	82	73	64	-5	27	1995	99	-35

( ) figures in parentheses relate to gross storage
** stocks affected by maintenance in 2013.
+ excludes Lough Neagh

• denotes reservoir groups

*last occurrence

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.

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.

10/2013

For further details please contact:

The Met Office
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Exeter
Devon
EX1 3PB

Tel.: 0870 900 0100
Email: enquiries@metoffice.gov.uk

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

Enquiries

Enquiries should be addressed to:

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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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