Hydrological Summary

for the United Kingdom

September 2014

General

September was the driest on record for the UK, in a series from 1910, and also registered as the equal fifth driest in the England & Wales Precipitation series from 1766. The majority of the western UK received less than 20% of the long-term average rainfall, with Wales recording 15% and 11% in Northern Ireland. Exceptionally low rainfall triggered river flow recessions and, around month-end, runoff from the UK closely approached the lowest on record for late September. For only the third time in the last 100 years, September was warmer than the preceding August in the Central England Temperature series from 1659. Soil moisture deficits (SMDs) increased throughout the UK from August to September, the largest such increases on record for many regions. Groundwater levels declined through September (with little sign of the commencement of recharge) although they mostly remained within the normal range or higher. Stocks in the majority of reservoirs declined by 10% or more in September. Some impoundments in western England (e.g. Northern Command Zone, Stithians and Clatworthy) lost almost a fifth of their late August stocks, whilst some in Scotland (e.g. Edinburgh/Mid-Lothian and Loch Katrine) lost more than 20%. The decrease from August to September was the largest on record by a wide margin for some Scottish reservoirs – Loch Thom registered its largest ever decline between any two consecutive months – and stocks in Loch Katrine were similar to those registered during the 2003 drought. For England & Wales, combined reservoir stocks fell marginally below average for the first time since March 2013. However, given the status of groundwater and the wet weather during the first half of October, the water resources situation remains healthy for the UK, although the longer-term outlook is sensitive to the rainfall received in autumn and winter.

Rainfall

High pressure became established to the north of the UK in early September, diverting Atlantic frontal systems away from the UK and bringing long periods of settled weather. For most of the UK, there was very little rainfall for much of the first three weeks. This dry weather was broken across the 19th and 20th by dramatic thunderstorms as a humid airmass moved north from the Bay of Biscay. This predominantly affected southern England; localised flash flooding with associated transport disruption was common and a storm total of 45mm was recorded on the 19th at Chesham (Buckinghamshire). Thereafter, the weather remained more unsettled but still predominantly dry. Rainfall totals for the month were exceptionally low across a wide area; the Squires Gate rain gauge in Lancashire recorded just 1mm, and the CEH Meteorological Station in Wallingford registered 26 dry days out of 30. North West England and North Wales registered 8% of its September average, and western Scotland experienced its driest September on record. Moderate rainfall deficiencies have developed over the June-September period, particularly in western areas of the UK. Wales recorded 74% of the long-term average June-September rainfall, and only north-east Scotland and East Anglia received moderately above average rainfall across large areas over this timeframe.

River flows

The lack of rainfall in early September triggered river flow recessions throughout the UK which lasted for the majority of the month. Declining flows were briefly broken in southern England in response to thunderstorms around mid-month, although there were no reports of fluvial flooding. Recessions were particularly steep in responsive catchments in northern and western areas, resulting in a significant shrinkage in the drainage network with many dry headwater reaches. New period of record daily flow minima for late September were established in a number of Scottish catchments such as the Clyde and Tay, and the Forth registered its lowest average September flow on record. Monthly average flows in the normal range or higher were largely confined to groundwater-fed rivers in south-east England and rivers in north-east Scotland, influenced by intense rainfall in winter 2013/14 and August 2014, respectively. Elsewhere, monthly average flows were below normal, notably or exceptionally so in western Scotland, northern England and north Wales. Average flows for September were amongst the lowest on record across large areas of north Wales (e.g. the Conwy and Dee), western Scotland (e.g. the Cree, Clyde, Nevis, Carron and Naver), north-west England (e.g. the Ribble, Lune and Eden) and Northern Ireland (e.g. the Mourne and Lagan). Since the beginning of June, below normal flows have been registered in catchments across south-west Scotland, north-west England and north Wales, as well as range of responsive catchments throughout the rest of the UK. Average June-September flows for the Conwy were the lowest in a 50-year record. Runoff was within the normal range for the majority of the UK over the summer half-year, with the exceptions of north-west England and north Wales (below normal) and central southern England (above normal).

Groundwater

SMDs were notably larger than average during September and groundwater levels continued to fall across all of the main aquifers, but mostly remained above or within the normal range. In the Chalk, levels were in the normal range or just above, with the exception of Stonor (in the slower responding Chilterns) where the September average was the second highest since 1983. In the Jurassic limestones, levels were normal for the time of year, whilst in the Magnesian limestones levels remained above average. Levels remained above average throughout the Permo-Triassic sandstones, with exceptionally high levels for the ninth consecutive month at Bussels No.7 (Devon). Lime Kiln Way in the Upper Greensand of south-west England has recorded new maximum levels in every month since February 2014. In these slow responding aquifers, the legacy of the wet winter has kept levels elevated, although they continued to decline slowly. Levels were below average in the more responsive Chalk at Killyglen (Northern Ireland) and the Carboniferous Limestone at Greenfield Garage (south-west Wales). The dry soil conditions in September imply a delay in the seasonal onset of aquifer recharge.

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Rainfall . . . Rainfall . . .

Met Office

Rainfall accumulations and return period estimates

Percentages are from the 1971-2000 average.

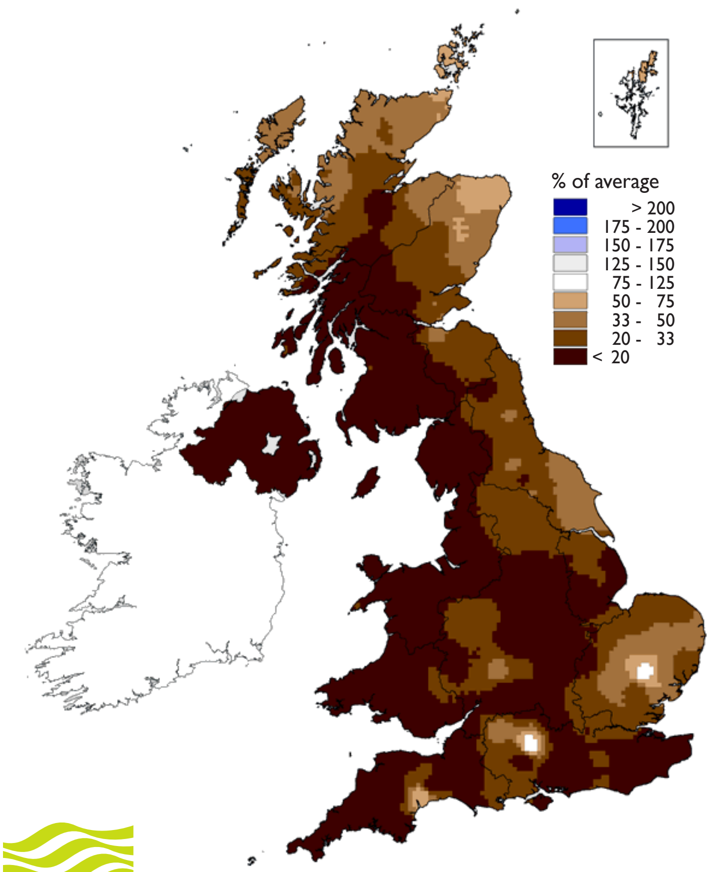
Area	Rainfall	Sep 2014	Jun14 – Sep14	*RP*	Apr14 – Sep14	*RP*	Jan14 – Sep14	*RP*	Oct13 – Sep14	*RP*
United	mm	**22**	281		451		889		1331	
Kingdom	%	**23**	90	2-5	102	2-5	121	20-30	123	>100
England	mm	**15**	223		372		704		1026	
	%	**21**	89	2-5	103	2-5	124	10-20	126	20-30
Scotland	mm	**37**	381		583		1156		1778	
	%	**28**	96	2-5	106	2-5	120	10-20	124	70-100
Wales	mm	**17**	278		487		1067		1631	
	%	**15**	74	8-12	92	2-5	117	5-10	120	10-15
Northern	mm	**10**	270		404		834		1202	
Ireland	%	**11**	82	5-10	86	5-10	109	2-5	109	5-10
England &	mm	**15**	231		388		754		1109	
Wales	%	**20**	86	2-5	101	2-5	123	10-20	125	15-25
North West	mm	**15**	279		427		875		1310	
	%	**15**	79	5-10	88	5-10	110	2-5	112	2-5
Northumbrian	mm	**18**	232		387		676		986	
	%	**25**	90	2-5	103	2-5	115	2-5	119	5-10
Severn-Trent	mm	**12**	211		358		659		939	
	%	**18**	87	2-5	102	2-5	123	8-12	125	10-20
Yorkshire	mm	**20**	231		387		680		938	
	%	**30**	92	2-5	107	2-5	119	5-10	116	2-5
Anglian	mm	**16**	206		324		515		718	
	%	**29**	100	2-5	109	2-5	119	5-10	120	5-10
Thames	mm	**15**	199		342		674		966	
	%	**23**	91	2-5	106	2-5	137	60-90	139	50-80
Southern	mm	**12**	190		338		743		1146	
	%	**16**	85	2-5	104	2-5	142	>100	148	>100
Wessex	mm	**16**	217		395		819		1210	
	%	**20**	87	2-5	109	2-5	139	>100	141	>100
South West	mm	**14**	274		472		1020		1573	
	%	**14**	87	2-5	104	2-5	128	20-35	132	40-60
Welsh	mm	**17**	276		479		1040		1586	
	%	**15**	76	5-10	93	2-5	119	5-10	121	10-15
Highland	mm	**51**	460		693		1284		2045	
	%	**32**	102	2-5	111	2-5	113	5-10	119	15-25
North East	mm	**40**	387		508		852		1201	
	%	**46**	133	2-5	122	2-5	130	15-25	127	15-25
Tay	mm	**30**	349		515		1121		1707	
	%	**26**	103	2-5	107	2-5	130	20-35	135	>100
Forth	mm	**24**	289		467		908		1395	
	%	**22**	88	2-5	102	2-5	117	5-10	124	25-40
Tweed	mm	**19**	272		448		857		1268	
	%	**24**	96	2-5	109	2-5	130	10-20	134	60-90
Solway	mm	**16**	308		513		1201		1808	
	%	**13**	78	5-10	93	2-5	127	25-40	129	80-120
Clyde	mm	**25**	363		622		1371		2117	
	%	**15**	75	8-12	95	2-5	118	8-12	122	40-60

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

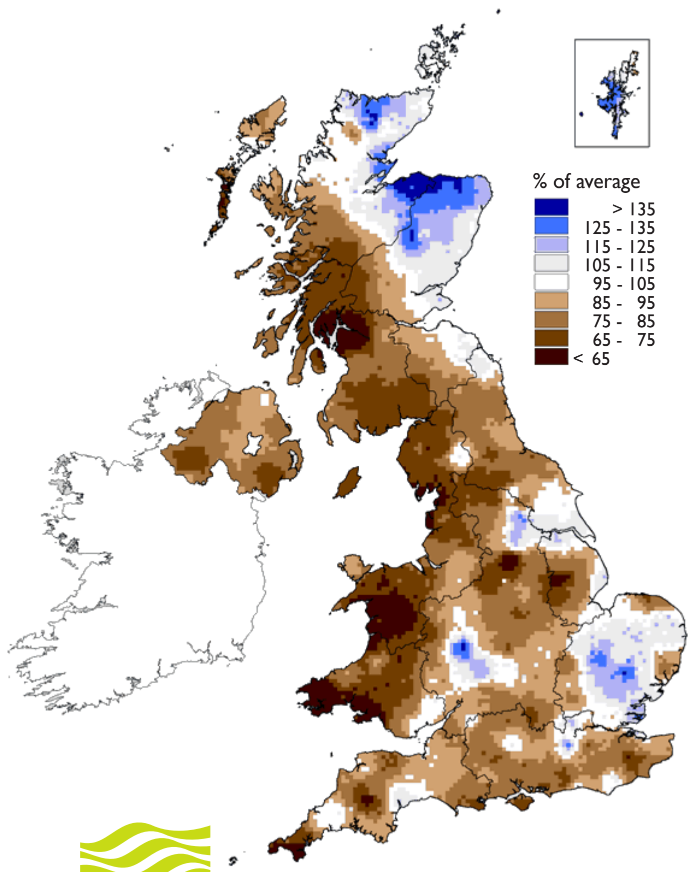
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic 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 from April 2014 (inclusive) are provisional.

Rainfall . . . Rainfall . . .

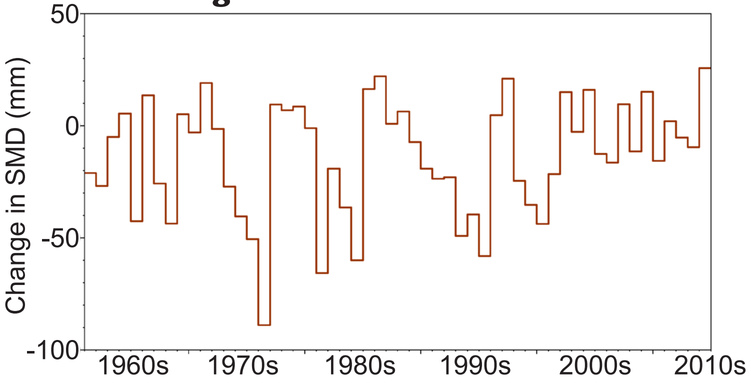
September 2014 rainfall as % of 1971-2000 average



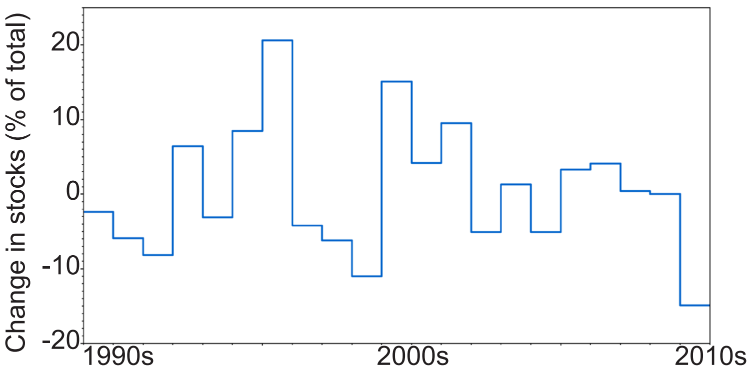
June 2014 - September 2014 rainfall as % of 1971-2000 average



August - September changes in MORECS SMDs for England & Wales



August - September change (% of total) in reservoir stocks for Scotland



Met Office

Met Office 3-month outlook Updated: September 2014

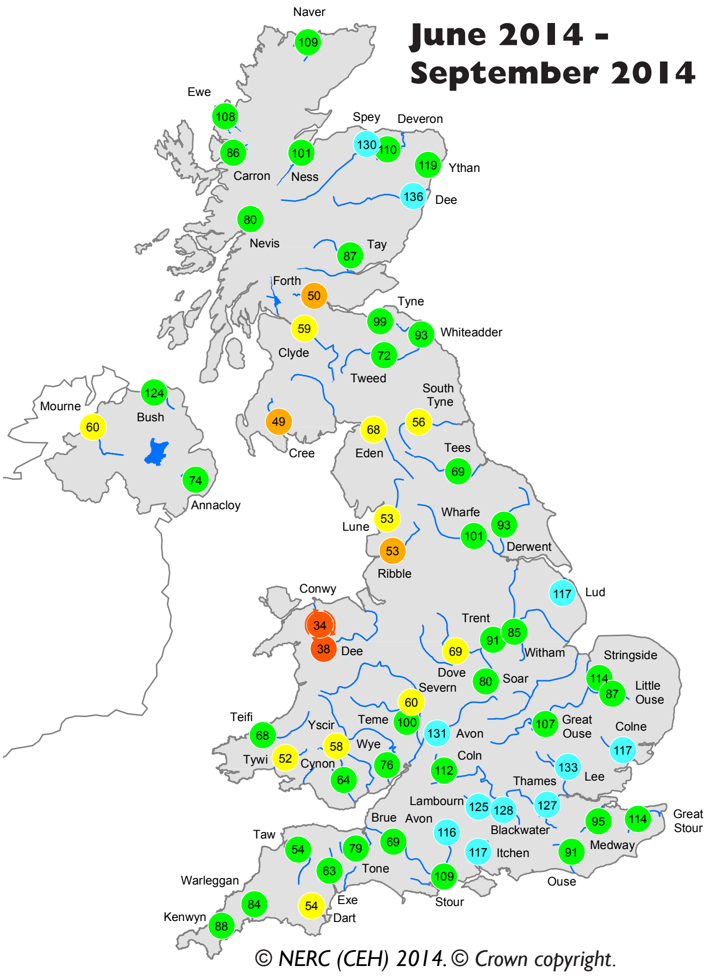
The latest predictions for UK precipitation favour above-average rainfall for October-November-December as a whole. The probability that UK precipitation for October-November-December will fall into the driest of our five categories is around 15% and the probability that it will fall into the wettest category is between 25 and 30% (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 2014 - September 2014



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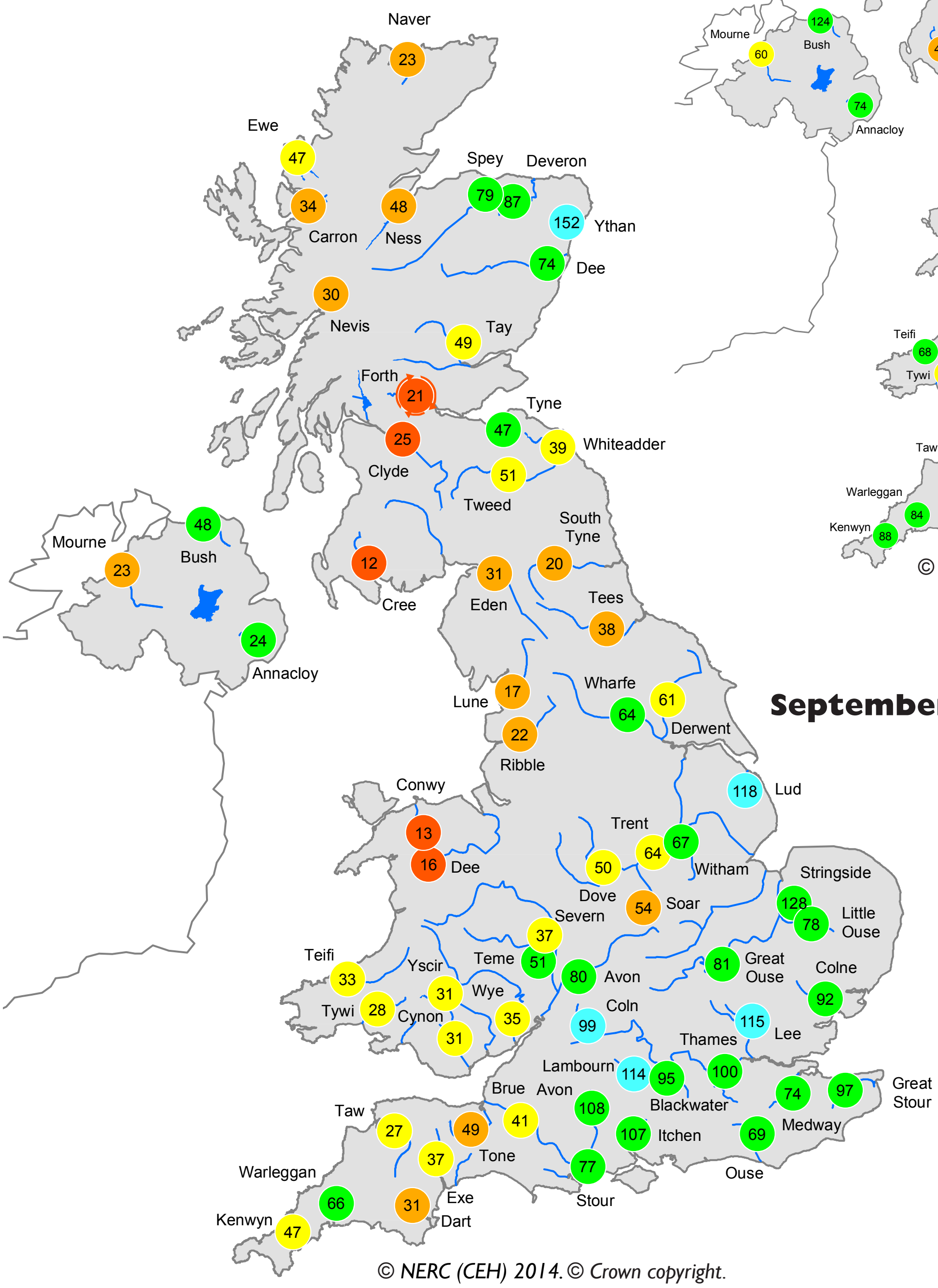
September 2014



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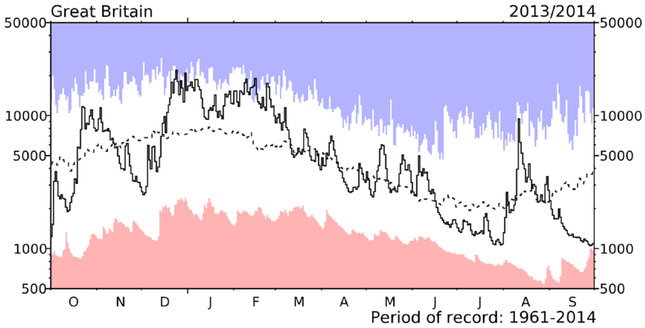
Key

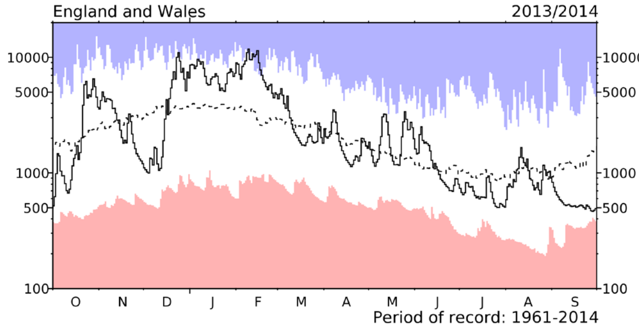
- 25 — % of long-term average (record figure when circled)
- Exceptionally high flow
- Notably high flow
- Above normal
- Normal range
- Below normal
- Notably low flow
- Exceptionally low flow

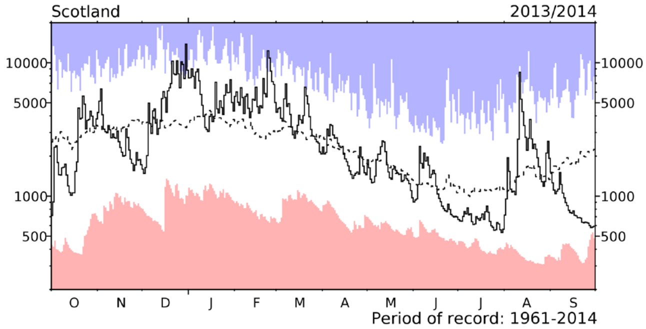
*Based on ranking of the monthly flow**

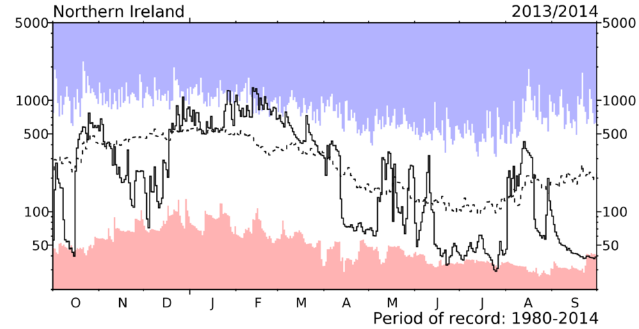
River flows

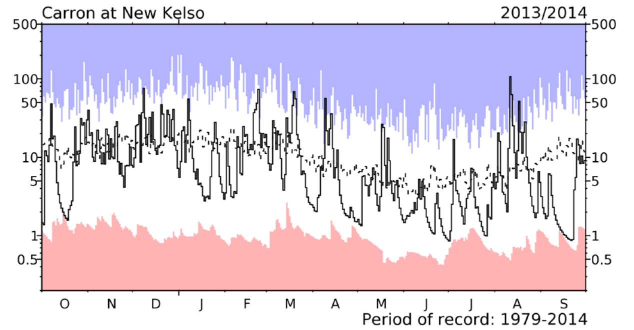
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much 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.

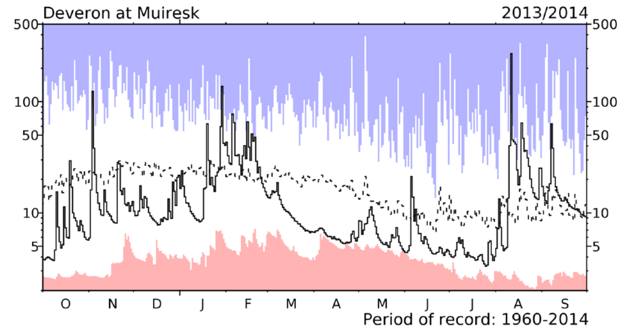


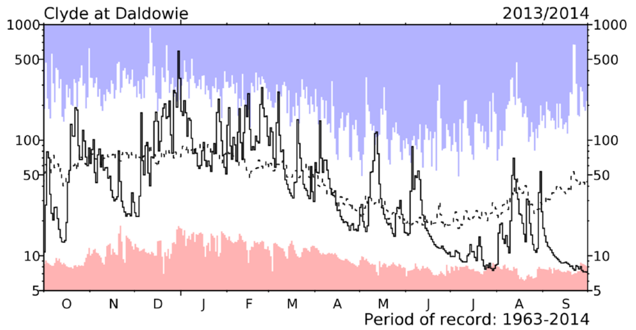


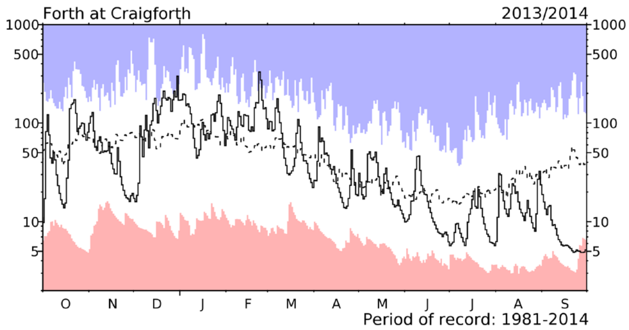


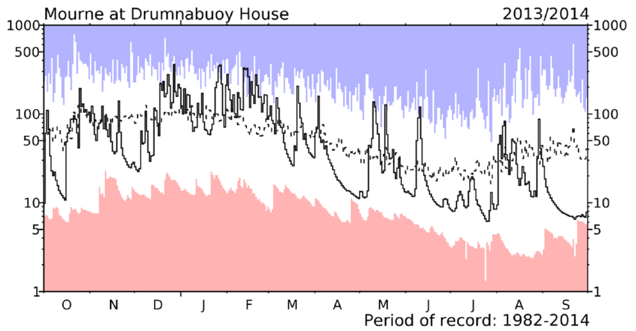


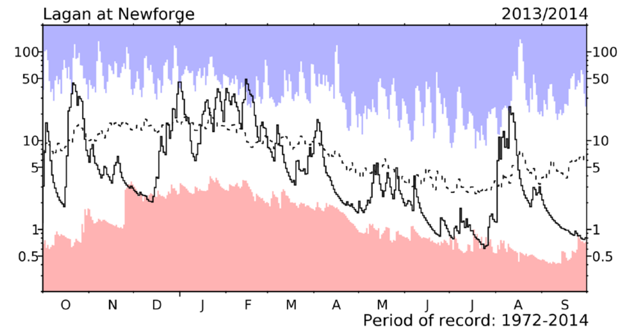








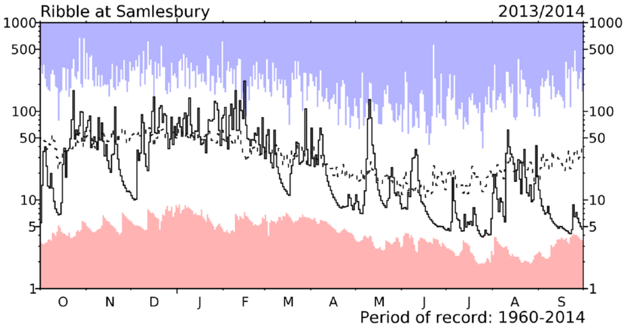


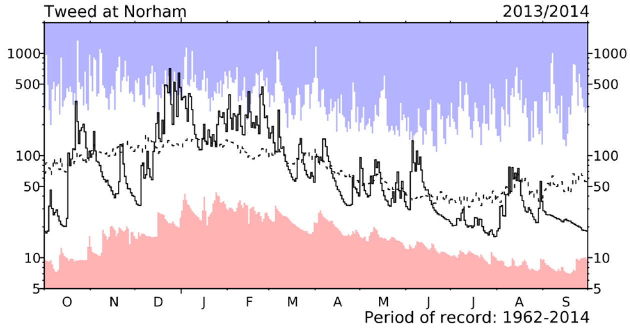


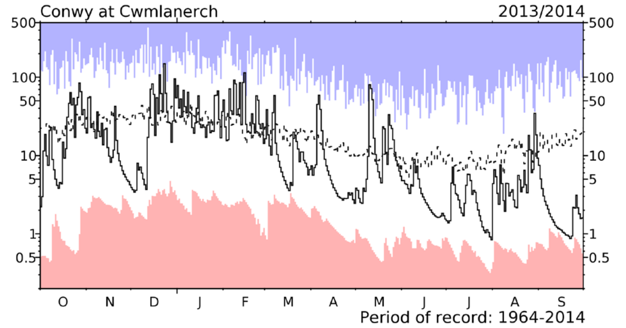
River flow hydrographs

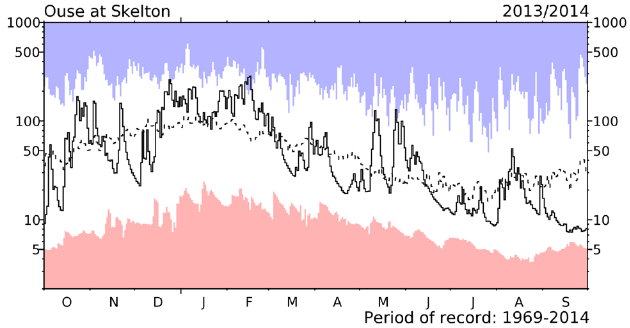
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to October 2013 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. Mean daily flows are shown as the dashed line.

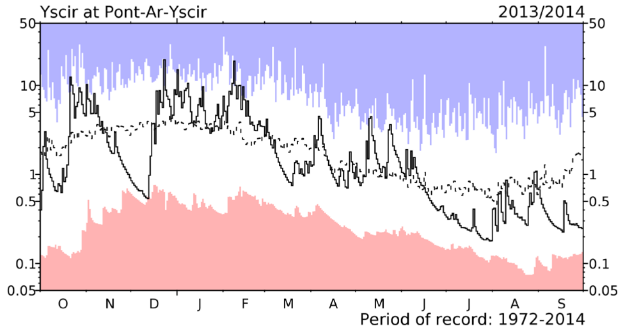
River flow . . . River flow . . .

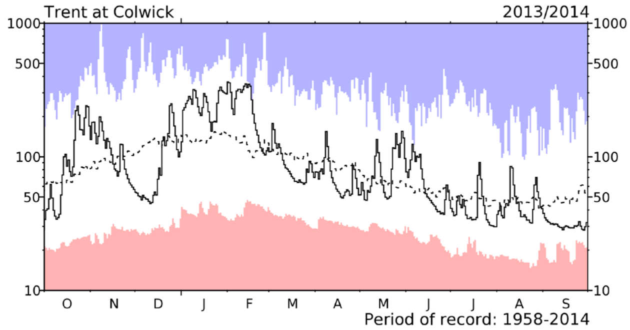


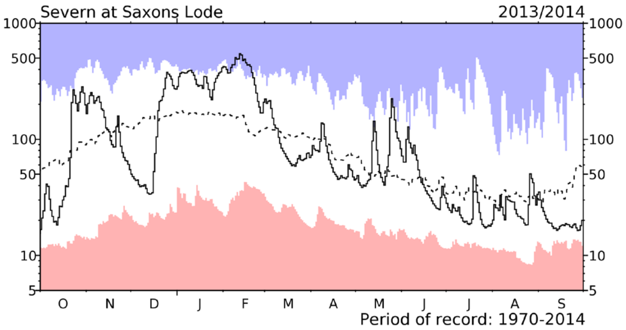


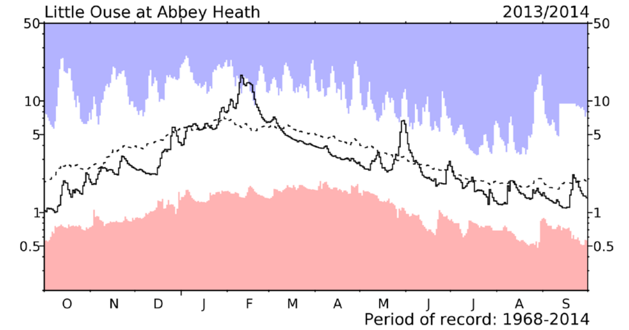


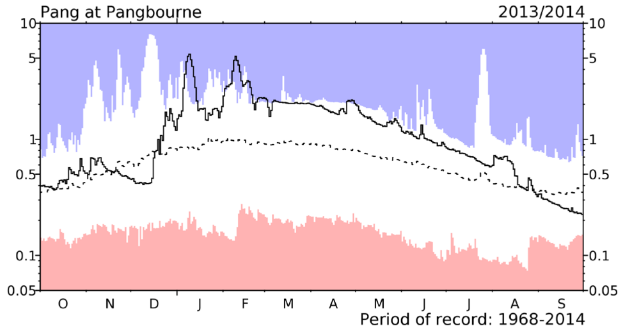


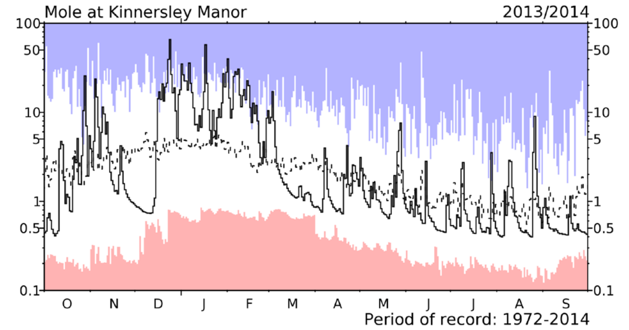


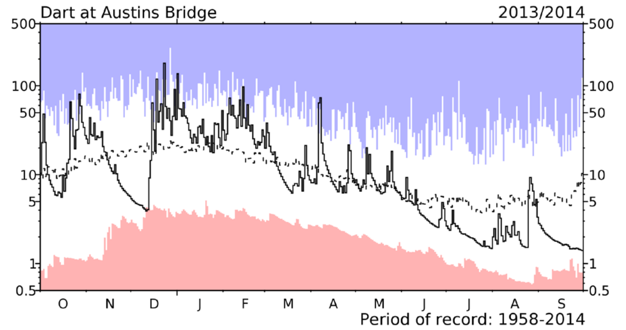


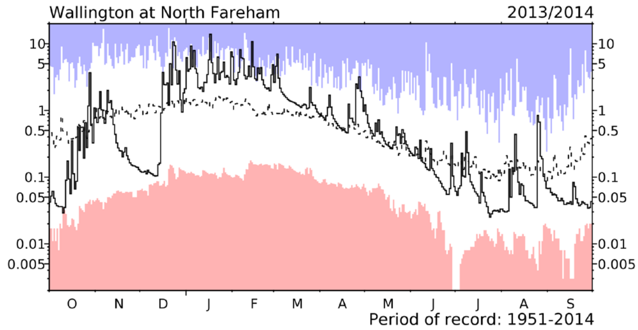




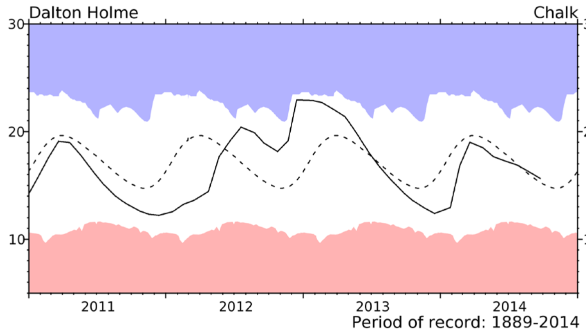


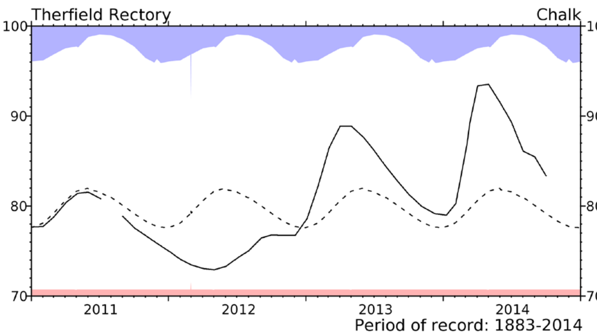


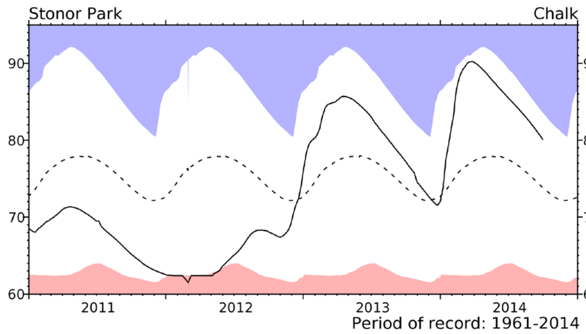


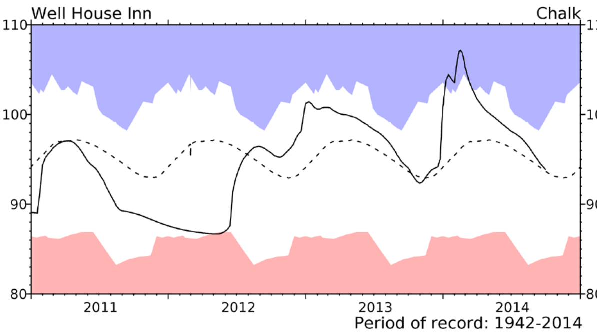


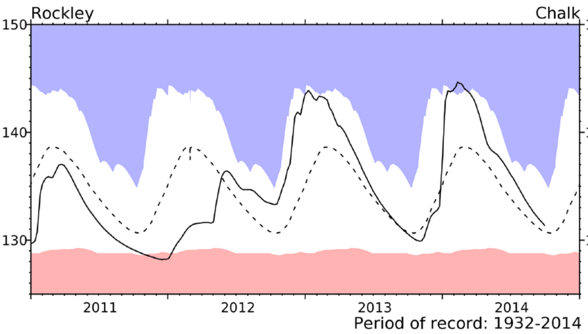
Groundwater . . . Groundwater

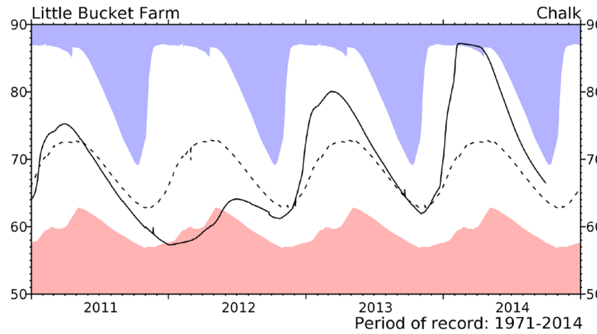


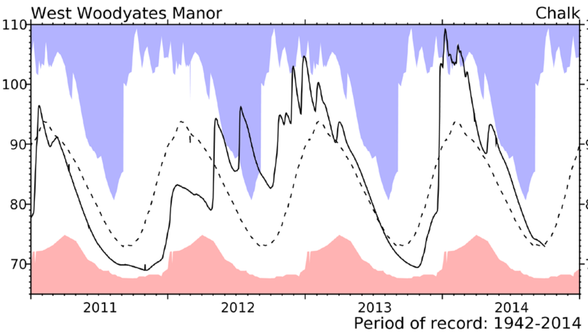


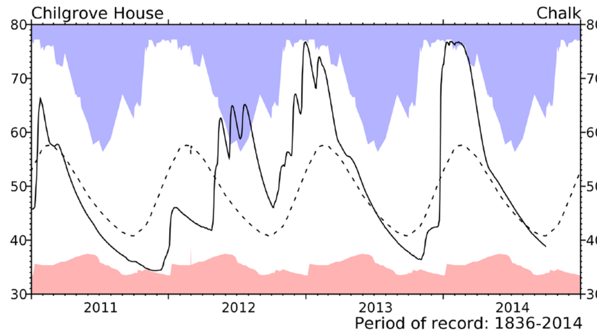


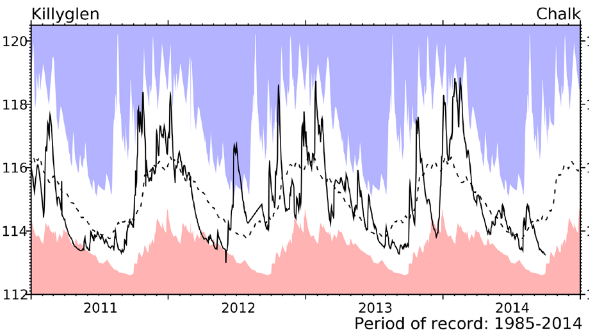


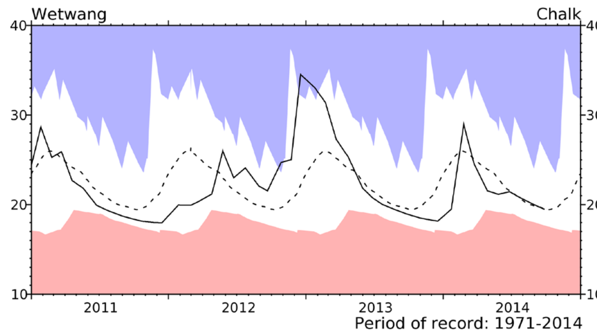






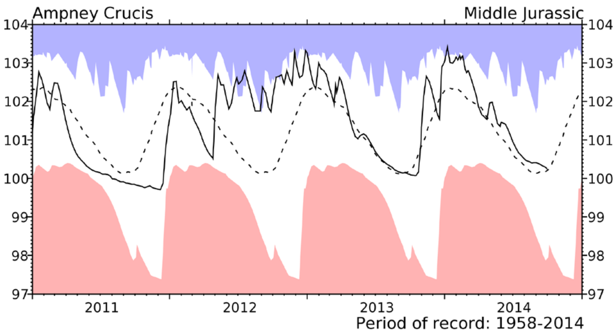


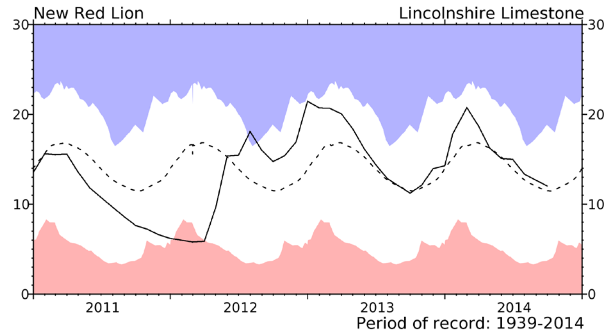


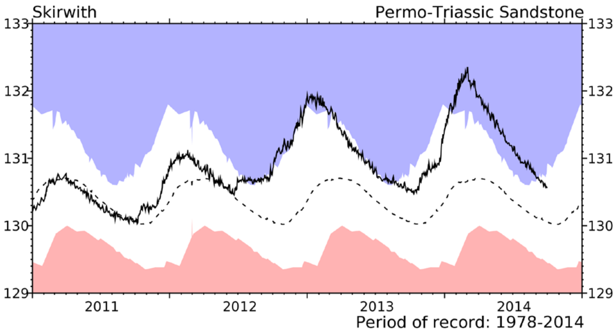


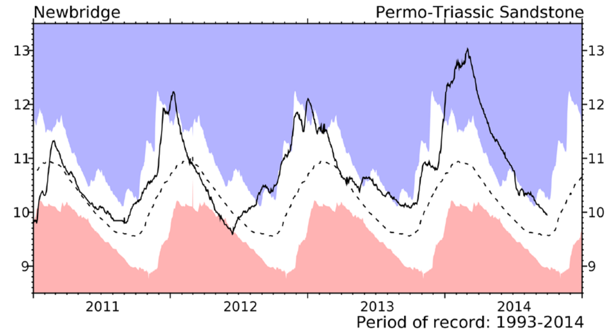
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

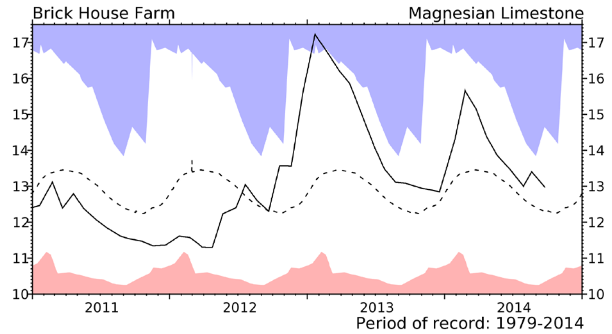
Groundwater ... Groundwater

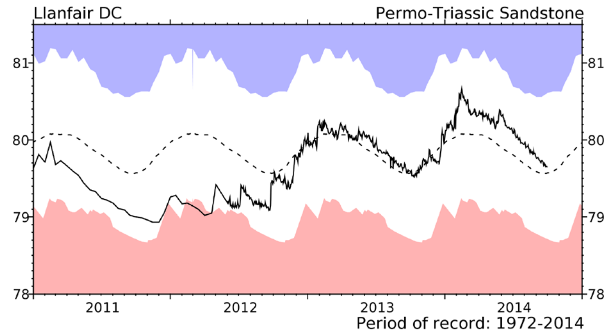


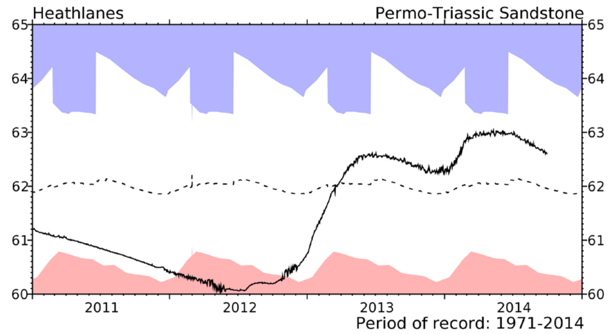


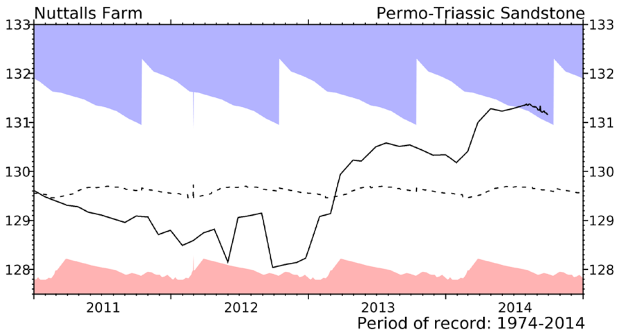


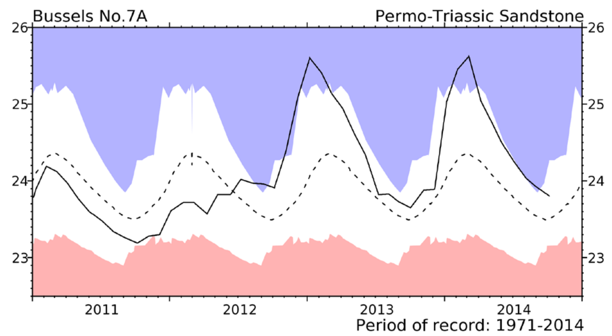


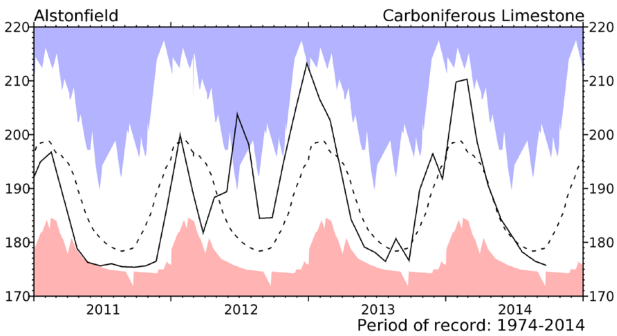










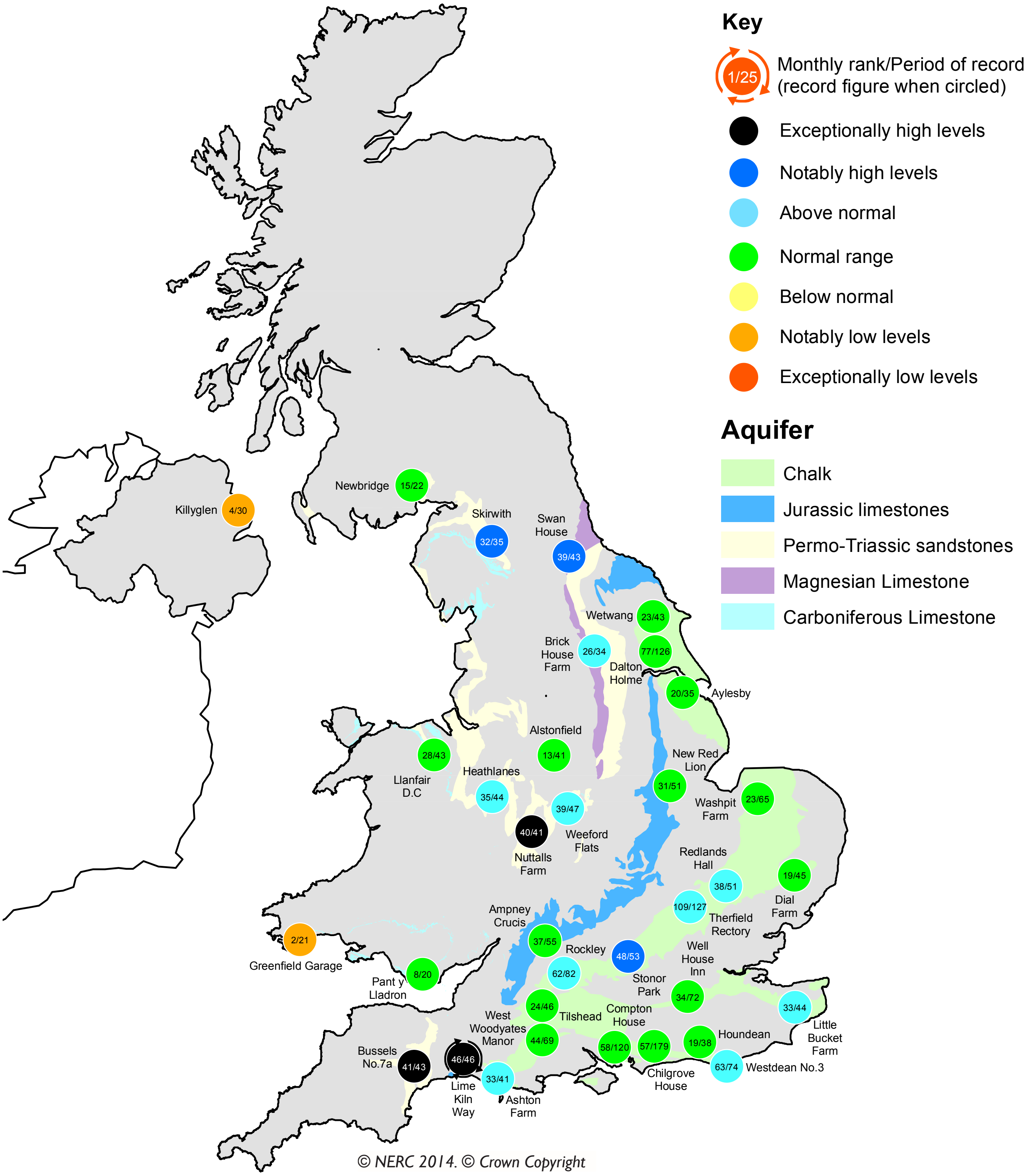


Groundwater levels September / October 2014

Borehole	Level	Date	Sep av.	Borehole	Level	Date	Sep av.	Borehole	Level	Date	Sep av.
Dalton Holme	15.63	24/09	15.45	Chilgrove House	38.80	30/09	40.74	Brick House Farm	12.97	24/09	12.36
Therfield Rectory	83.35	01/10	79.97	Killyglen (NI)	113.24	30/09	114.38	Llanfair DC	79.65	30/09	79.55
Stonor Park	80.10	30/09	74.30	Wetwang	19.47	26/09	19.72	Heathlanes	62.90	30/09	61.64
Tilshead	80.78	30/09	81.31	Ampney Crucis	100.25	30/09	100.17	Nuttalls Farm	131.16	29/09	129.60
Rockley	131.35	30/09	131.09	New Red Lion	12.02	30/09	11.66	Bussels No.7a	23.80	06/10	23.52
Well House Inn	93.85	30/09	93.92	Skirwith	130.57	30/09	130.14	Alstonfield	175.71	24/09	178.61
West Woodyates	72.94	30/09	73.18	Newbridge	9.94	30/09	9.66				

Levels in metres above Ordnance Datum

Groundwater . . . Groundwater

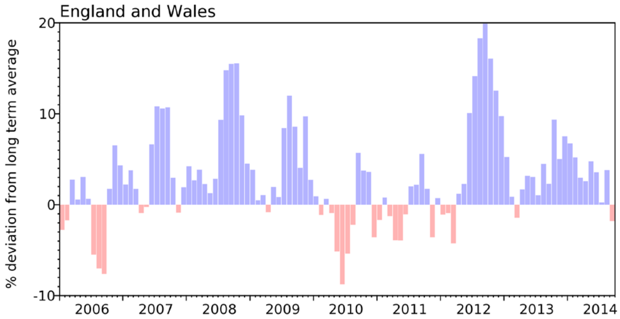


Groundwater levels - September 2014

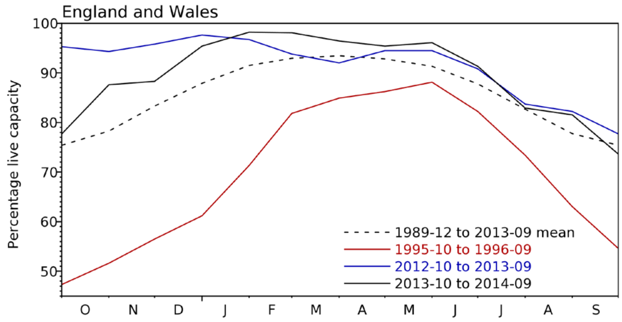
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated.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



Percentage live capacity of selected reservoirs at end of month

Area	Reservoir		Capacity (Ml)	2014 Jul	2014 Aug	2014 Sep	Sep Anom.	Min Sep	Year* of min	2013 Sep	Diff 14-13
North West	N Command Zone	•	124929	54	60	49	-9	13	1995	63	-14
	Vyrnwy		55146	75	71	60	-9	26	1995	70	-10
Northumbrian	Teesdale	•	87936	77	84	74	4	31	1995	91	-17
	Kielder		(199175)	88	91	83	-2	59	1989	85	-3
Severn-Trent	Clywedog		44922	89	90	79	9	24	1989	90	-11
	Derwent Valley	•	39525	69	66	54	-9	24	1989	55	0
Yorkshire	Washburn	•	22035	68	63	54	-12	24	1995	62	-8
	Bradford Supply	•	41407	76	72	61	-7	15	1995	54	7
Anglian	Grafham		(55490)	83	78	79	-4	46	1997	91	-11
	Rutland		(116580)	91	89	87	9	61	1995	78	9
Thames	London	•	202828	94	92	87	9	53	1997	86	0
	Farmoor	•	13822	97	89	88	-3	54	2003	98	-10
Southern	Bewl		28170	86	79	70	7	32	1990	69	1
	Ardingly**		4685	84	77	67	1	32	2003	56	12
Wessex	Clatworthy		5364	73	75	61	4	25	2003	47	14
	Bristol	•	(38666)	84	79	77	14	31	1990	52	25
South West	Colliford		28540	86	79	71	3	38	2006	65	6
	Roadford		34500	87	80	74	4	26	1995	69	5
	Wimbleball		21320	88	78	66	1	30	1995	48	18
	Stithians		4967	75	66	54	-3	22	1990	60	-6
Welsh	Celyn & Brenig	•	131155	86	75	65	-16	39	1989	79	-14
	Brianne		62140	88	93	84	-2	48	1995	99	-15
	Big Five	•	69762	84	78	68	-1	19	1995	76	-8
	Elan Valley	•	99106	83	84	73	-2	33	1976	78	-5
Scotland(E)	Edinburgh/Mid-Lothian	•	97639	86	84	66	-12	43	1998	74	-8
	East Lothian	•	10206	98	96	92	11	52	1989	83	9
Scotland(W)	Loch Katrine	•	111363	73	69	55	-19	43	1995	60	-5
	Daer		22412	76	82	72	-6	32	1995	58	14
	Loch Thom	•	11840	90	91	73	-9	56	1995	81	-8
Northern Ireland	Total+	•	56800	73	82	73	0	29	1995	71	2
	Silent Valley	•	20634	69	82	72	3	27	1995	64	8

( ) figures in parentheses relate to gross storage • denotes reservoir groups *last occurrence

** the monthly record of Ardingly reservoir stocks is under review.

+ excludes Lough Neagh

Details of the individual reservoirs in each o 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. Monthly figures may be artificially low due to routine maintenance or turbidity effects in feeder rivers.

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.

For further details please contact:

The Met Office
FitzRoy Road
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

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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

10/2014

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