Hydrological Summary
for the United Kingdom

August 2012

General

August was another rather wet and relatively dull month contributing to the wettest summer since 1912; rainfall accumulations since March are even more outstanding across much of England & Wales. The extreme departures from normal seasonal rainfall patterns during 2012 resulted in soils being close to saturation over wide areas through most of the summer. Correspondingly, many rivers responded rapidly to the August rainfall and moderate floodplain inundations were common; there was also a high incidence of flash flooding. Estimated outflows from England & Wales over the April-August period were twice the long-term average. The abundant late spring and summer runoff ensured that stocks in almost all index reservoirs increased to well above the seasonal average. For early September, aggregated stocks for England & Wales are the highest on record; more remarkably, average summer stocks through the summer of 2012 exceeded the average for December to February for all but the wettest winters. With soil moisture deficits since March also more typical of the winter, aquifer replenishment has also been very exceptional and groundwater levels in most index wells and boreholes are within, or above, the normal early autumn range. The late spring and summer of 2012 have witnessed an extraordinary transformation in the water resource outlook. Dramatic post-drought recoveries have occurred before, most notably following the extreme drought of 1975/76, but sustained recoveries during the late spring and summer are extremely rare.

Rainfall

August was unsettled across most of the UK with low pressure commonly centred in the eastern Atlantic drawing in a moisture-laden south-westerly airflow. Consequently, many western catchments were particularly wet (north-west Scotland was an exception). Persistent frontal rainfall produced a 24-hr total of 64mm at Lerwick on the 22nd and convective events were common; at St Bees (Cumbria) torrential rain on the night of the 29th (15mm fell in 15 minutes, contributing to a storm total of 46.2mm) triggered a landslide which caused a train derailment. August rainfall totals exceeded twice the monthly average in parts of the South West but sheltered parts of the South East and East Anglia registered less than 70%. At the national scale, the summer was the wettest in the last 100 years (with new summer maxima established for northern England and southern Scotland) but rainfall accumulations since March are even more remarkable. For England & Wales, the April-August rainfall is the highest in the National Climate Information Centre series by a wide margin and exceeds the long-term average by over 65% - this percentage exceedence is unmatched for any 5-month sequence on record (although many higher rainfall totals have been registered). Using the longer HadUKP England & Wales precipitation series (see page 12), only in 1879 has a greater April-August rainfall total been recorded in the last 230 years. The post-March rainfall has made up the bulk of the rainfall deficiencies built up over the preceding 25 months.

River flows

Following steep late-July recessions, river flows were mostly in the normal range during early August but runoff rates increased generally and were exceptionally high from around mid-month. Unusually for late summer, flood alerts were common and widespread e.g. on the 5th, 15-17th, 25-27th (when the River Earn exceeded its previous August peak flow) and the 29/30th (in Cumbria, the swollen River Ehen caused substantial damage at Egremont and flash flooding was severe in and around St Bees (see above)). August runoff totals were depressed in the extreme north west and south east of the country but substantially above average elsewhere; in Wiltshire, the River Avon clearly eclipsed its previous August runoff maximum in a series from 1965. Summer outflows from the UK as a whole closely approached the 2007 record (in the 52-yr national series). More exceptionally, the April-August outflow from England & Wales exceeded the previous maximum by a wide margin and was much more typical of winter river flow patterns. The maps presented on page 4 provide a guide to the hydrological transformation since the drought achieved its maximum intensity in late March. Almost half of the index catchments in England & Wales reported new record April-August runoff totals. Flows remain below average in a few baseflow-dominated streams (e.g. the Winterbourne in the Berkshire Downs) but, generally, the seasonal decline in runoff, and the associated (temporary) loss of aquatic habitats has been dramatically reversed. Some parallels could be drawn with 1903 but the river flow patterns experienced this year have been decidedly singular in character (see runoff ratio plot; page 3).

Groundwater

Across the Chalk outcrop, average soil moisture deficits for the April-August period were the lowest in a 40-year series – around a third of the previous lowest figure – following the remarkably wet late spring and summer. Groundwater levels in the Chalk remain above or near maximum levels in most of Dorset and south Wiltshire, and although now falling in the South Downs and Yorkshire they remain well above average. In Lincolnshire, East Anglia, the North Downs, the Chilterns and Northern Ireland levels are generally still rising. Groundwater flooding was reported in St Mary Bourne, Hampshire in early September. Of the slower responding Permo-Triassic sandstones, those in the north west reached record August levels and were well above average in the south west, but average or below in North Wales and the Midlands. Heathlanes, although now rising, recorded the lowest ever August level, and some boreholes in the East Midlands, such as Weeford Flats, remain dry. In the Magnesian Limestone, levels are at or above the average for August. In the highly responsive Carboniferous Limestone aquifer, exceptionally high August levels were recorded at Alstonfield; this was also the case in the Jurassic limestones. The full effects of the exceptional recharge in early summer are still being manifested. The groundwater resources outlook is now generally healthy, with below average levels confined to some slower responding boreholes where further recoveries are still expected. It is harder to predict the risks of extensive groundwater flooding over the coming winter, but in some areas of the Chalk the levels recorded at the end of August were more typical of late December, and even average rainfall may see the activation of bournes (intermittent chalk streams that only flow in particularly wet years) and flooding events over the winter.

Centre for Ecology & Hydrology
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British Geological Survey
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Rainfall . . . Rainfall . . .

Rainfall accumulations and return period estimates

Percentages are from the 1971-2000 average.

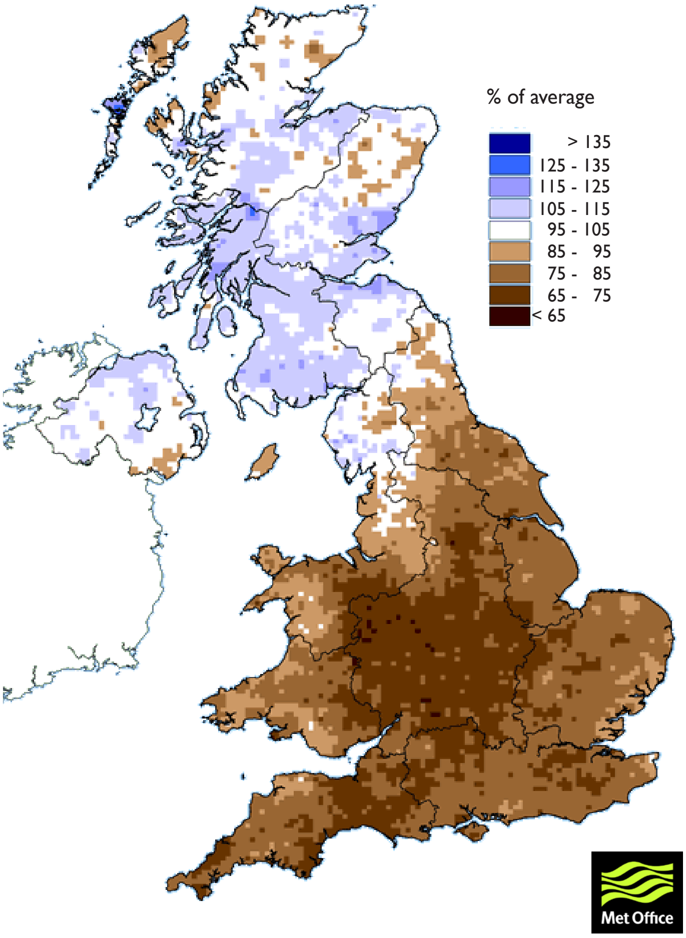
Area	Rainfall	Aug 2012	Apr12 - Aug12	RP	Sep11 - Aug12	RP	Feb11 - Aug12	RP	Mar10 - Aug12	RP
United Kingdom	mm	**110**	564		1272		1841		2740	
	%	**136**	163	>>100	117	20-30	115	20-30	105	2-5
England	mm	**88**	526		916		1281		1946	
	%	**135**	182	>>100	112	2-5	104	2-5	98	2-5
Scotland	mm	**134**	596		1787		2693		3910	
	%	**135**	143	25-40	124	>100	128	>100	114	25-40
Wales	mm	**152**	723		1514		2087		3203	
	%	**151**	175	>>100	110	2-5	104	2-5	98	2-5
Northern Ireland	mm	**111**	500		1330		1911		2875	
	%	**123**	133	8-12	120	>100	115	40-60	107	5-10
England & Wales	mm	**96**	553		998		1392		2119	
	%	**138**	181	>>100	112	2-5	104	2-5	98	2-5
North West	mm	**141**	659		1464		2133		3113	
	%	**148**	171	>100	124	20-30	122	25-40	110	2-5
Northumbria	mm	**120**	624		1003		1513		2304	
	%	**170**	204	>>100	121	8-12	120	10-15	113	5-10
Midlands	mm	**78**	504		832		1119		1696	
	%	**125**	178	>100	110	2-5	97	2-5	91	8-12
Yorkshire	mm	**99**	554		948		1342		2000	
	%	**150**	188	>>100	117	5-10	109	2-5	101	2-5
Anglian	mm	**52**	414		646		893		1405	
	%	**100**	171	>>100	107	2-5	96	2-5	94	5-10
Thames	mm	**59**	466		734		1027		1571	
	%	**109**	180	>>100	105	2-5	97	2-5	92	5-10
Southern	mm	**43**	450		772		1080		1735	
	%	**81**	176	>>100	99	2-5	94	2-5	92	5-10
Wessex	mm	**107**	566		944		1303		1942	
	%	**163**	199	>>100	109	2-5	101	2-5	93	5-10
South West	mm	**150**	682		1329		1762		2693	
	%	**181**	191	>>100	110	2-5	100	2-5	94	2-5
Welsh	mm	**147**	709		1458		2005		3082	
	%	**150**	176	>>100	110	2-5	103	2-5	98	2-5
Highland	mm	**117**	509		2034		3049		4409	
	%	**106**	109	2-5	119	20-30	122	30-50	109	8-12
North East	mm	**102**	559		1084		1753		2741	
	%	**146**	170	>100	114	2-5	123	10-20	119	10-20
Tay	mm	**139**	657		1561		2465		3589	
	%	**167**	179	>100	123	20-30	133	>>100	119	>100
Forth	mm	**133**	689		1487		2307		3335	
	%	**162**	196	>>100	131	70-100	138	>>100	123	>100
Tweed	mm	**144**	716		1295		1999		2910	
	%	**194**	217	>>100	136	80-120	139	>100	126	80-120
Solway	mm	**185**	735		1874		2788		4025	
	%	**174**	172	>>100	133	>>100	135	>>100	120	80-120
Clyde	mm	**156**	676		2333		3393		4802	
	%	**124**	137	10-20	135	>>100	134	>100	117	25-40

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

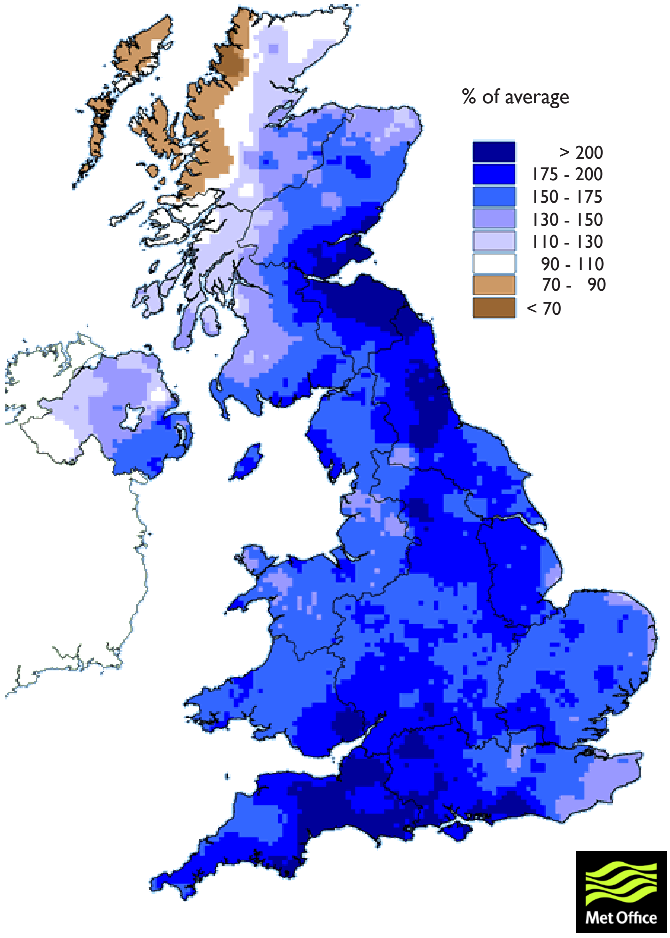
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic 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. All monthly rainfall totals since February 2012 are provisional.

Rainfall . . . Rainfall . . .

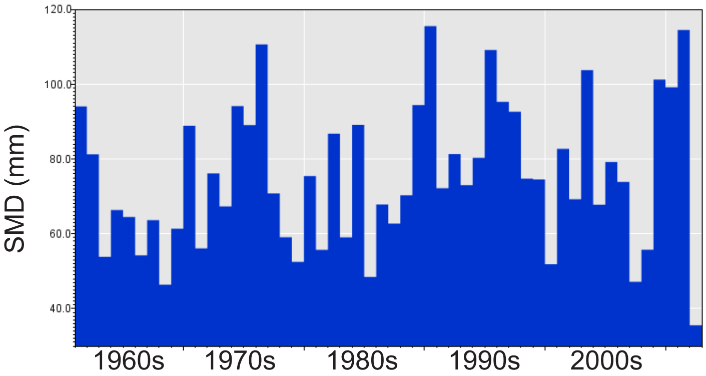
March 2010 - March 2012 rainfall as % of 1971-2000 average



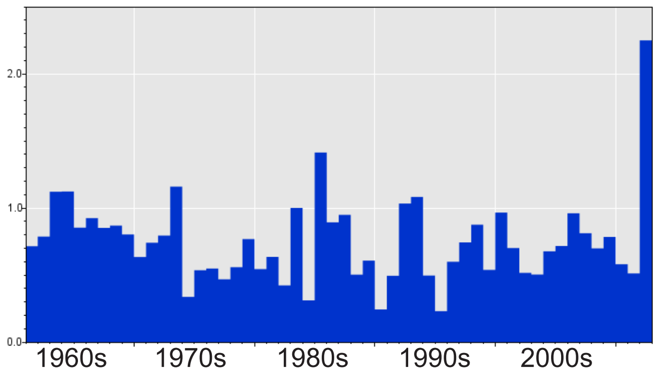
April 2012 - August 2012 rainfall as % of 1971-2000 average



Mean (end-of-month) MORECS soil moisture deficits for April-August for the Chalk outcrop



Ratio between Apr-Aug and Jan-Mar runoff for England & Wales



Met Office 3-month outlook

Updated: September 2012

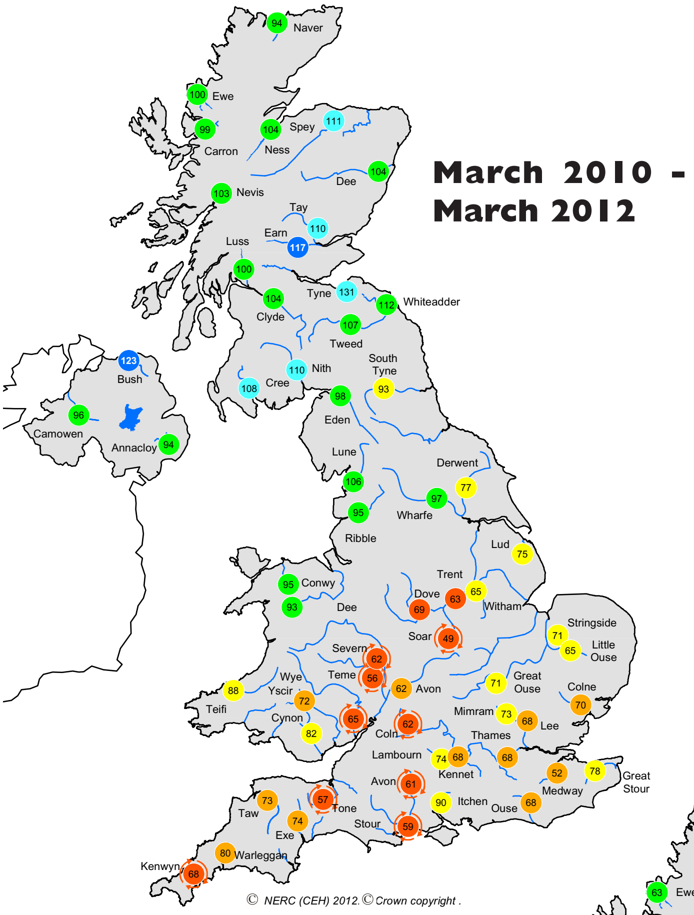
For UK averaged rainfall the predicted probabilities weakly favour below normal values during September. For the period September-October-November as a whole, the forecast favours a slightly higher than usual risk of above average rainfall, whilst the risk of dry conditions remains around climatological levels.

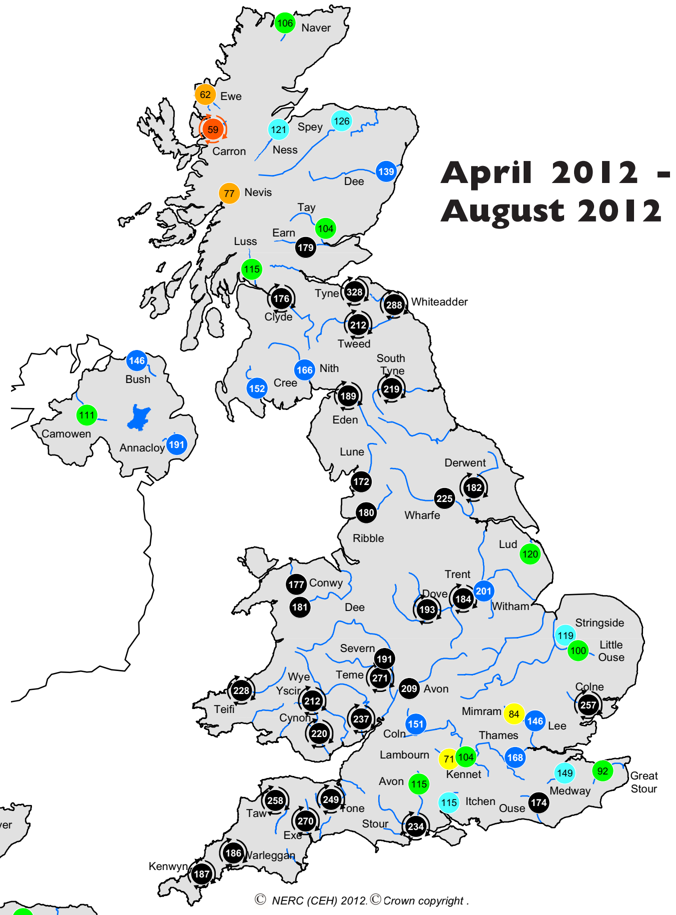
The probability that UK rainfall for September-October-November will fall into the driest of our five categories is around 20%, whilst the probability that it will fall into the wettest of our five categories in around 25% (the probability, based on climatic variability over the 1981-2010 period, for each of these categories is 20%).

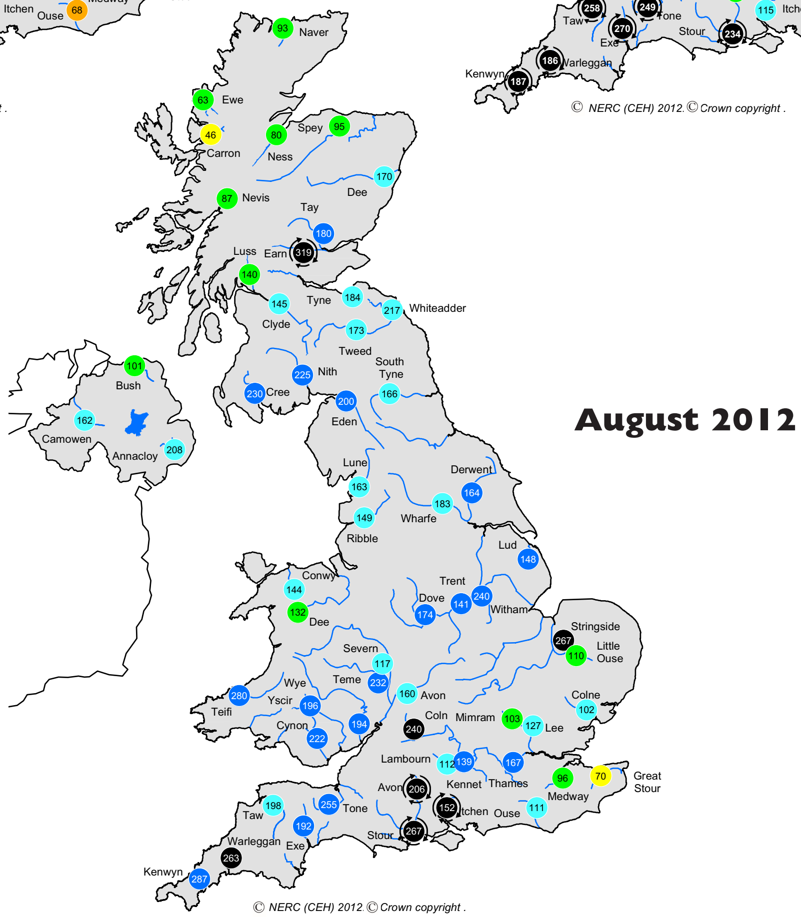
The complete version of the 3-month outlook may be found at:
http://www.metoffice.gov.uk/publicsector/contingency-planners
This outlook is updated towards the end of each calendar month.

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 . . .







Key

% of long-term average (record figure when circled)

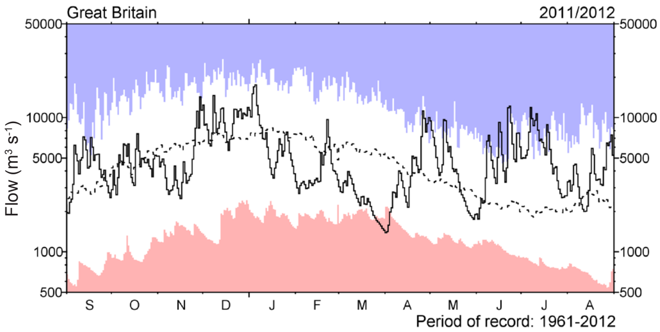
- Exceptionally high flow
- Notably high flow
- Above normal
- Normal range
- Below normal
- Notably low flow
- Exceptionally low flow

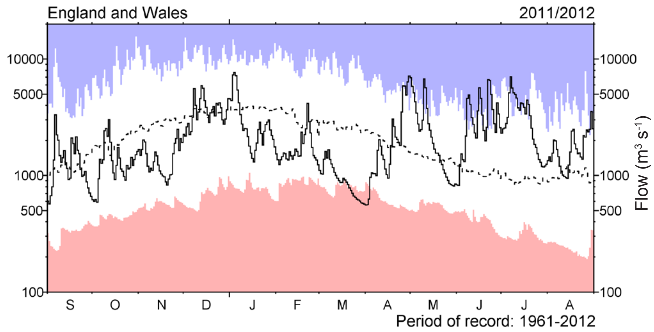
*Based on ranking of the monthly flow**

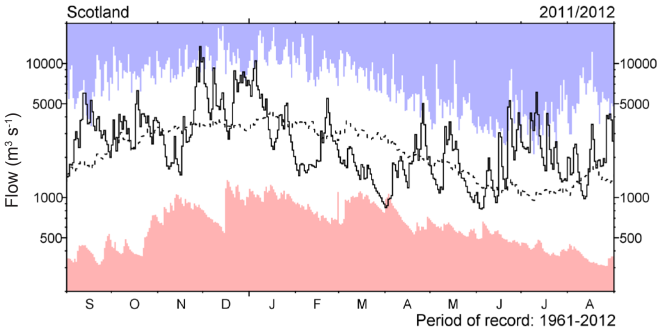
River flows

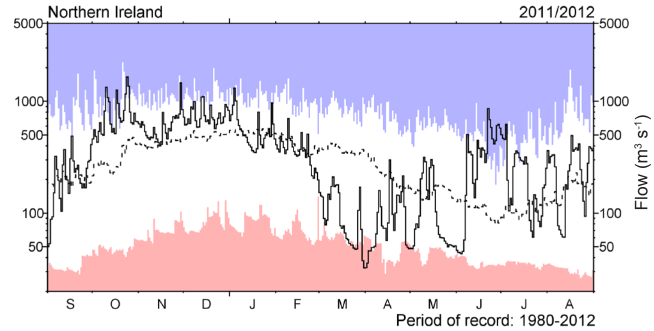
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

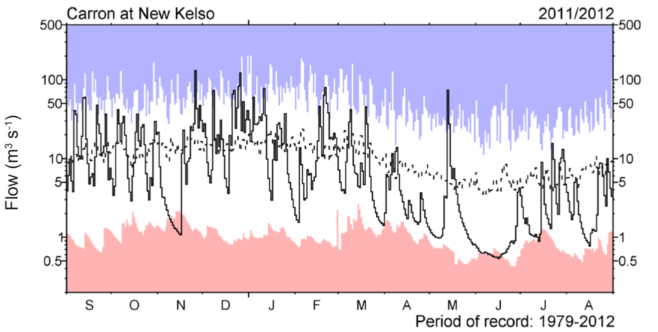
River flow . . . River flow . . .

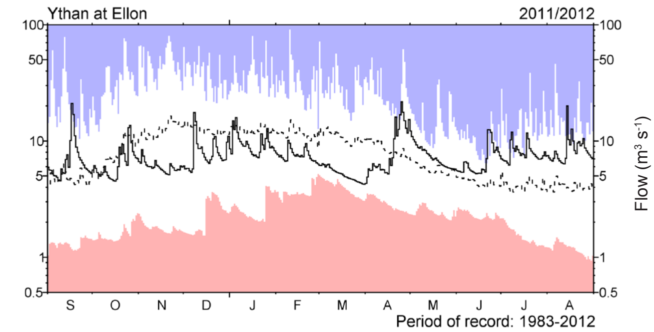


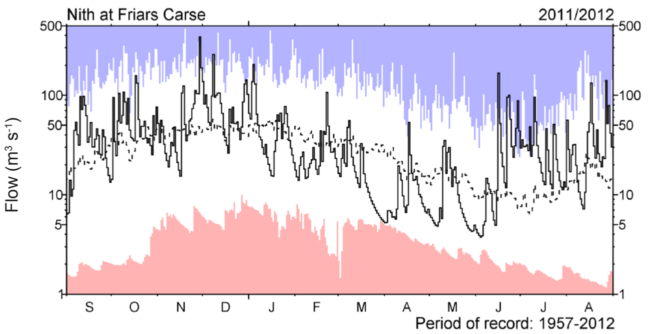


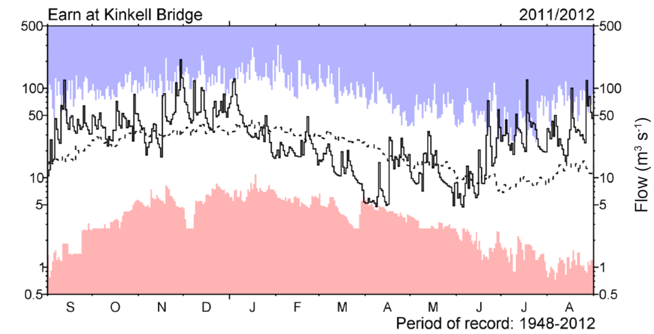


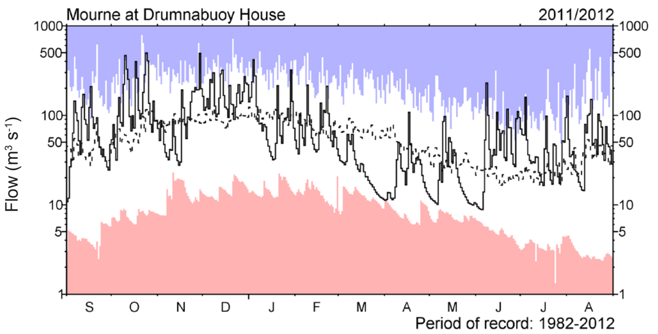


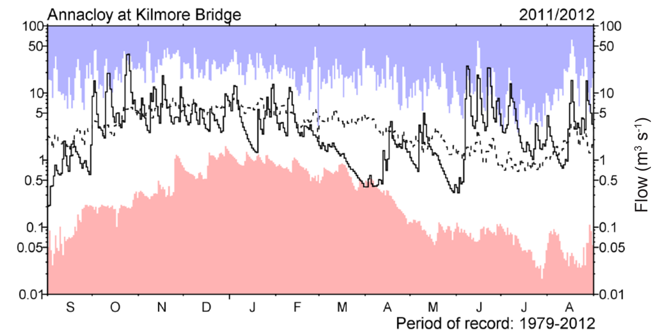








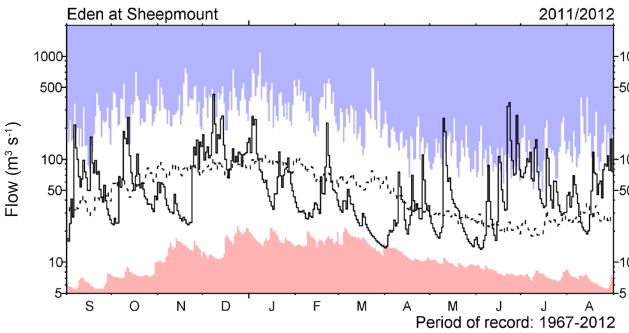


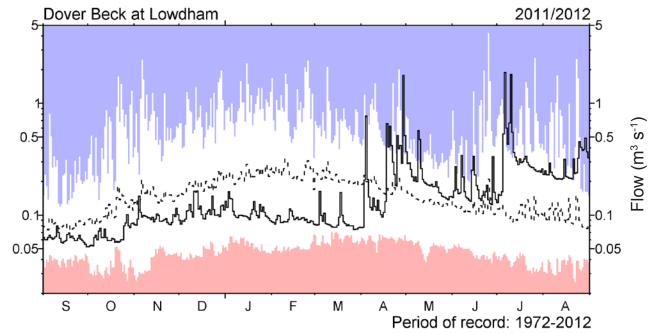


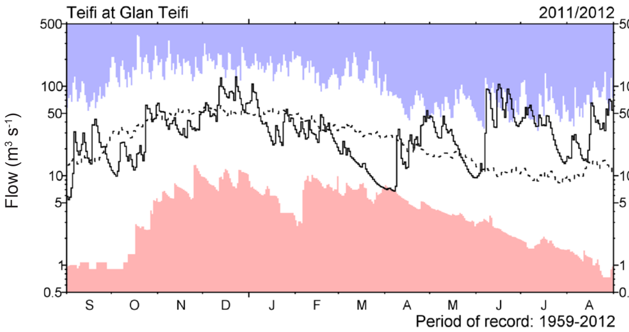
River flow hydrographs

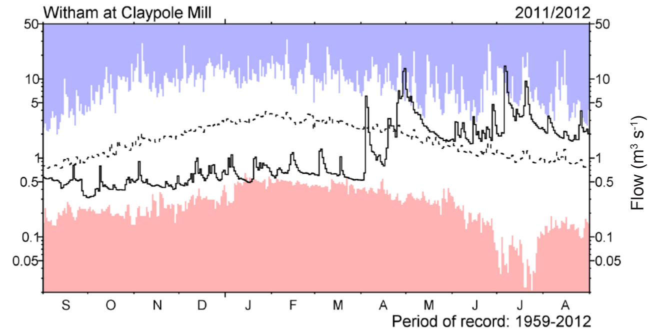
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to September 2011 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. Mean daily flows are shown as the dashed line.

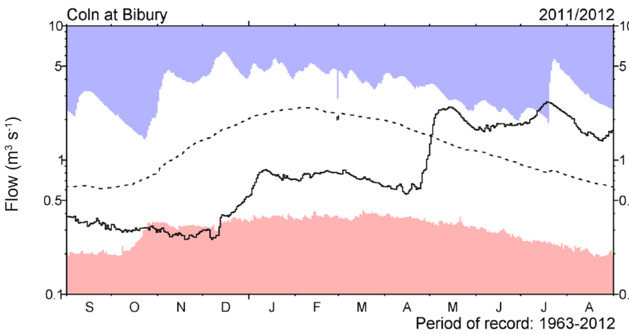
River flow . . . River flow . . .

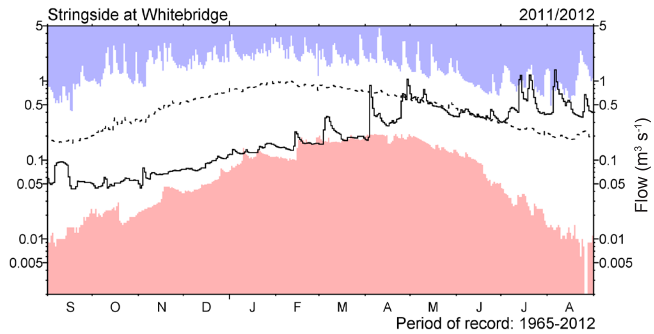


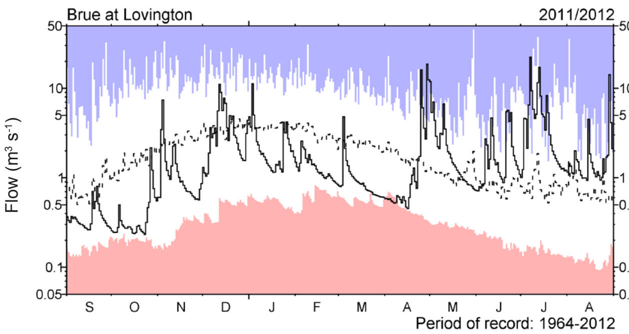


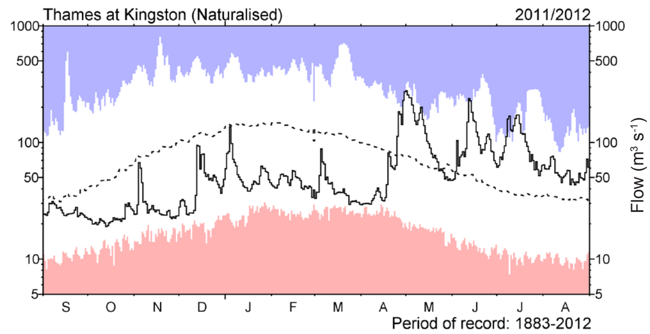


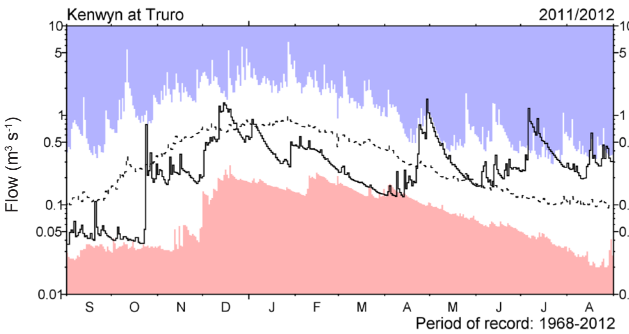


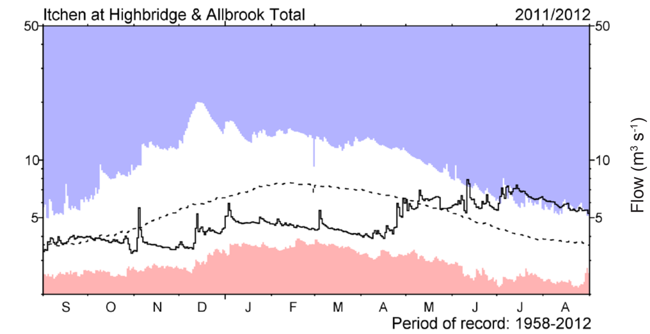












Notable runoff accumulations (a) April 2012 - August 2012

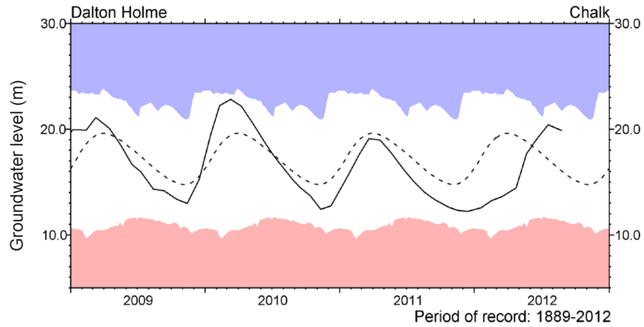
	River	%lta	Rank
a)	Deveron (Avochie)	169	53/53
	Don	171	42/43
	Bervie	184	30/32
	Tyne (Bywell)	239	53/53
	Ouse (Skelton)	230	40/40
	Dover Beck	212	37/38
	Bedford Ouse (Roxton)	203	39/39

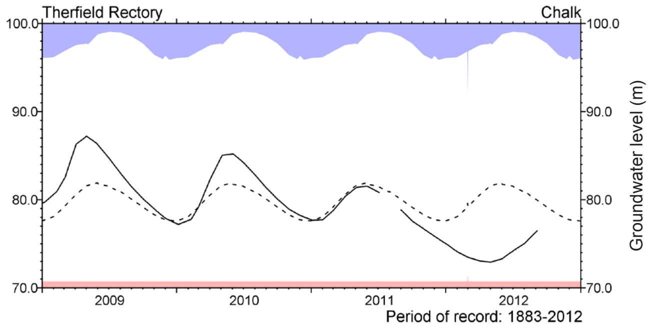
	River	%lta	Rank
a)	Blackwater	156	58/60
	Mole	273	39/39
	Wallington	285	59/59
	Lymington	316	50/50
	Piddle	145	47/49
	Otter	231	50/50

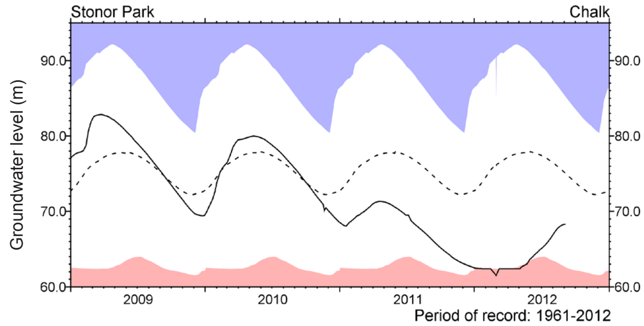
	River	%lta	Rank
a)	Dart	222	54/54
	Brue	262	47/47
	Usk (Chain Bridge)	205	56/56
	Tawe	205	54/54
	Tywi	191	54/54
	Dyfi	221	44/44
	Faughan	149	34/36

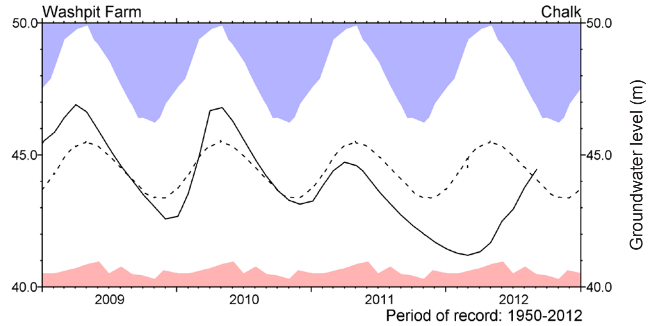
lta = long term average; Rank 1 = lowest on record

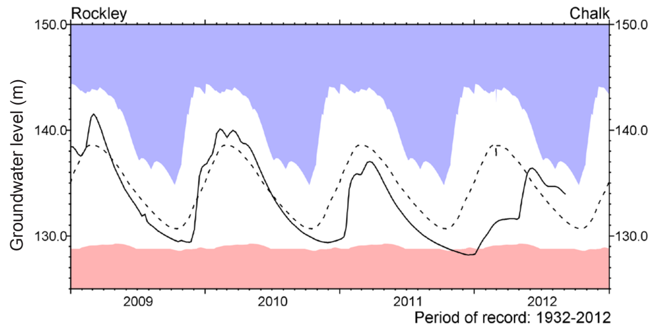
Groundwater . . . Groundwater

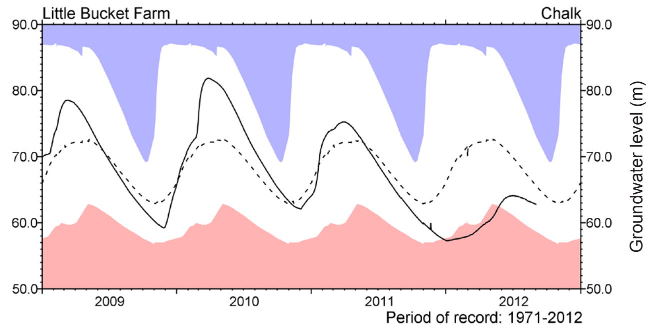


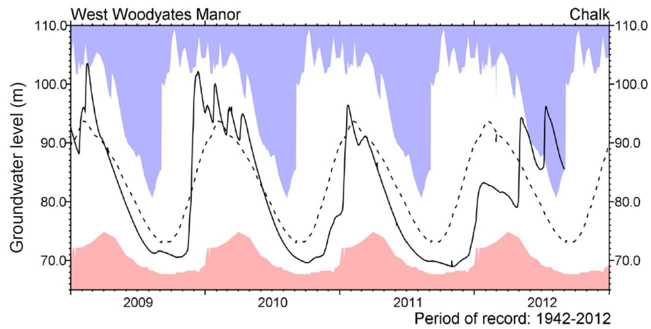


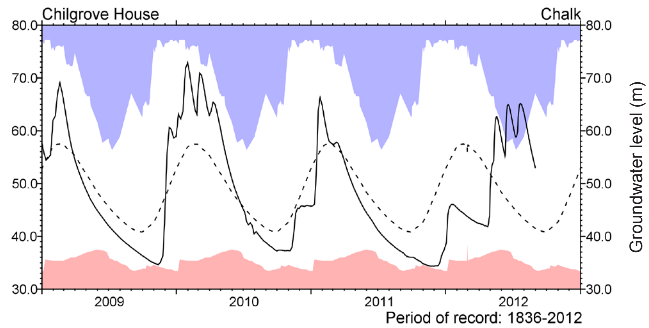


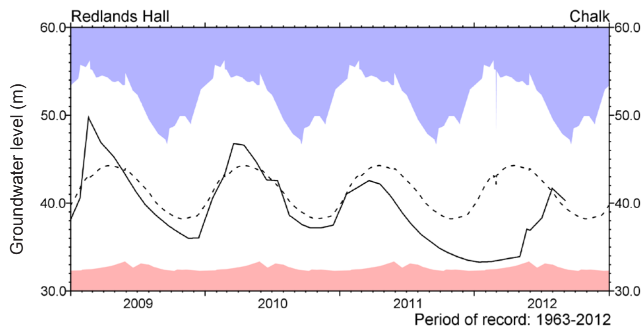


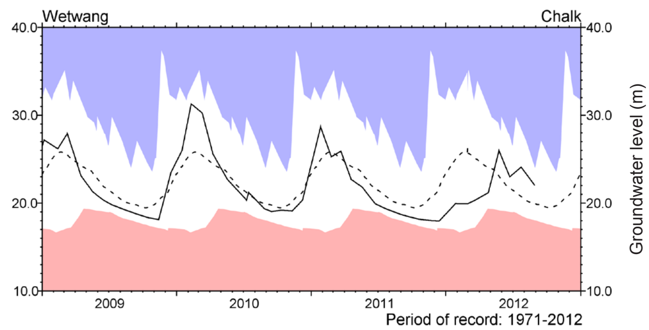






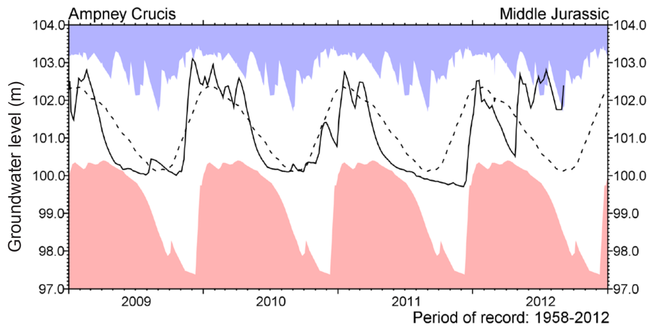


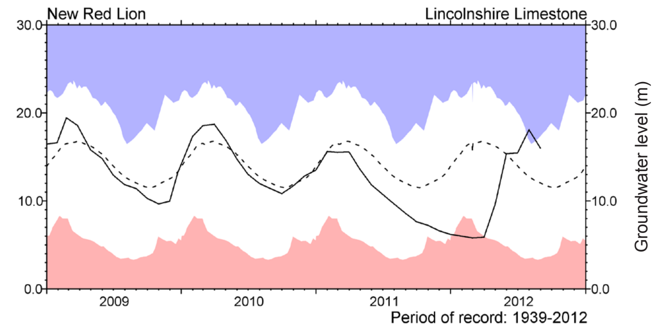


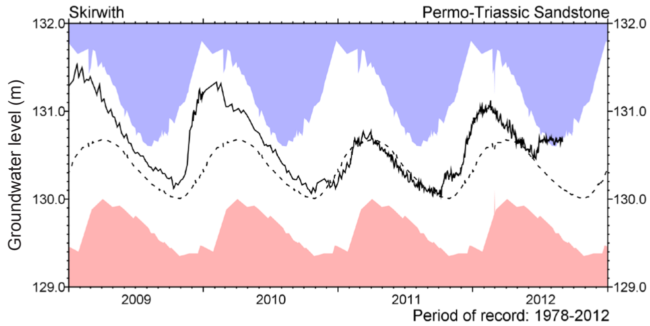


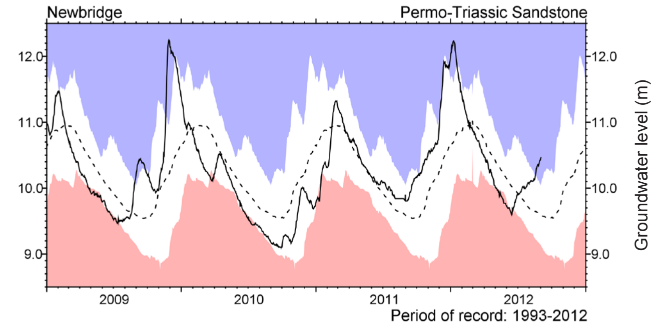
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

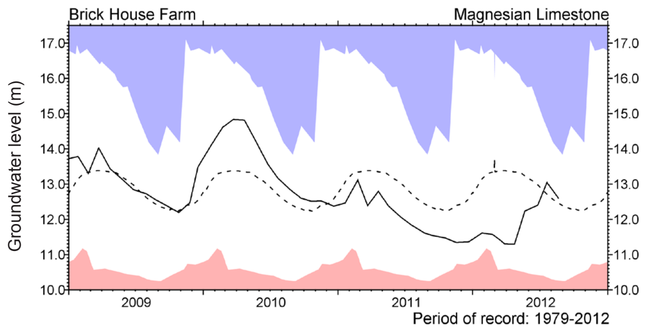
Groundwater . . . Groundwater

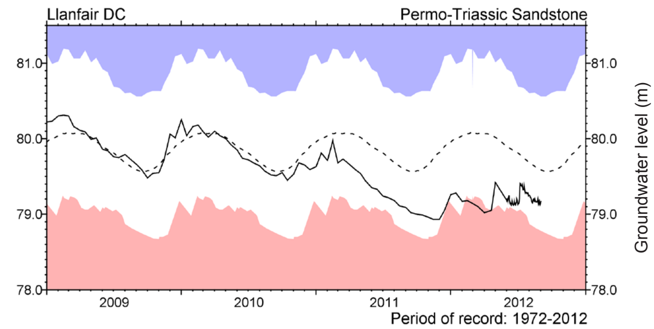


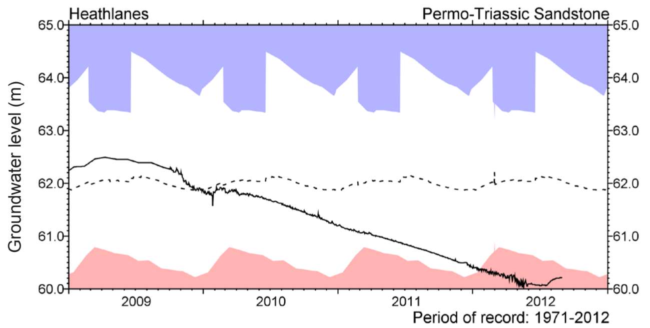


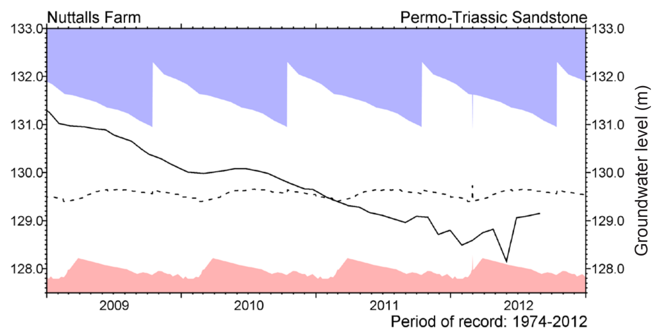


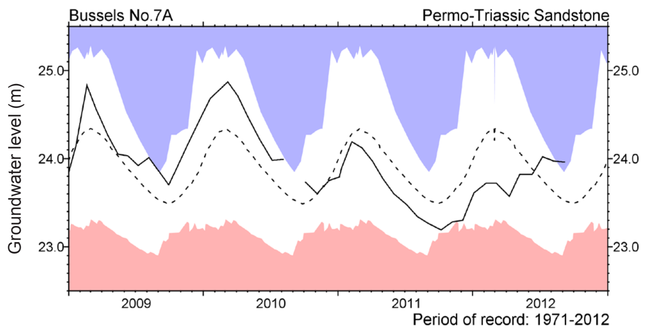


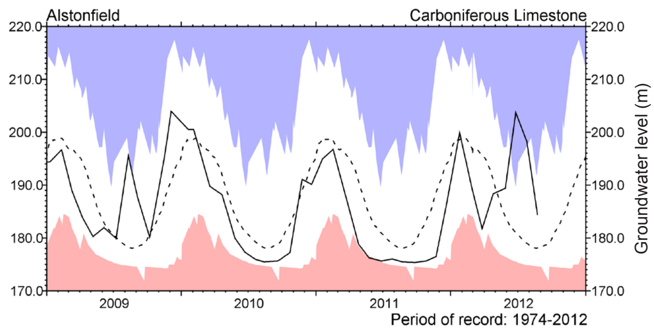










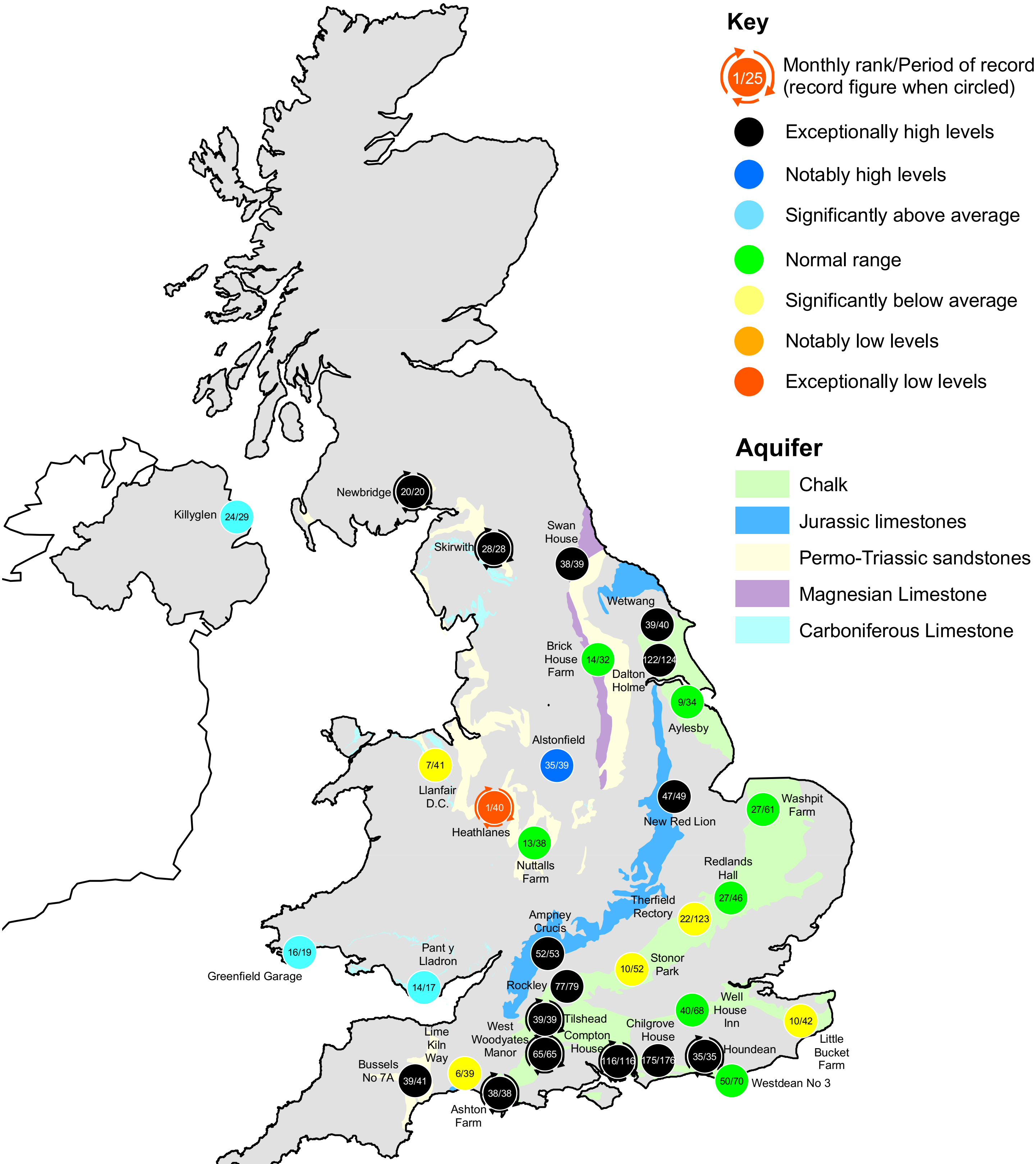


Groundwater levels August / September 2012

Borehole	Level	Date	Aug av.	Borehole	Level	Date	Aug av.	Borehole	Level	Date	Aug av.
Dalton Holme	19.88	24/08	16.25	Chilgrove House	52.87	31/08	41.69	Brick House Farm	12.60	20/08	12.52
Therfield Rectory	76.44	04/09	80.93	Killyglen (NI)	114.80	05/09	114.06	Llanfair DC	79.17	01/09	79.64
Stonor Park	68.29	03/09	75.72	New Red Lion	15.99	31/08	12.27	Heathlanes	60.21	29/08	62.06
Tilshead	90.61	31/08	82.72	Ampney Crucis	102.38	03/09	100.21	Nuttalls Farm	129.15	29/08	129.63
Rockley	133.96	03/09	132.05	Newbridge	10.46	01/09	9.64	Bussels No.7a	23.96	06/09	23.60
Well House Inn	96.38	03/09	94.81	Skirwith	130.68	31/08	130.20	Alstonfield	184.42	23/08	178.43
West Woodyates	85.58	31/08	73.98	Swan House	85.62	21/08	82.74				

Levels in metres above Ordnance Datum

Groundwater . . .Groundwater



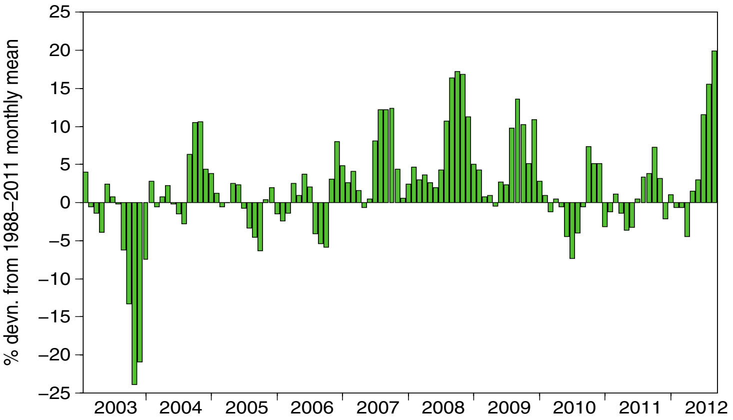
Groundwater levels - August 2012

The rankings are based on a comparison between the average level in the featured month (but often only single readings are available) and the average level in each corresponding month on record. Rankings – and the designation of period of record maxima and minima – need to be interpreted with caution; where the latest monthly mean values are based on one or two level measurements only, their recording dates can be very influential, particularly during periods of relatively rapid change. Rankings may be omitted where they are considered misleading.

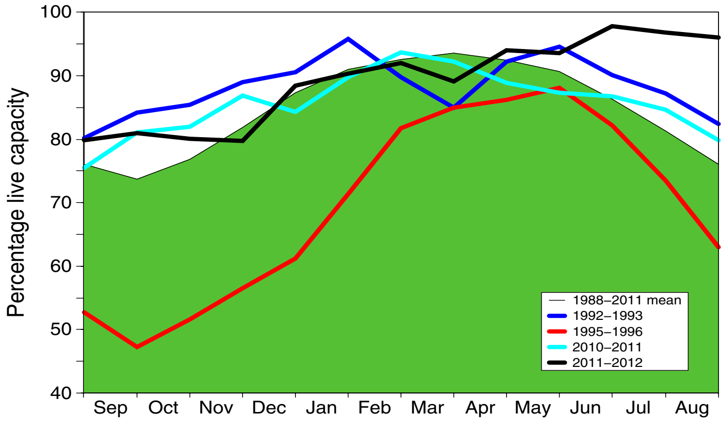
Notes:
i. The outcrop areas are coloured according to British Geological Survey conventions.
ii. Yew Tree Farm levels are now received quarterly.

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 start of month

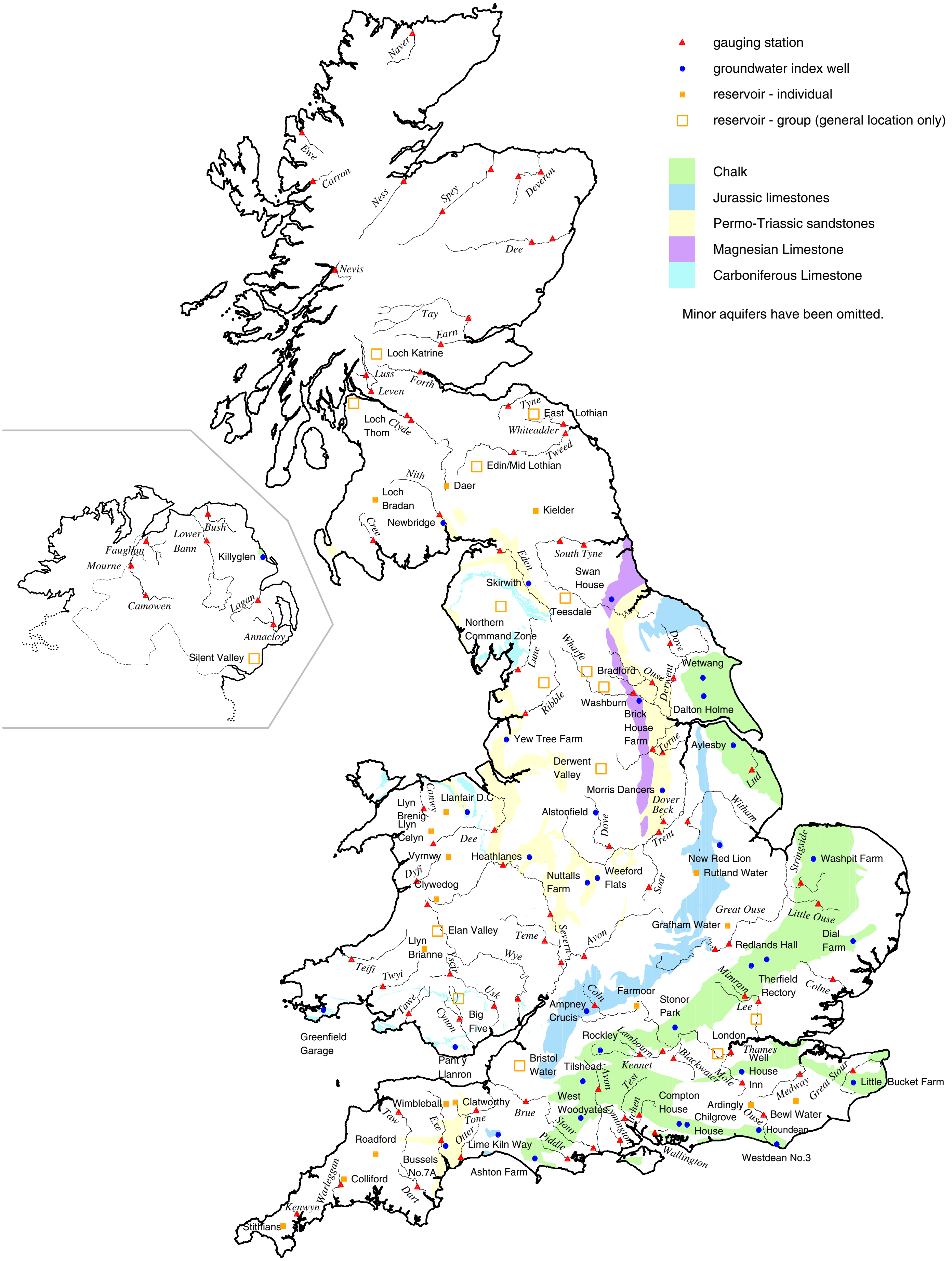
Area	Reservoir		Capacity (Ml)	2012 July	Aug	Sep	Sep Anom.	Min Sep	Year* of min	2011 Sep	Diff 12-11
North West	N Command Zone	•	124929	95	92	**92**	34	24	1995	66	26
	Vyrnwy		55146	99	98	**100**	29	36	1995	77	23
Northumbrian	Teesdale	•	87936	100	95	**95**	27	38	1995	91	4
	Kielder		(199175)	99	100	**95**	8	66	1989	93	2
Severn Trent	Clywedog		44922	98	94	**91**	14	38	1989	80	11
	Derwent Valley	•	39525	100	97	**95**	28	34	1995	56	39
Yorkshire	Washburn	•	22035	96	93	**94**	25	34	1995	69	25
	Bradford supply	•	41407	99	97	**97**	30	21	1995	73	24
Anglian	Grafham		(55490)	96	94	**95**	10	59	1997	90	5
	Rutland		(116580)	98	97	**98**	17	66	1995	73	25
Thames	London	•	202828	98	98	**96**	16	62	1995	86	10
	Farmoor	•	13822	98	97	**93**	0	64	1995	98	-5
Southern	Bewl		28170	91	90	**83**	15	38	1990	57	26
	Ardingly*		4685	100	100	**100**	27	47	1996	61	39
Wessex	Clatworthy		5364	100	100	**98**	34	31	1995	49	49
	Bristol WW	•	(38666)	97	98	**98**	30	43	1990	62	36
South West	Colliford		28540	83	86	**89**	18	43	1997	50	39
	Roadford		34500	89	93	**94**	22	40	1995	53	41
	Wimbleball		21320	100	100	**100**	30	40	1995	47	53
	Stithians		4967	95	98	**95**	34	30	1990	51	44
Welsh	Celyn and Brenig	•	131155	100	100	**99**	17	49	1989	94	5
	Brianne		62140	100	100	**100**	14	55	1995	94	6
	Big Five	•	69762	100	98	**98**	28	29	1995	76	22
	Elan Valley	•	99106	100	97	**100**	23	46	1995	83	17
Scotland(E)	Edinburgh/Mid Lothian	•	97639	97	100	**100**	22	45	1998	91	9
	East Lothian	•	10206	100	100	**100**	16	63	1989	100	0
Scotland(W)	Loch Katrine	•	111363	73	88	**90**	19	50	2000	92	-2
	Daer		22412	100	100	**100**	24	41	1995	99	1
	Loch Thom	•	11840	93	95	**99**	18	58	1997	96	3
Northern Ireland	Total+	•	56920	96	95	**97**	21	40	1995	72	25
	Silent Valley	•	20634	100	97	**100**	31	33	2000	66	34

() figures in parentheses relate to gross storage • denotes reservoir groups +excludes Lough Neagh *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 1988-2011 period except for West of Scotland and Northern Ireland where data commence in the mid-1990's. In some gravity-fed reservoirs (e.g. Clywedog) stocks are kept below capacity during the winter to provide scope for flood attenuation purposes.

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

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. 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, the Environment Agency Wales, the Scottish Environment Protection Agency and, for Northern Ireland, the Rivers Agency and the Northern Ireland Environment Agency. In all cases the data are subject to revision following validation (flood and drought 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.

NATURAL ENVIRONMENT RESEARCH COUNCIL

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EX1 3PB

Tel.: 0870 900 0100 Fax: 0870 900 5050
E-mail: enquiries@metoffice.com

The HadUKP England & Wales precipitation series (EWP) from 1766 is available here:
http://www.metoffice.gov.uk/hadobs/hadukp/

Ref: Alexander, L.V. and Jones, P.D. (2001) Updated precipitation series for the UK and discussion of recent extremes. Atmospheric Science Letters
doi: 10.1006/asle.2001.0025

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

Enquiries

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Selected text and maps are available on the WWW at
http://www.ceh.ac.uk/data/nrfa/nhmp/nhmp.html
Navigate via Hydrological Summary for the UK.

09/12