Hydrological Summary

for the United Kingdom

September 2012

General

September was generally a cool but sunny month with limited rainfall over the first three weeks. Thereafter cyclonic conditions prevailed with exceptionally high 7- to 10-day rainfall totals. River flows climbed rapidly in the fourth week and floodplain inundations were very widespread from the 23rd; in many rivers flows remained close to, or above, bankfull for a week or more. Provisional data suggest that September outflows from England & Wales were the 2nd highest since 1968 and the associated extensive flooding provided a dramatic climax to the wettest summer half-year (April-September) on record for the UK. The exceptional runoff reversed a belated seasonal decline in reservoir stocks and early October stocks for England & Wales exceeded the previous monthly maximum (the fourth successive month in which this has occurred). Stocks in the great majority of index reservoirs are currently within 10% of capacity – remarkable for the early autumn. Groundwater resources present a less coherent picture – due to a combination of rainfall patterns, soil moisture conditions and, more particularly, aquifer storage characteristics which determine the lag between surface infiltration and water-table response. Groundwater levels in the generality of index wells are above, to well above, the early autumn mean but remain depressed in some of the slower-responding aquifers – in the Midlands, particularly. The water resources outlook is far healthier than could have been envisaged during the early spring of 2012.

Rainfall

Anticyclonic synoptic patterns initially dominated the September weather; many southern areas recorded rainfall totals of <5mm over the first three weeks. Weather conditions then changed decisively. On the 20th, Prestwick (Ayrshire) reported a 24-hr rainfall of 72mm heralding an exceptionally unsettled episode with severe gales across parts of northern Britain. On the 24-26th, the most intensive September storm for 30 years (spawned from the remnant of Hurricane Nadine) resulted in 2- to 3-day rainfall totals exceeding the September average in many areas – particularly in northern England and southern Scotland. At Ravensworth (North Yorkshire), a 3-day total of 130mm was recorded and 24-hr totals of 98.2mm at Killyane (Antrim) and 66mm at Rhyl (Denbyshire) were also reported. With soils unusually wet for the time of year, such storm totals triggered both fluvial and pluvial flooding and several landslides were reported (one draining a section of the Trent and Mersey canal). The September rainfall total for the UK as a whole was close to the 1971-2000 average but spatial variations were very substantial particularly where convective storms produced intense deluges. In a zone from northern England to North Wales many areas recorded >150% of the monthly mean; the eastern flanks of the Pennines were particularly wet. In contrast, below average rainfall characterised some eastern parts of the English Lowlands – for the second successive month in some areas (e.g. the Chilterns and parts of East Anglia). Nonetheless, medium term regional rainfall accumulations (4-6 months) remain exceptionally high and the April-September rainfall for England & Wales eclipsed the previous maximum (1924) by a considerable margin.

River flows

In many rivers, mostly draining impermeable catchments, mid-September flows were the lowest since May and in a few eastern rivers (e.g. the Great Stour in Kent) flows during the 2nd week were close to the early-autumn minimum. Thereafter, flow recoveries were generally very steep and, by the 24-26th, estimated outflows from England & Wales exceeded the previous late-September maximum. Bankfull flows were exceeded over wide areas and flood alerts (of varying severity) extended from central Scotland to southern England. In Yorkshire, the Ouse recorded its 3rd highest level at York in a series extending back to the 1880s and floodplain inundations were both extensive and sustained. Several rivers, including the Swale, recorded peak flows above previous maxima. In the Tweed basin, the Whiteadder registered a new maximum flow in a series from 1969 and the Bush (Northern Ireland) reported its highest September flow since 1985. The fluvial flooding was most severe in north-east England (e.g. at Morpeth and Stockton) and flash flooding affected many localities (e.g. Chew Magna, Somerset). Generally, the flood risk was accentuated by the near-saturated soil conditions and, in some areas, seasonally very high groundwater levels – the associated heavy spring outflows contributing to sustained spate conditions (e.g. in Dorset). The flooding resulted in widespread and persistent transport disruption. With a few exceptions in Scotland and, more significantly, south-east England, mean river flows for September were well above average – contributing to extraordinary runoff totals in the April-September timeframe. For England & Wales outflows were more than 30% greater than the previous highest for the summer half-year.

Groundwater

Across most aquifers, the majority of the exceptional late spring and summer recharge has now reached the water tables, and the drier conditions experienced during early September allowed recessions to continue. Groundwater levels in the Chalk fell (or at best remained relatively constant) during September, with post-drought recoveries continuing only in the deep and slow responding parts of the Chalk (e.g. at Therfield Rectory). Despite the recessions, levels in the Chalk remain above average everywhere except the Chilterns and parts of East Anglia and are still at or near record high levels in Dorset, parts of the South Downs and Wiltshire. In the slower responding Permo-Triassic sandstones, levels are average or below in North Wales, notably so in the Midlands, where Heathlanes recorded its lowest ever September level, Nuttalls Farm and Morris Dancers are very low and Weeford Flats remains dry. In contrast, Bussels in the South West was close to its seasonal maximum, and wells in northern England and Scotland were still at or near record highs. In the Magnesian Limestone, while levels fell during September, they are still notably high. In the highly responsive Carboniferous Limestone aquifer and the Jurassic Limestones, levels remain above average. The contrast between groundwater levels in the late spring, following prolonged drought, and now, when levels have largely recovered, is notable. The winter recharge season will commence from a much more normal point than in 2011. There are, however, large regional and local variations, reflecting both the uneven distribution of rainfall and local hydrogeological conditions. Even with average winter rainfall we can expect to see localised record-breaking levels, where recoveries in some Chalk aquifers start from already high levels.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Rainfall . . . Rainfall . . .

Met Office

Rainfall accumulations and return period estimates

Percentages are from the 1971-2000 average.

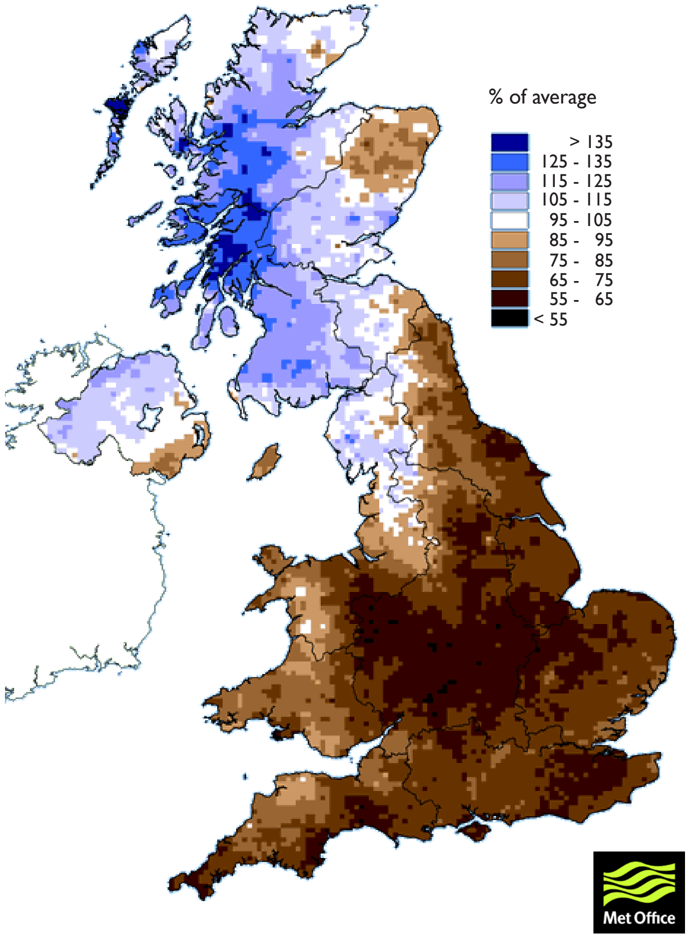
Area	Rainfall	Sep 2012	Aug12 - Sep12	RP	Apr12 - Sep12	RP	Oct11 - Sep12	RP	Apr11 - Sep12	RP
United	mm	**112**	222		676		1275		1789	
Kingdom	%	**116**	125	2-5	153	>>100	118	20-30	117	25-40
England	mm	**88**	175		614		949		1271	
	%	**122**	128	2-5	170	>>100	116	5-10	108	2-5
Scotland	mm	**149**	283		745		1746		2570	
	%	**112**	122	2-5	135	20-30	121	40-60	129	>>100
Wales	mm	**134**	286		857		1518		2060	
	%	**114**	131	2-5	161	>100	111	2-5	108	2-5
Northern	mm	**104**	216		604		1308		1824	
Ireland	%	**111**	117	2-5	129	8-12	118	25-40	115	20-30
England &	mm	**94**	191		647		1028		1380	
Wales	%	**121**	129	2-5	169	>>100	115	5-10	108	2-5
North West	mm	**191**	332		850		1513		2114	
	%	**185**	168	10-20	174	>>100	129	40-60	127	40-60
Northumbria	mm	**135**	255		759		1075		1506	
	%	**193**	181	20-30	202	>>100	129	50-80	125	20-30
Midlands	mm	**79**	158		584		875		1121	
	%	**119**	122	2-5	167	>100	115	2-5	101	2-5
Yorkshire	mm	**115**	214		669		1015		1340	
	%	**167**	159	8-12	184	>>100	125	10-20	114	2-5
Anglian	mm	**41**	93		456		661		882	
	%	**76**	87	2-5	153	60-90	110	2-5	98	2-5
Thames	mm	**54**	113		519		752		1019	
	%	**85**	96	2-5	161	>100	107	2-5	100	2-5
Southern	mm	**69**	112		519		800		1071	
	%	**97**	90	2-5	159	70-100	102	2-5	97	2-5
Wessex	mm	**73**	180		639		961		1292	
	%	**95**	126	2-5	177	>100	111	2-5	105	2-5
South West	mm	**90**	240		772		1329		1725	
	%	**91**	132	5-10	169	>100	110	2-5	104	2-5
Welsh	mm	**129**	276		837		1465		1983	
	%	**113**	130	2-5	162	>100	111	2-5	108	2-5
Highland	mm	**185**	302		694		1985		2960	
	%	**117**	113	2-5	111	2-5	116	10-20	127	>100
North East	mm	**71**	174		630		1059		1633	
	%	**81**	110	2-5	151	30-45	112	2-5	120	5-10
Tay	mm	**95**	234		752		1491		2278	
	%	**85**	120	2-5	157	35-50	118	8-12	130	>100
Forth	mm	**115**	248		804		1473		2149	
	%	**110**	133	2-5	176	>100	130	50-80	135	>100
Tweed	mm	**129**	273		845		1321		1923	
	%	**160**	176	10-20	206	>>100	138	>100	141	>100
Solway	mm	**166**	352		901		1864		2650	
	%	**134**	152	8-12	163	>100	132	>100	135	>>100
Clyde	mm	**185**	341		860		2256		3235	
	%	**113**	118	2-5	131	10-20	130	70-100	135	>>100

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

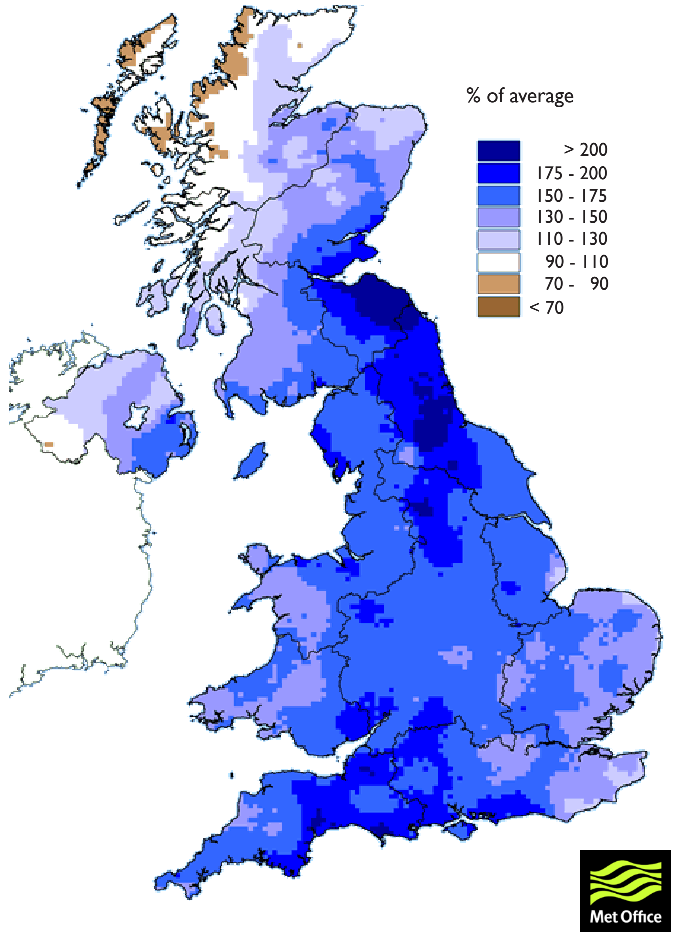
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic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

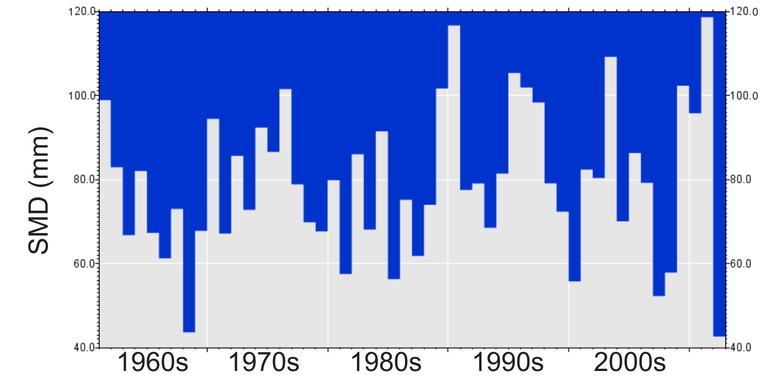
March 2011 - March 2012 rainfall as % of 1971-2000 average



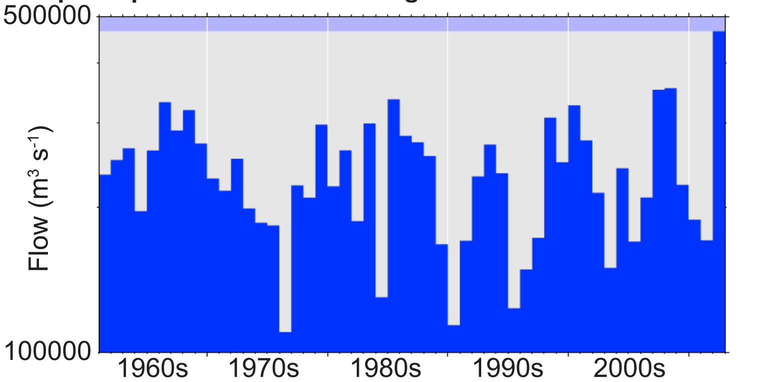
April 2012 - September 2012 rainfall as % of 1971-2000 average



Mean (end-of-month) MORECS soil moisture deficits for April-September for the English Lowlands



April-September outflows for England & Wales



Met Office 3-month outlook

Updated: October 2012

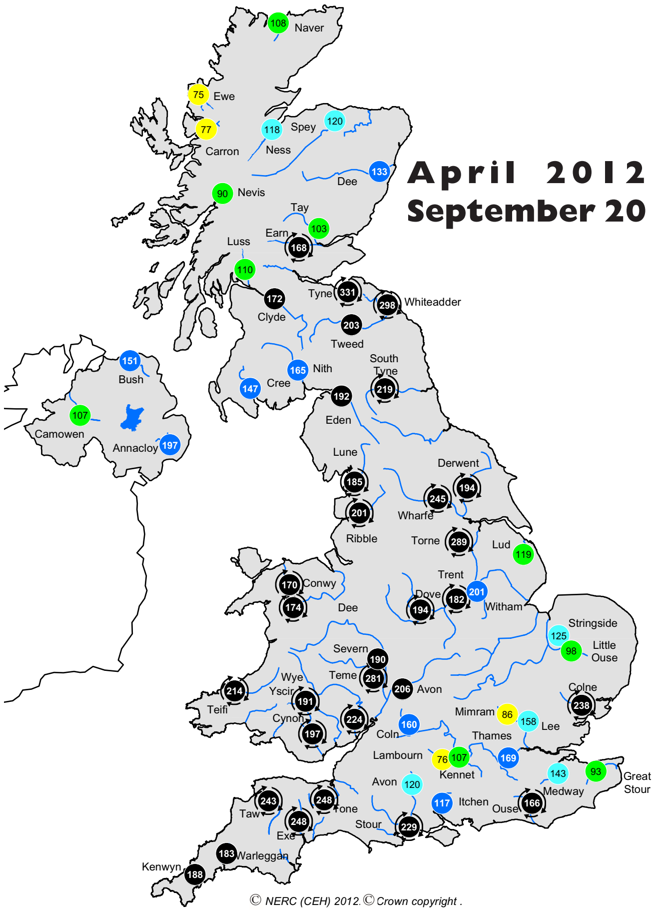
For UK-averaged rainfall the predicted probabilities favour below normal rainfall during October. For the period October-November-December as a whole the range of forecasts also favours lower than average rainfall.

The probability that UK rainfall for October-November-December will fall into the driest of our five categories is around 25% whilst the probability that it will fall into the wettest of our five categories is 15-20%, close to the climatological average. (The 1981-2010 probability for each of these categories is 20%).

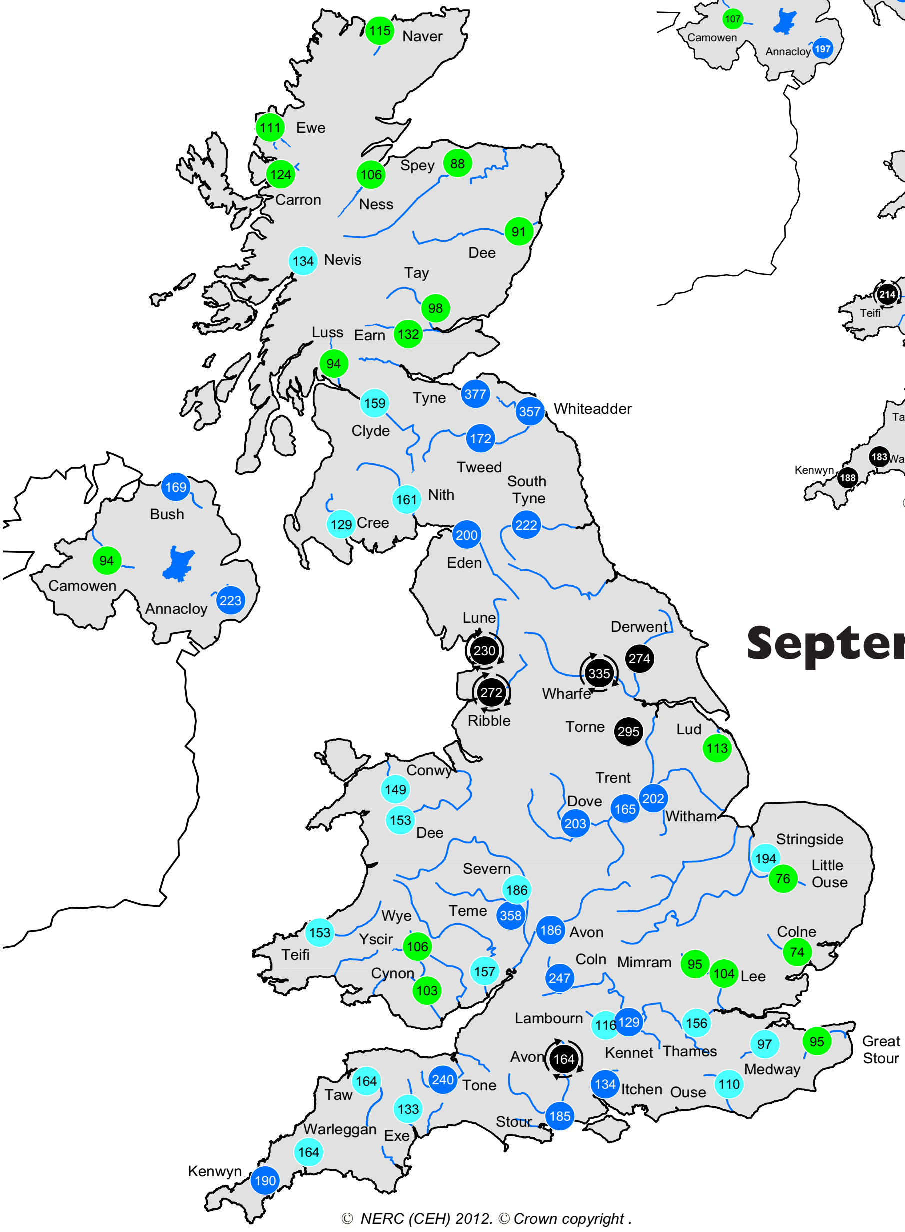
The complete version of the 3-month outlook may be found at:
http://www.metoffice.gov.uk/publicsector/contingency-planners
This outlook is updated towards the end of each calendar month.

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 . . .



April 2012 - September 2012



September 2012

Key

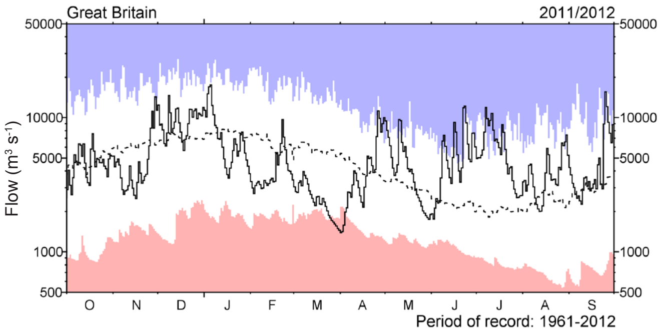
- 25 — % of long-term average (record figure when circled)
- Exceptionally high flow
- Notably high flow
- Above normal
- Normal range
- Below normal
- Notably low flow
- Exceptionally low flow

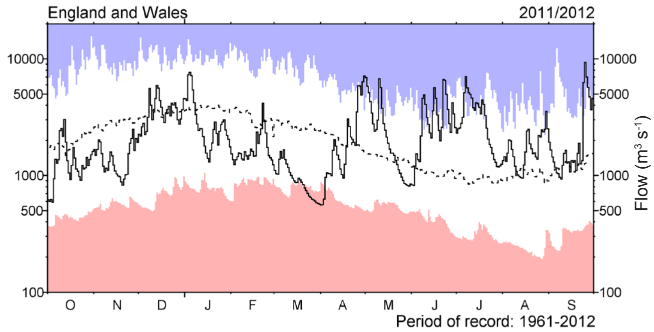
*Based on ranking of the monthly flow**

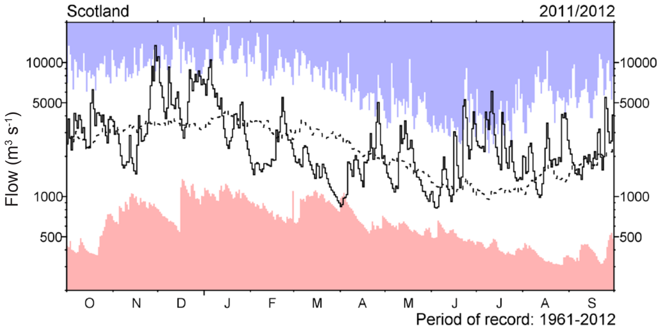
River flows

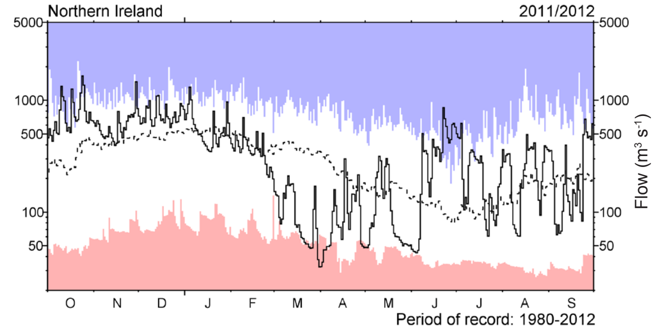
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

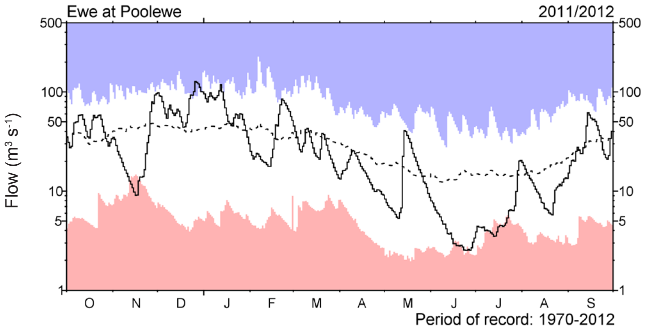
River flow . . . River flow . . .

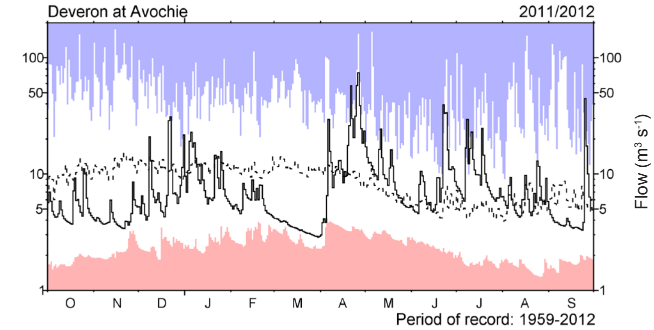


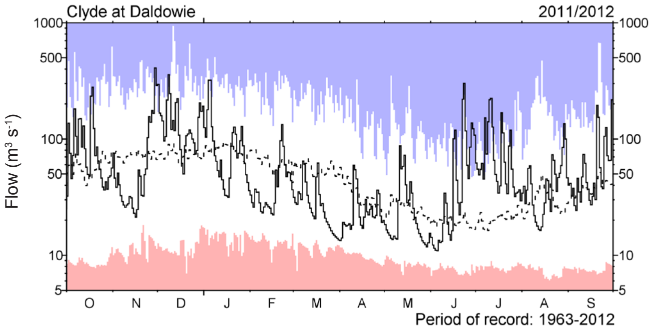


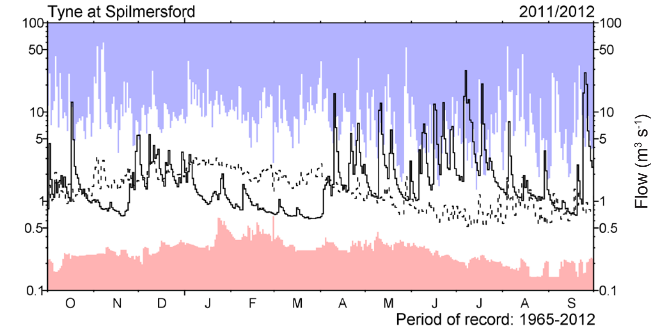


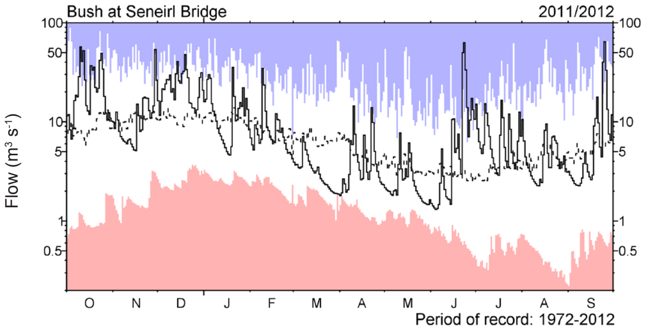


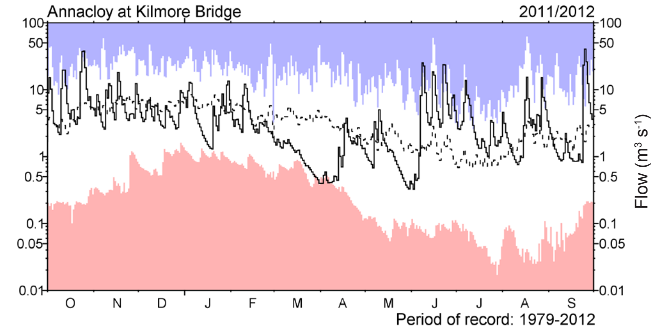








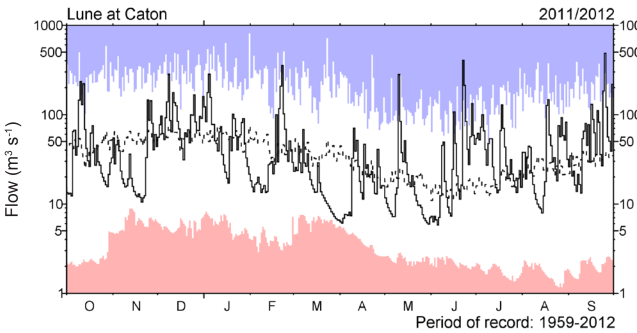


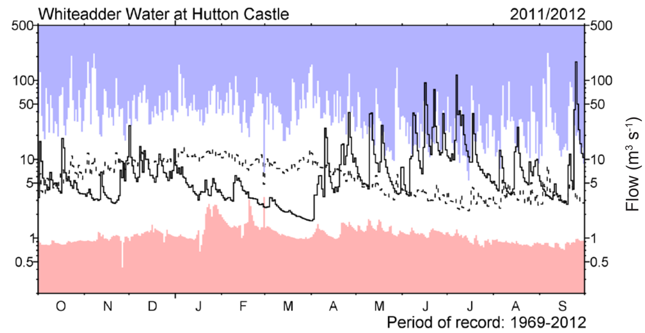


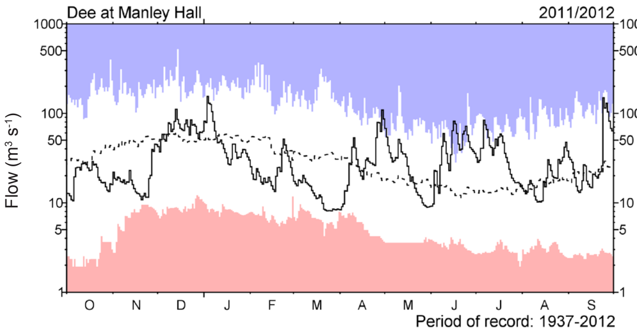
River flow hydrographs

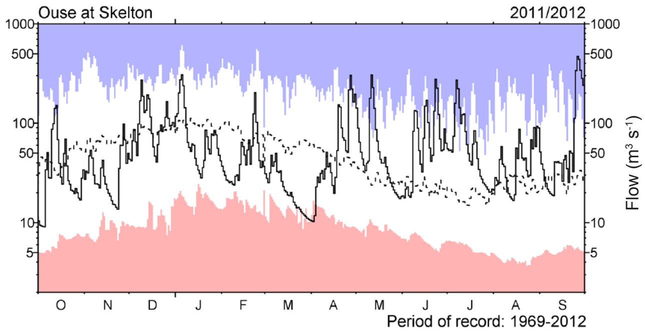
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to October 2011 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. Mean daily flows are shown as the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

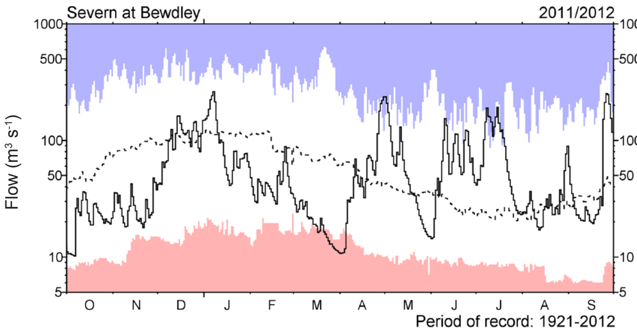
River flow . . . River flow . . .

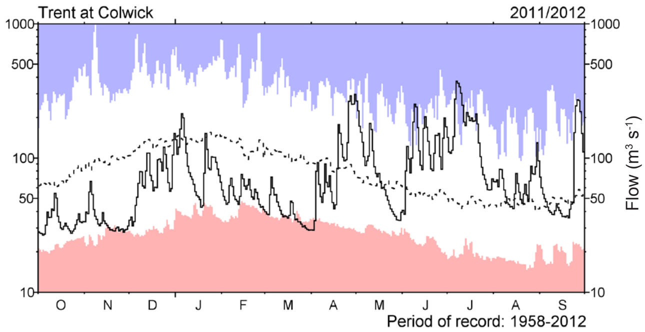


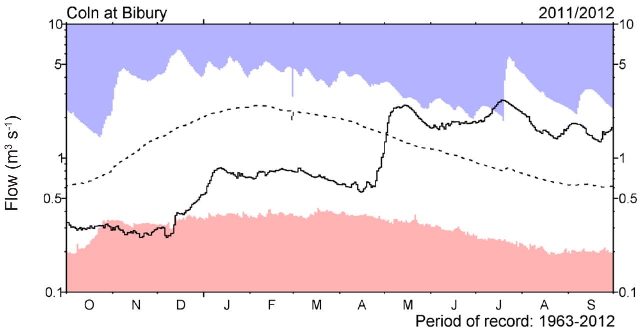


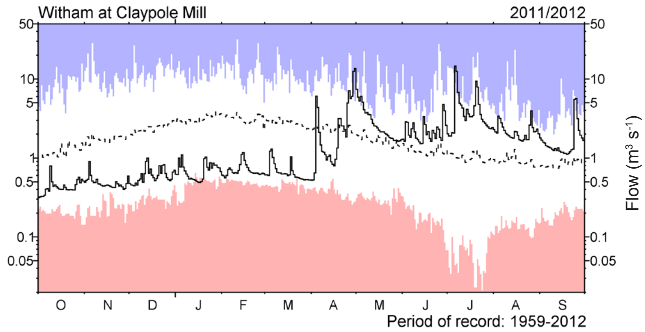


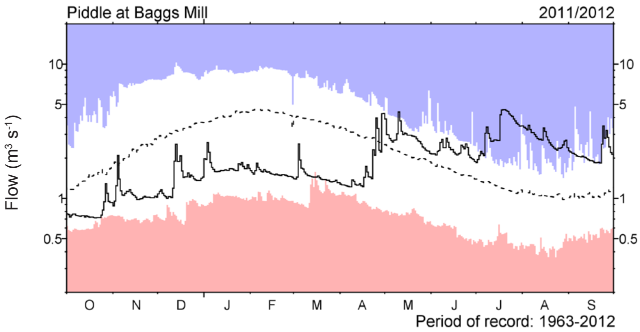


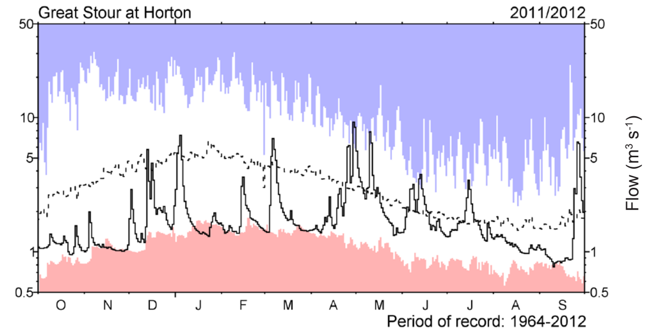










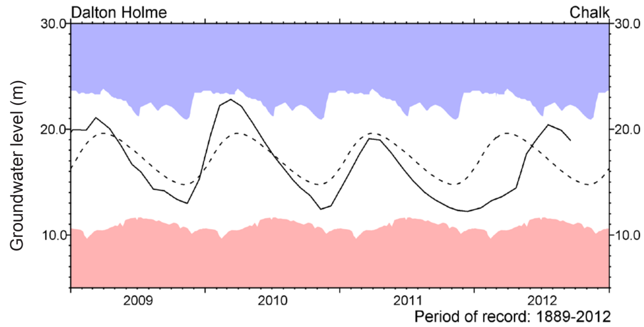


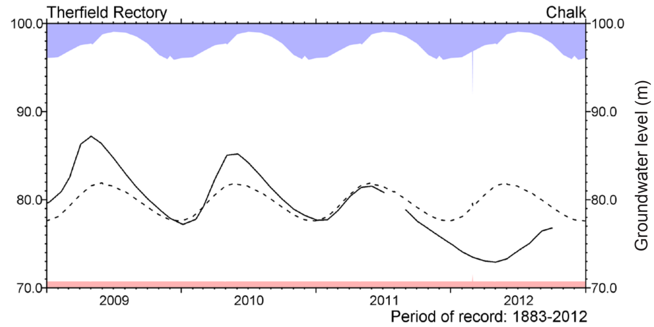
Notable runoff accumulations (a) April 2012 - September 2012

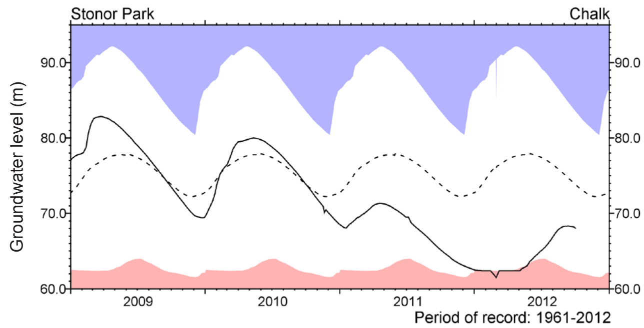
	River	%lta	Rank		River	%lta	Rank		River	%lta	Rank
a)	Deveron (Avochie)	157	51/53	a)	Thames (Kingston)	165	126/130	a)	Dart	207	53/54
	Don	163	42/43		Blackwater	150	58/60		Brue	247	47/47
	Bervie	171	30/32		Wallington	269	59/59		Usk (Chain Bridge)	186	56/56
	Tyne (Bywell)	238	53/53		Lymington	299	50/50		Tawe	184	54/54
	Ouse (Skelton)	259	38/38		Piddle	151	48/49		Tywi	173	54/54
	Dover Beck	226	37/38		Otter	221	50/50		Dyfi	212	44/44
	Bedford Ouse (Roxton)	196	39/39						Faughan	146	34/36

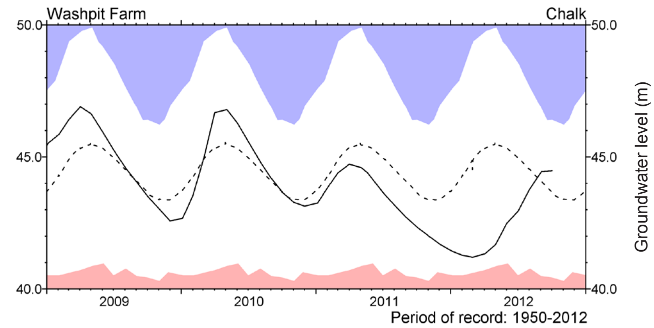
lta = long term average; Rank 1 = lowest on record

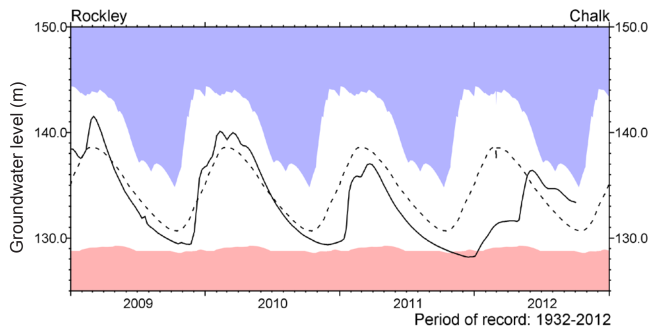
Groundwater . . . Groundwater

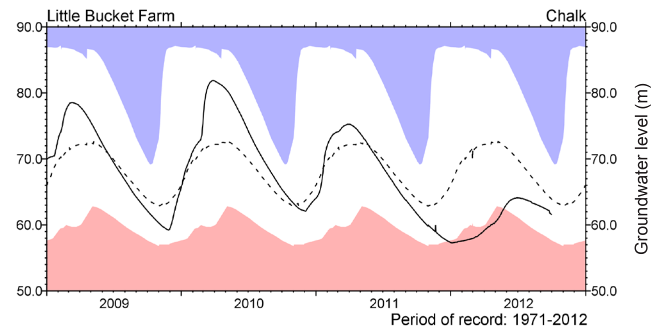


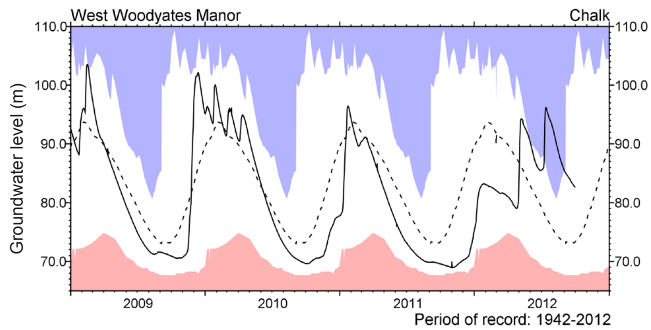


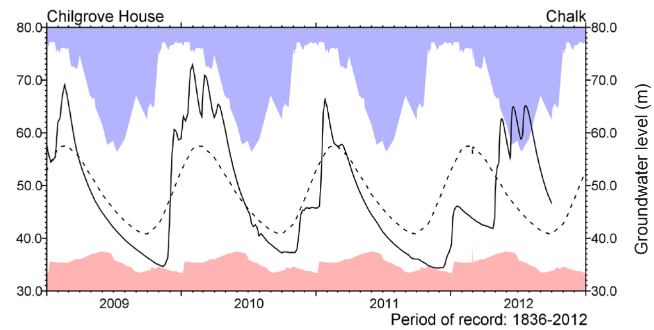


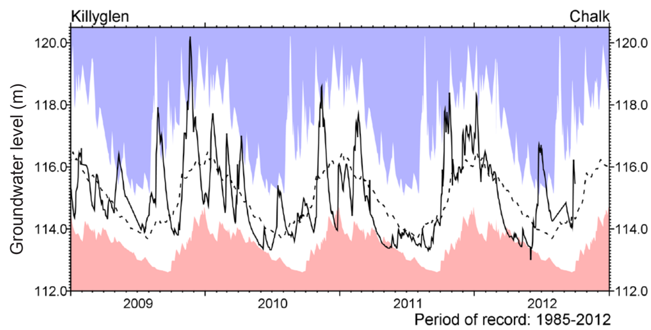


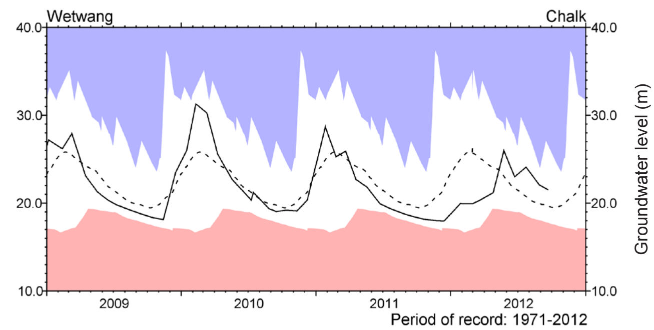






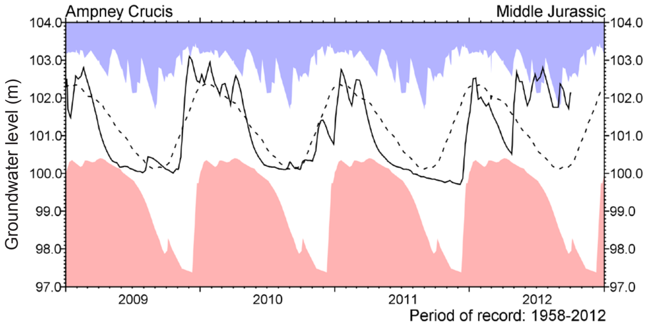


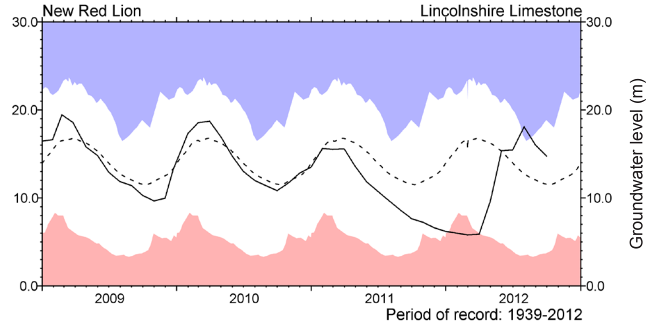


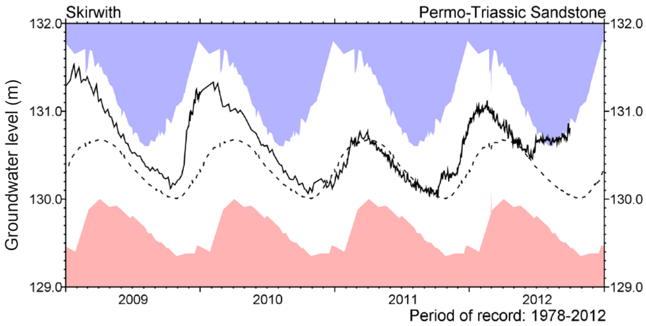


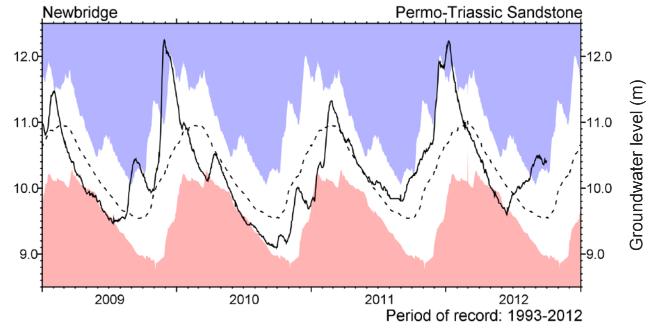
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

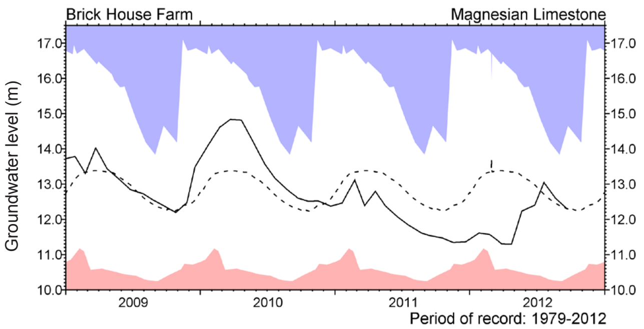
Groundwater . . . Groundwater

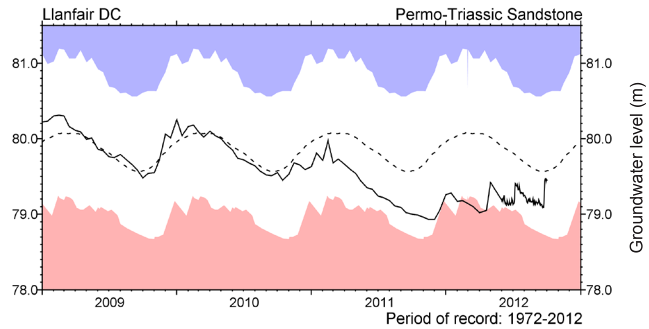


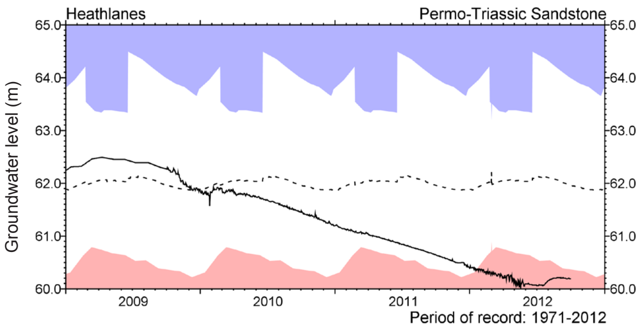


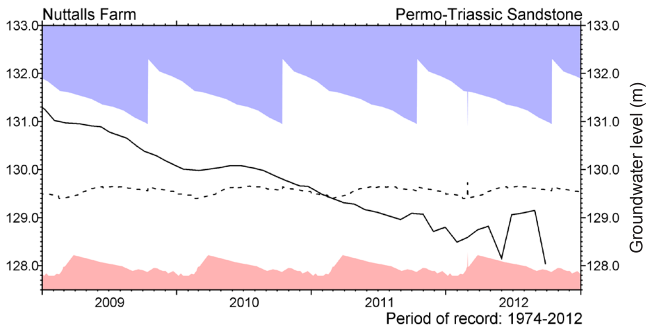


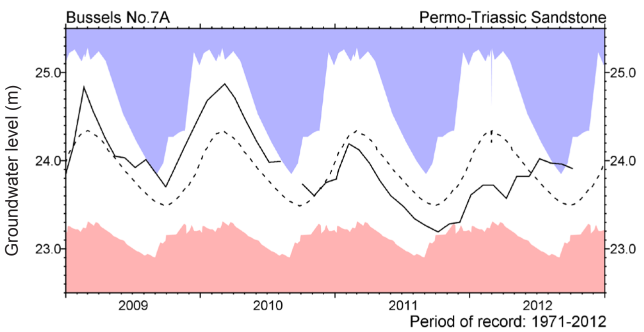


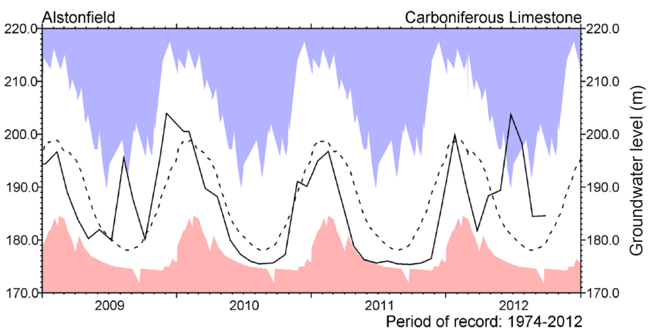










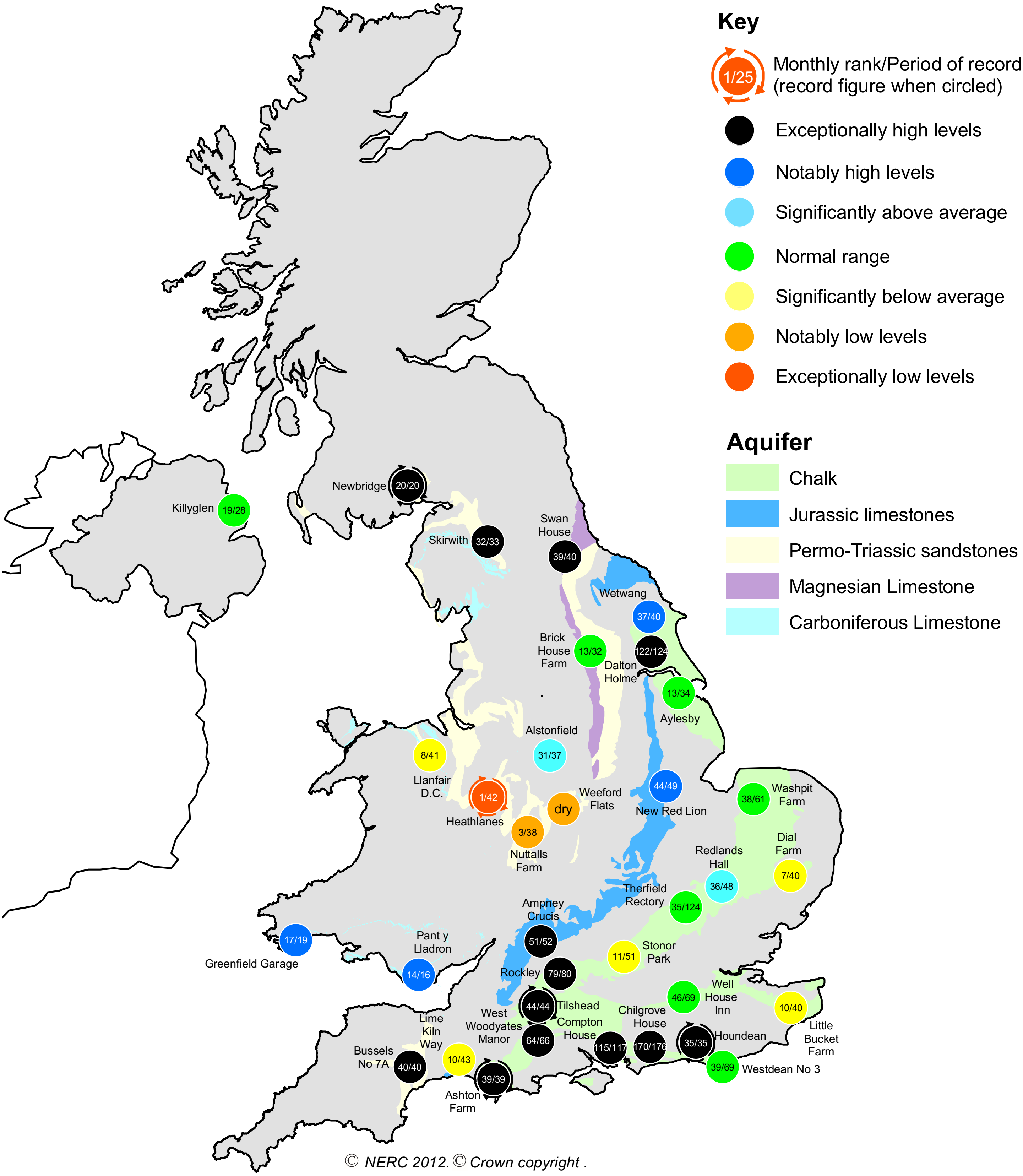


Groundwater levels September / October 2012

Borehole	Level	Date	Sep av.	Borehole	Level	Date	Sep av.	Borehole	Level	Date	Sep av.
Dalton Holme	18.95	17/09	15.44	Chilgrove House	46.58	30/09	40.71	Brick House Farm	12.30	20/09	12.33
Therfield Rectory	76.78	01/10	79.98	Killyglen (NI)	115.47	30/09	114.41	Llanfair DC	79.45	01/10	79.56
Stonor Park	68.05	01/10	74.34	Wetwang	21.52	20/09	19.69	Heathlanes	60.19	30/09	61.79
Tilshead	86.67	30/09	81.16	Ampney Crucis	102.13	01/10	100.13	Nuttalls Farm	128.04	27/09	129.62
Rockley	133.38	01/10	131.06	New Red Lion	14.73	30/09	11.61	Bussels No.7a	23.91	05/10	23.51
Well House Inn	95.66	01/10	93.88	Skirwith	130.82	30/09	130.11	Alstonfield	184.55	26/09	178.50
West Woodyates	82.67	30/09	73.05	Newbridge	10.41	30/09	9.60				

Levels in metres above Ordnance Datum

Groundwater . . .Groundwater



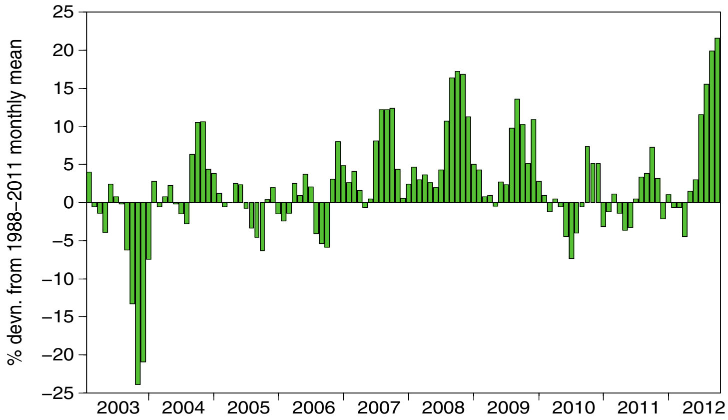
Groundwater levels - September 2012

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.

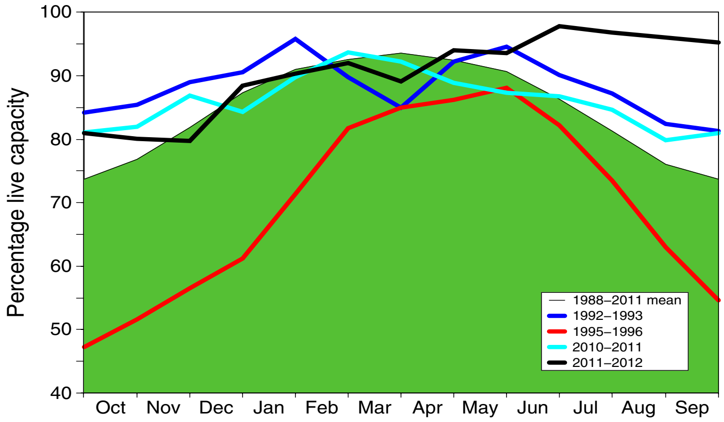
Notes:
i. The outcrop areas are coloured according to British Geological Survey conventions.
ii. Yew Tree Farm levels are now received quarterly.

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

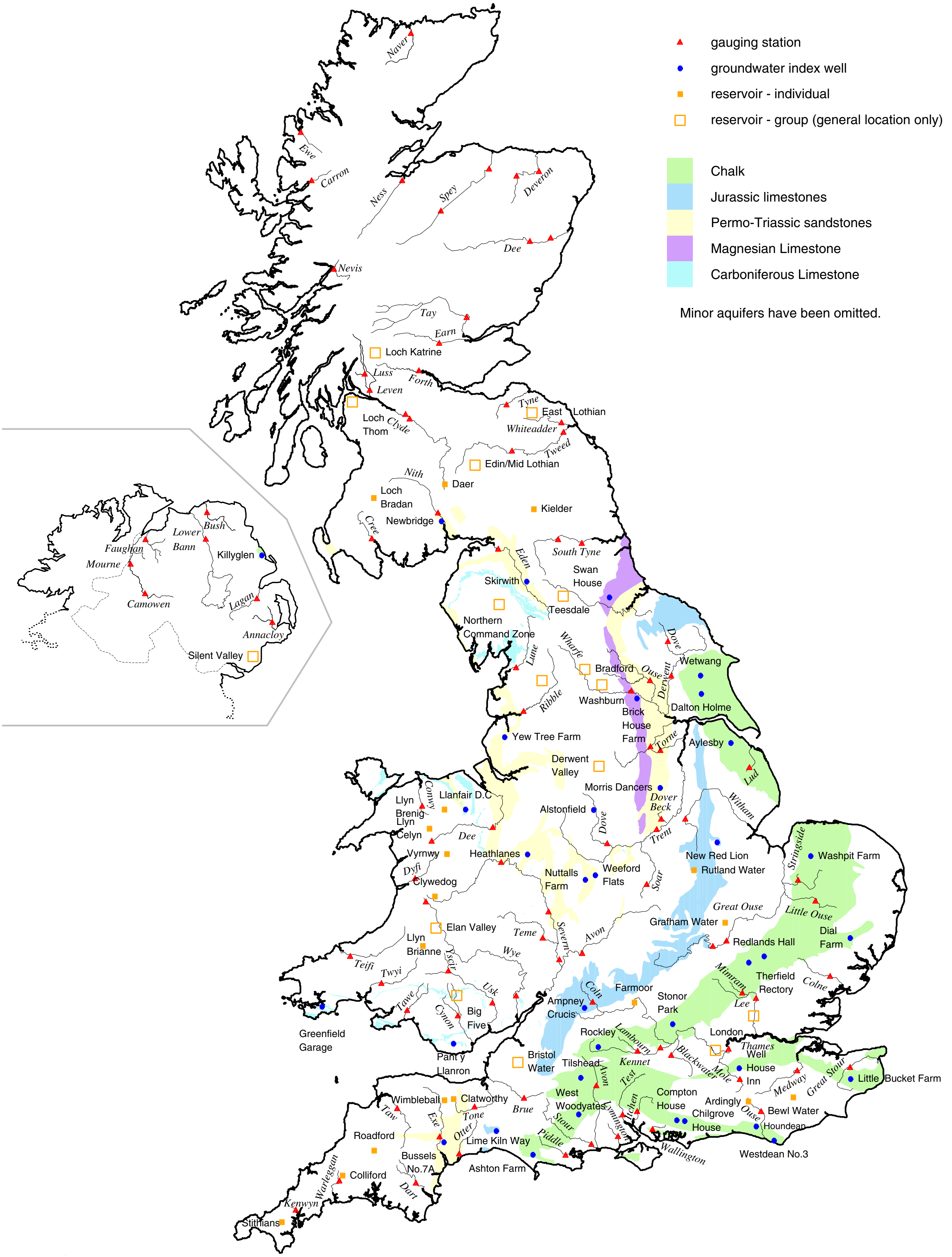
Area	Reservoir		Capacity (Ml)	2012 Aug	Sep	Oct	Oct Anom.	Min Oct	Year* of min	2011 Oct	Diff 12-11
North West	N Command Zone	•	124929	92	92	**97**	39	13	1995	78	19
	Vyrnwy		55146	98	100	**98**	28	26	1995	86	12
Northumbrian	Teesdale	•	87936	95	95	**97**	30	31	1995	93	4
	Kielder		(199175)	100	95	**93**	8	59	1989	91	2
Severn Trent	Clywedog		44922	94	91	**90**	18	24	1989	87	3
	Derwent Valley	•	39525	97	95	**100**	36	24	1989	53	47
Yorkshire	Washburn	•	22035	93	94	**98**	32	24	1995	71	27
	Bradford supply	•	41407	97	97	**100**	33	15	1995	76	24
Anglian	Grafham		(55490)	94	95	**95**	12	46	1997	89	6
	Rutland		(116580)	97	98	**98**	20	61	1995	70	28
Thames	London	•	202828	98	96	**88**	12	53	1997	80	8
	Farmoor	•	13822	97	93	**92**	2	54	2003	93	-1
Southern	Bewl		28170	90	83	**79**	17	32	1990	50	29
	Ardingly*		4685	100	100	**100**	35	32	2003	48	52
Wessex	Clatworthy		5364	100	98	**91**	35	25	2003	37	54
	Bristol WW	•	(38666)	98	98	**97**	35	31	1990	57	40
South West	Colliford		28540	86	89	**89**	21	38	2006	48	41
	Roadford		34500	93	94	**92**	22	26	1995	54	38
	Wimbleball		21320	100	100	**100**	36	30	1995	44	56
	Stithians		4967	98	95	**93**	38	22	1990	44	49
Welsh	Celyn and Brenig	•	131155	100	99	**100**	19	39	1989	96	4
	Brianne		62140	100	100	**100**	15	48	1995	98	2
	Big Five	•	69762	98	98	**99**	31	19	1995	85	14
	Elan Valley	•	99106	97	100	**100**	23	34	1995	90	10
Scotland(E)	Edinburgh/Mid Lothian	•	97639	100	100	**100**	23	43	1998	97	3
	East Lothian	•	10206	100	100	**100**	20	52	1989	100	0
Scotland(W)	Loch Katrine	•	111363	88	90	**91**	17	43	1995	96	-5
	Daer		22412	100	100	**100**	22	32	1995	99	1
	Loch Thom	•	11840	95	99	**100**	19	56	1995	95	5
Northern Ireland	Total+	•	56920	95	97	**98**	24	29	1995	78	20
	Silent Valley	•	20634	97	100	**99**	31	27	1995	73	26

() 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.

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

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.

NATURAL ENVIRONMENT RESEARCH COUNCIL

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