Hydrological Summary

for the United Kingdom

December 2012

General

December started settled and largely dry, but the last two weeks of 2012 saw the return of the sustained frontal rainfall which has been characteristic of much of the year since early April. The runoff response was remarkable for its spatial extent; floodplain inundations were widespread across much of the UK (the combined outflows from England & Wales over the last 12 days were only eclipsed by 2000 in the series from 1961). Pluvial, fluvial and groundwater flooding incidents were all reported, causing widespread disruption and major damage to some localities: the EA reported that 570 properties were flooded between 15th and 31st December. The fact that 2012 is the wettest year on record for England, despite the severe drought conditions during the first three months, stands testament to the exceptional nature of the rainfall received since April; correspondingly, new maximum annual runoff totals were widespread. Entering 2013, aquifer levels in most boreholes were exceptionally high and England & Wales reservoir stocks were the highest on record for early January (note the low stocks at Grafham reflect a lack of artificial refill due to poor water quality in the Great Ouse). The water resources outlook for 2013 is therefore very healthy but, with soils saturated across the UK, there is high risk of further flooding in the late winter and early spring of 2013. With several months of the recharge season left, and a considerable amount of water still draining through the unsaturated zone, more extensive groundwater flooding is probable given the high levels in the Chalk.

Rainfall

For much of the first half of December, high pressure predominated across much of the UK, leading to cold, settled and generally dry conditions, albeit with modest rainfall (and some significant snow on the hills) in northern and western areas. The synoptic situation changed around the 14th, as low pressure became established and dominated the latter half of the month. Successive slow-moving frontal systems brought persistent heavy rainfall to many areas of the UK (with 24h totals exceeding 40mm widely reported on the 20th) with the heaviest falls in southwest England (e.g. 49mm in 12h in Plymouth and 73mm in 24h at Withypool, Exmoor, on the 22nd), northeast Scotland (e.g. 84.2mm in 24h at Stoneyford, Angus; the three day total for this event was 169mm) and parts of central England. The exceptional late-December rainfall contributed to significant monthly totals, notwithstanding the dry start to the month: the monthly total for England & Wales was 170% of the average for December, and parts of northeast Scotland received over 250% of average. The wet December adds to the exceptional rainfall accumulations registered since March, with April-December rainfall totals exceeding previous maxima by a substantial margin over wide areas. This contributed to 2012 being the wettest year on record for England, and the second wettest year for the UK (using the National Climate Information Centre series from 1910); it was the third wettest year in the long England & Wales rainfall series (from 1766).

River flows

A majority of index rivers were in recession entering December, following the high flows registered in late November. However, with catchments saturated, rapid flow increases followed inevitably from the heavy rainfall around mid-month, and flood warnings and alerts were widespread by the 20th (with an unusually high prevalence across all regions on the 22nd) and became a fixture for the remainder of the month. Widespread flooding occurred, firstly in smaller, rapidly-responding catchments, with the most destructive flood episodes in southwest England (e.g. Braunton in north Devon) and northeast Scotland (e.g. Stonehaven, Aberdeenshire, where around 100 properties were evacuated) on the 22nd/23rd. The year ended with extensive floodplain inundation across large tracts of England and Wales, as large rivers such as the Thames and Severn responded to the prolonged rainfall. Flooding and landslides caused widespread transport disruption (e.g. the extended closure of the main rail link into southwest England) over the Christmas holiday season. New December maxima were registered in ten index catchments, whilst the Ythan (Aberdeenshire) registered its highest peak flow in a record from 1983 and the Coln (Cotswolds) reached a new maximum in a record from 1963. Exceptional late-December flows were observed in many spring-fed rivers (e.g. the Hampshire Avon). New maximum annual runoff totals were widespread, in a band from southwest England to northeast Scotland. Correspondingly, the total annual outflows from England & Wales for 2012 were the second highest on record (after 2000).

Groundwater

Across nearly all aquifer outcrop areas, December saw continued rises in response to the exceptional autumn rainfall. In the Chalk, levels rose by more than 9m during the month in several boreholes and levels are now above average at all sites, with new monthly maxima recorded at Wetwang, Rockley and Houndean Bottom and second highest levels on record at a number of sites – including the long record boreholes, Chilgrove (1836) and Compton (1894) in the South Downs. Many bournes are flowing (e.g. the Pang, Berkshire and the Nailbourne, Kent) and some groundwater flooding occurred in the Cranbourne Chase and Salisbury Plain areas (Wessex Chalk), plus rising groundwater levels have affected sewerage systems in parts of the Hampshire Chalk. The EA had issued 19 groundwater flooding alerts for the Chalk covering different outcrop areas from Lincolnshire to Dorset by the end of the month. In the Permo-Triassic sandstones water levels are very high in the North West and South West, with record monthly maxima for the second consecutive month at Skirwith and Bussels. In contrast, in North Wales and the Midlands, levels remained average or below; with Weeford Flats still dry, but with some recovery elsewhere. In the limestone aquifers, levels rose to record high monthly levels at Swan House (Magnesian) and Ampney Crucis (Jurassic), and near-record December levels in most of the other boreholes. The change in the groundwater situation in the last nine months, from a prevalence of exceptionally low levels in early spring to the current extremely high levels, has no modern parallel.

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
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Rainfall . . . Rainfall . . .

Rainfall accumulations and return period estimates

Percentages are from the 1971-2000 average.

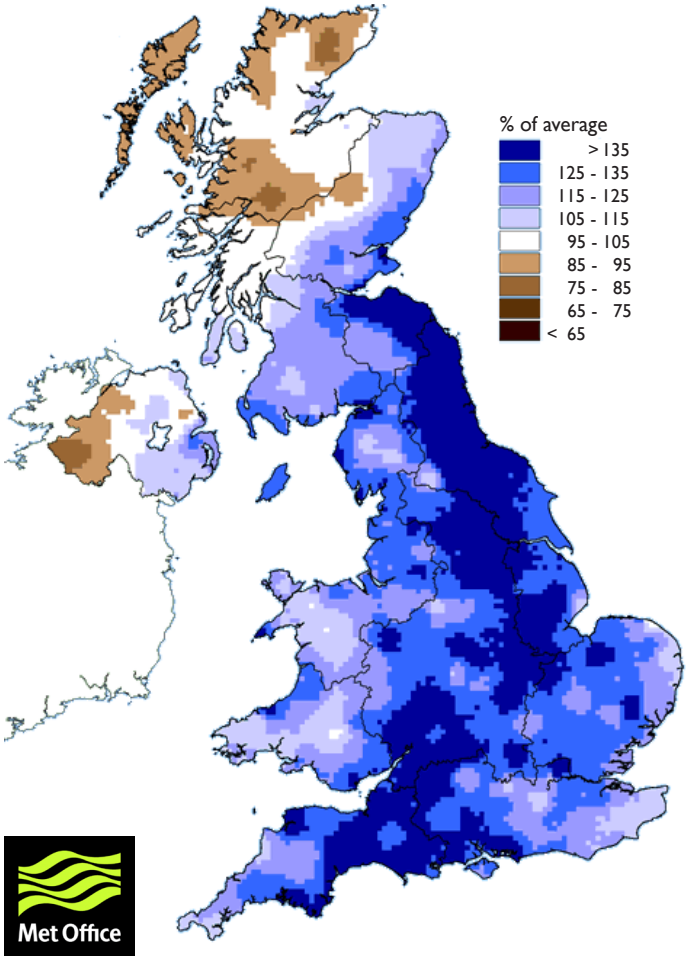
Area	Rainfall	Dec 2012	Nov 12 — Dec 12	RP	Apr 12 — Dec 12	RP	Jan 12 — Dec 12	RP	Jul 11 — Dec 12	RP
United Kingdom	mm	**180**	314		1123		1331		2013	
	%	**150**	134	10-20	142	>>100	123	60-90	120	>100
England	mm	**151**	271		1003		1123		1531	
	%	**170**	159	20-30	164	>>100	137	>100	121	15-25
Scotland	mm	**213**	367		1254		1603		2709	
	%	**132**	114	2-5	122	20-30	111	5-10	121	>100
Wales	mm	**277**	457		1491		1716		2459	
	%	**168**	144	10-20	150	>>100	125	20-30	115	5-10
Northern Ireland	mm	**127**	205		945		1154		1921	
	%	**108**	90	2-5	116	5-10	104	2-5	112	5-10
England & Wales	mm	**168**	297		1070		1205		1658	
	%	**170**	156	20-30	161	>>100	135	>100	120	10-20
North West	mm	**206**	361		1366		1597		2394	
	%	**157**	141	10-20	157	>>100	136	>100	130	80-120
Northumbria	mm	**153**	278		1151		1248		1739	
	%	**178**	164	35-50	185	>>100	150	>>100	137	>>100
Midlands	mm	**136**	245		925		1034		1343	
	%	**169**	162	20-30	162	>>100	136	70-100	116	5-10
Yorkshire	mm	**149**	279		1049		1175		1596	
	%	**167**	166	25-40	173	>>100	144	>>100	128	40-60
Anglian	mm	**100**	183		731		822		1071	
	%	**178**	162	15-25	156	>>100	136	70-100	116	5-10
Thames	mm	**122**	222		849		937		1238	
	%	**168**	160	10-20	160	>>100	134	40-60	116	5-10
Southern	mm	**150**	245		902		999		1345	
	%	**171**	143	5-10	154	>100	128	15-25	111	2-5
Wessex	mm	**170**	329		1111		1218		1631	
	%	**168**	175	25-40	174	>>100	141	>100	123	10-20
South West	mm	**269**	460		1411		1588		2207	
	%	**179**	163	25-40	163	>>100	131	>100	119	10-20
Welsh	mm	**265**	442		1452		1663		2372	
	%	**168**	145	10-20	151	>>100	126	20-35	116	5-10
Highland	mm	**217**	393		1244		1737		3041	
	%	**110**	98	2-5	103	2-5	101	2-5	114	15-25
North East	mm	**171**	236		981		1124		1770	
	%	**188**	124	2-5	138	30-50	118	5-10	121	8-12
Tay	mm	**222**	336		1204		1418		2414	
	%	**158**	124	2-5	136	40-60	112	5-10	124	>100
Forth	mm	**196**	320		1239		1432		2305	
	%	**159**	135	8-12	153	>>100	126	50-80	132	>>100
Tweed	mm	**165**	288		1271		1398		2134	
	%	**159**	146	10-20	181	>>100	146	>>100	145	>>100
Solway	mm	**233**	412		1476		1778		2866	
	%	**145**	133	5-10	145	>100	126	50-80	131	>100
Clyde	mm	**254**	462		1497		1966		3419	
	%	**129**	121	5-10	122	10-20	113	5-10	126	>100

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

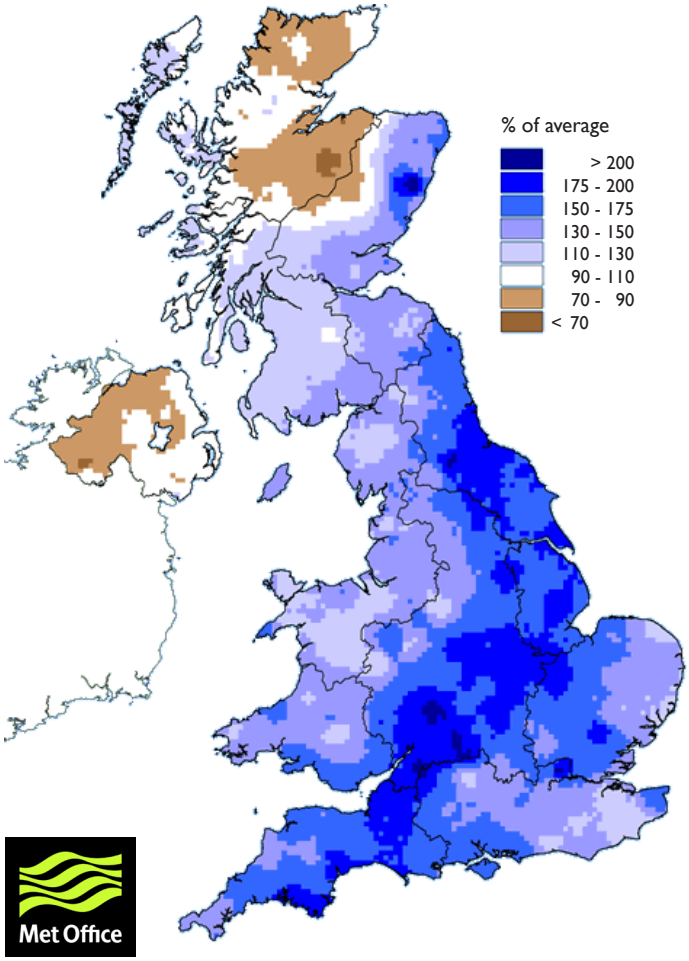
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic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

Rainfall . . . Rainfall . . .

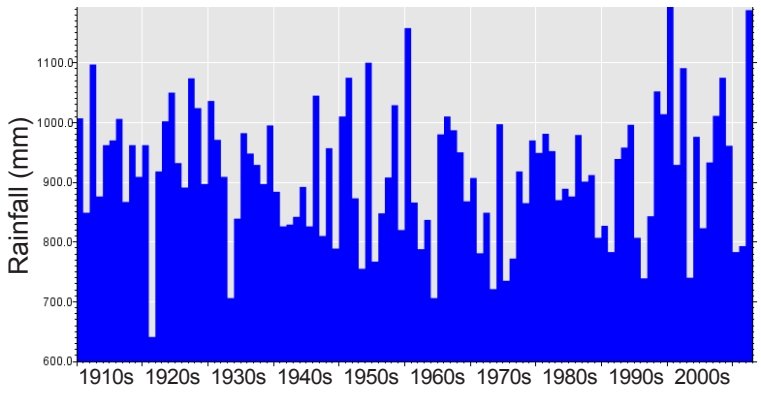
January 2012 - December 2012
rainfall as % of 1971-2000 average



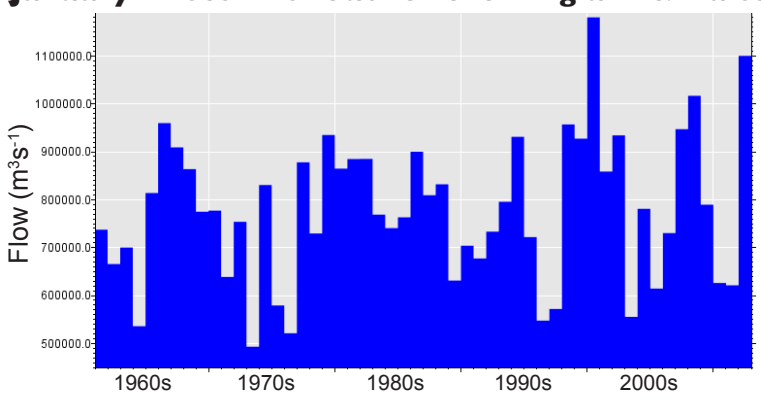
November 2012 - December 2012
rainfall as % of 1971-2000 average



January - December rainfall for England & Wales



January - December outflows for England & Wales



Met Office 3-month outlook Updated: January 2013

Predictions for UK-mean precipitation are very uncertain, although for the January-February-March period as a whole above-average values are a little more likely than below-average.

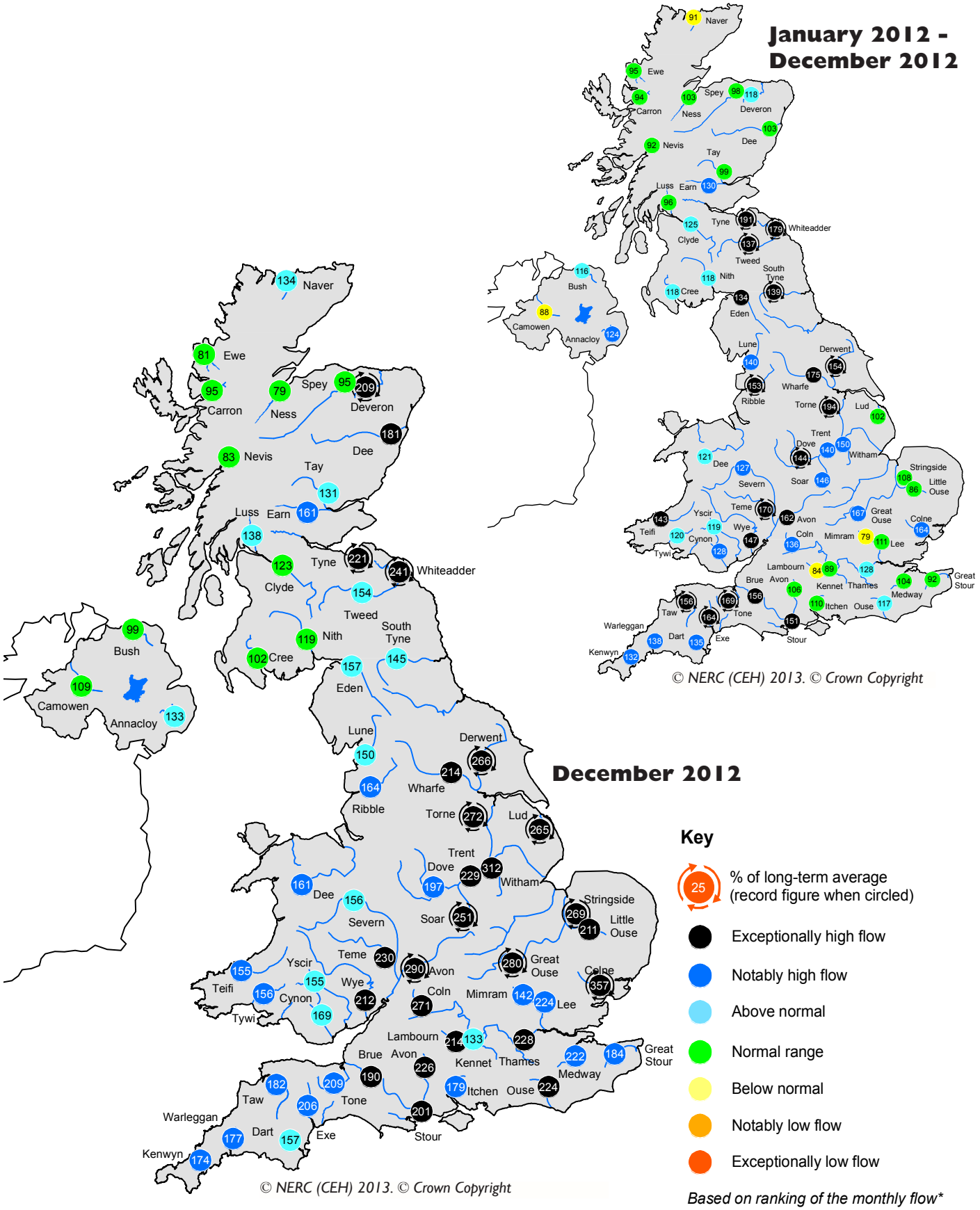
The saturated state of the ground means that there will be a high sensitivity to heavy rainfall events early in 2013, and should a wetter-than-average outcome be realised impacts in terms of flooding could be very significant.

The probability that UK precipitation for January-February-March will fall into the driest quintile is around 15% and the probability that it will fall into the wettest quintile is around 20% (the 1981-2010 probability for each of these categories is 20%).

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

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

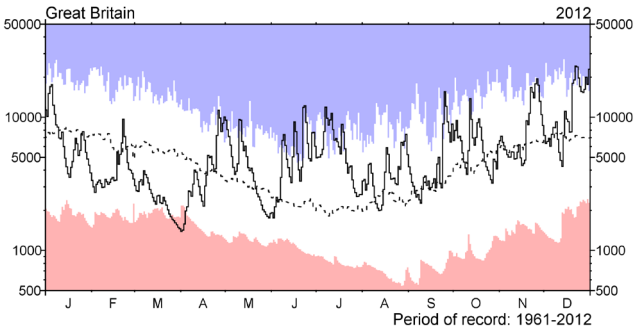
River flow . . . River flow . . .

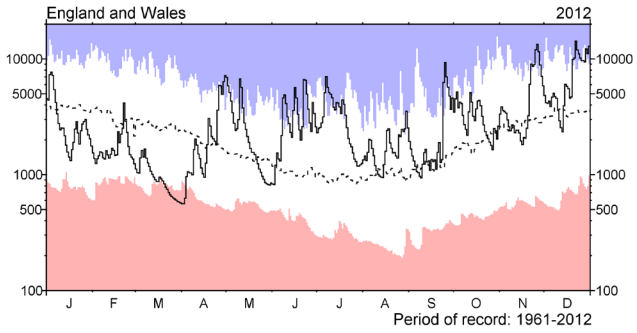


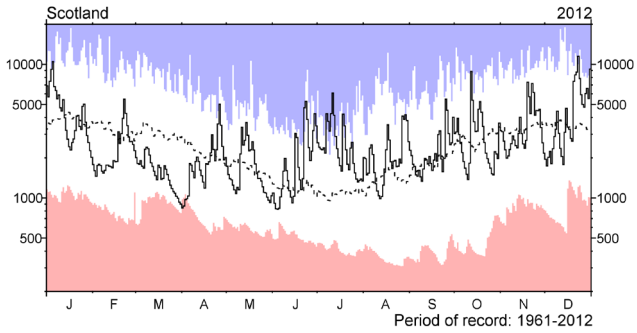
River flows

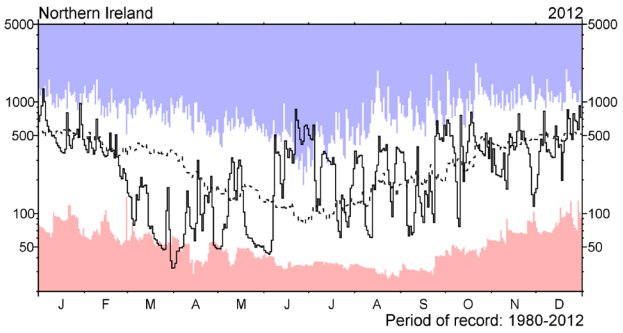
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

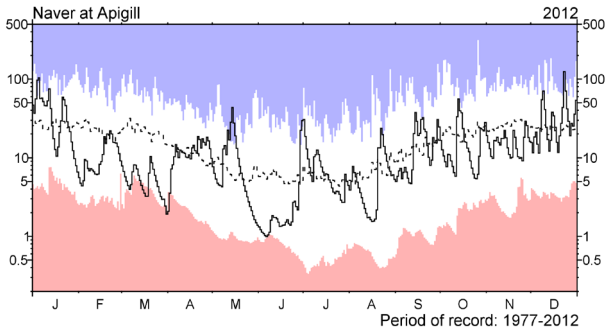
River flow . . . River flow . . .

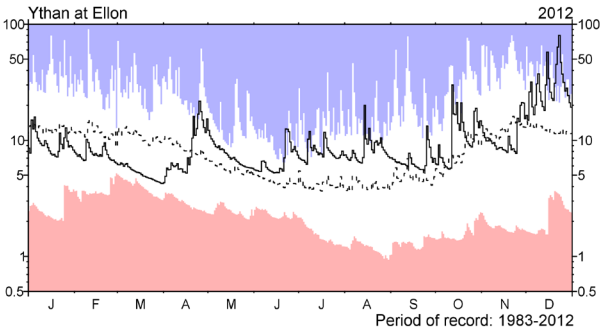


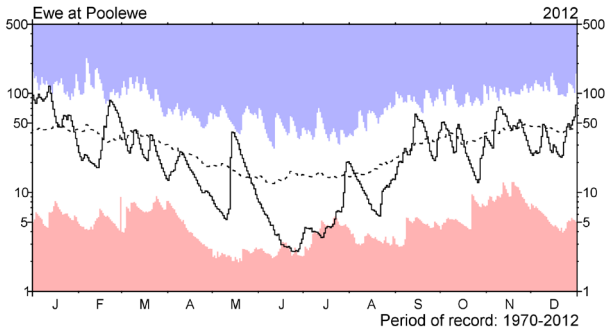


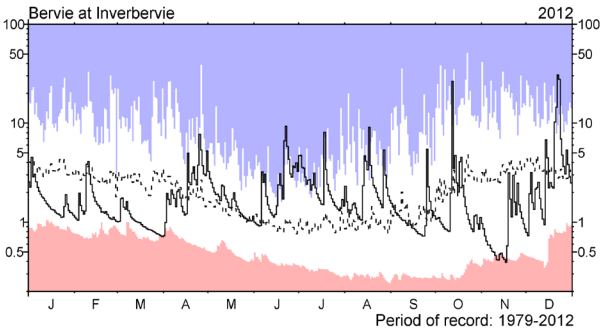


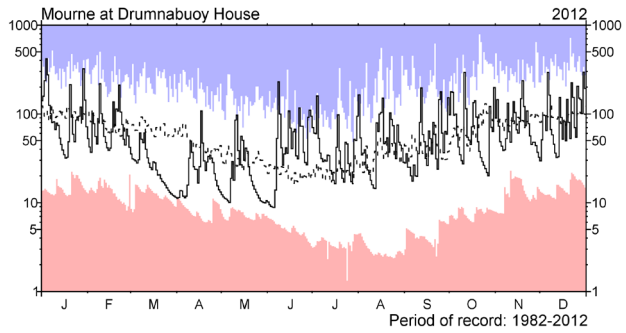


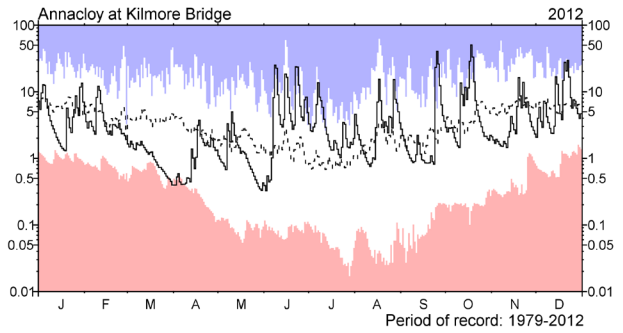








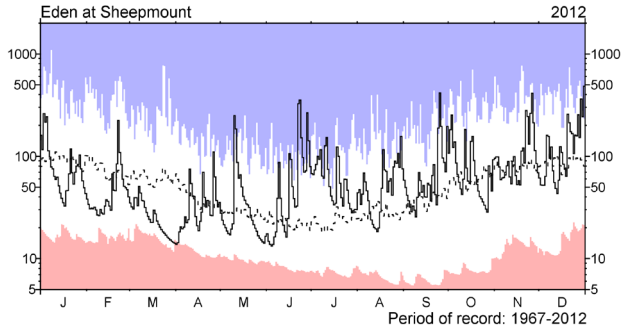


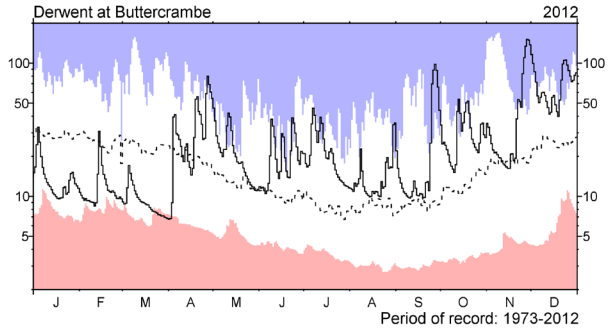


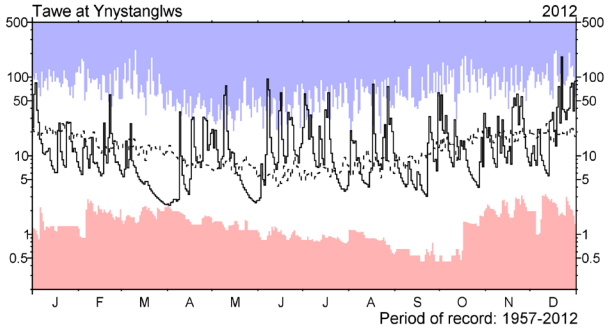
River flow hydrographs

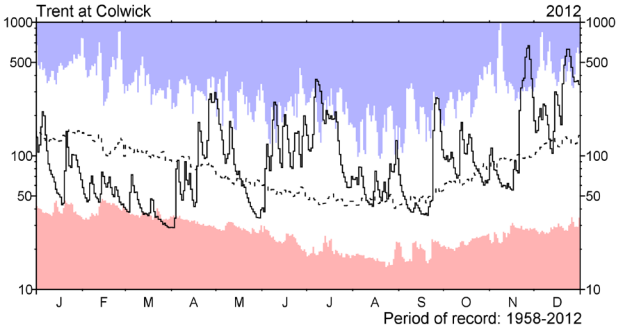
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to January 2012 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. Mean daily flows are shown as the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

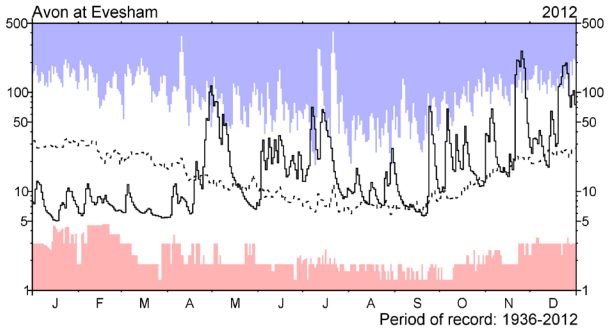
River flow . . . River flow . . .

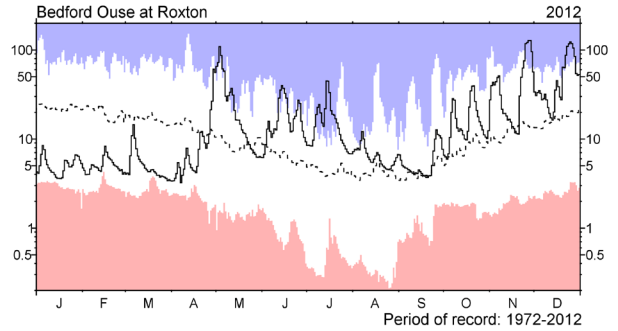


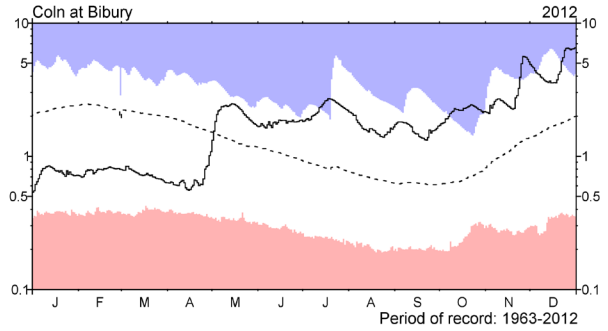


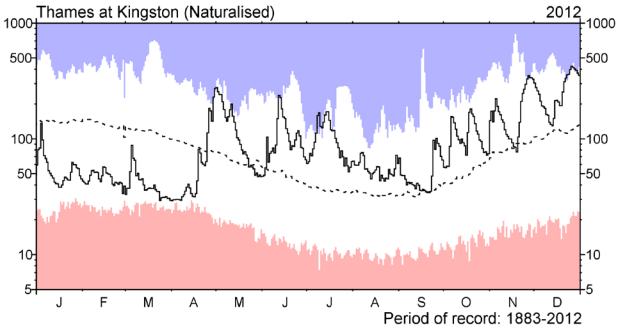


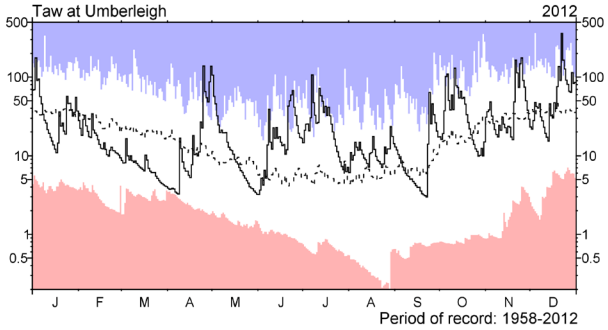


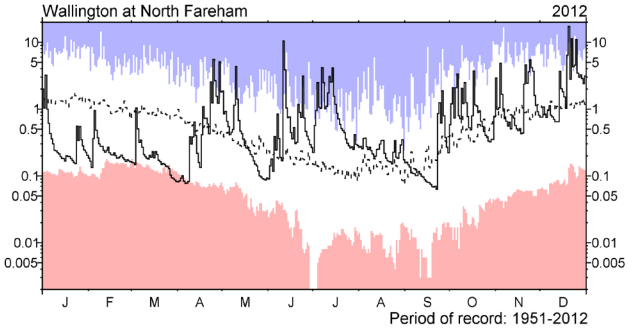










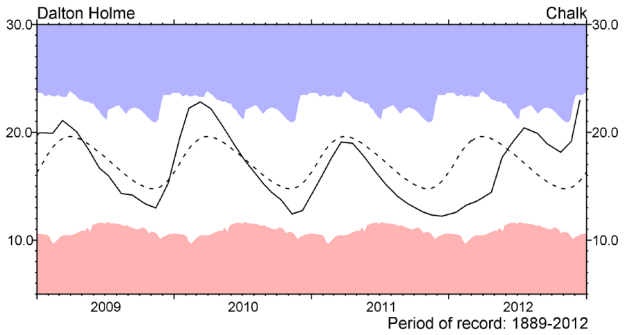


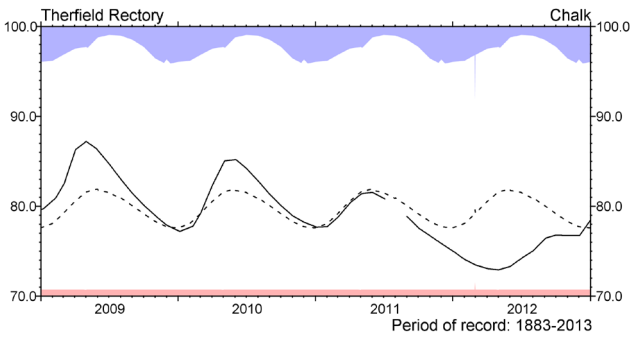
Notable runoff accumulations (a) April 2012 - December 2012

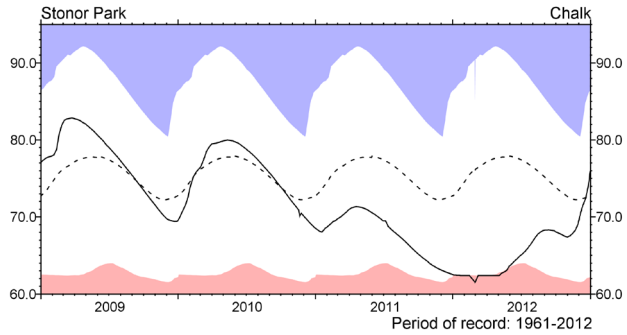
	River	%lta	Rank		River	%lta	Rank		River	%lta	Rank
a)	Tyne (Spilmersford)	270	44/44	a)	Colne (Lexden)	253	52/52	a)	Severn (Bewdley)	173	90/92
	Tweed (Norham)	199	50/50		Thames (Kingston)	190	128/130		Avon (Evesham)	252	76/76
	Whiteadder	260	43/43		Coln (Bibury)	204	49/49		Teifi	177	52/52
	Ouse (Skelton)	224	37/37		Lymington	278	50/50		Dyfi	163	44/44
	Derwent	219	39/39		Stour (Throop)	234	40/40		Ribble	171	52/52
	Trent	189	54/54		Tone	250	52/52		Lune	158	52/52
	Soar	228	41/41		Brue	223	47/47		Clyde (Blairston)	159	52/52
	Bedford Ouse (Bedford)	277	80/80						Annacloy	153	31/33

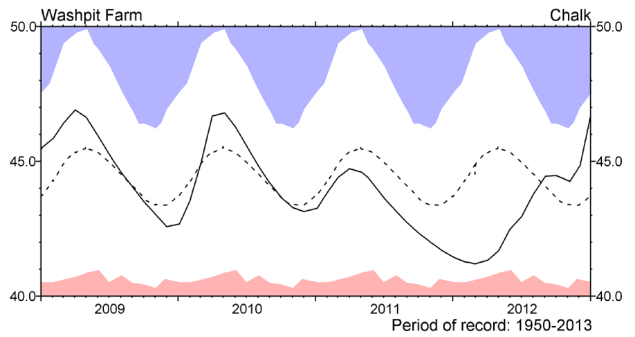
lta = long term average; Rank 1 = lowest on record

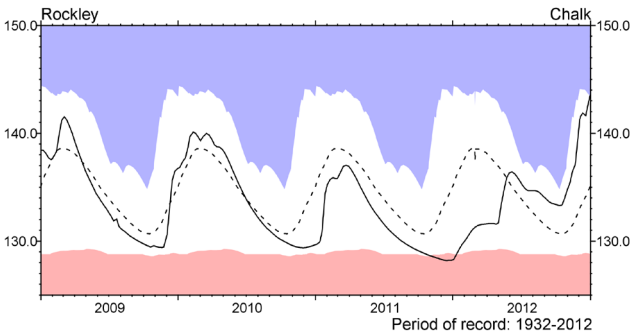
Groundwater…Groundwater

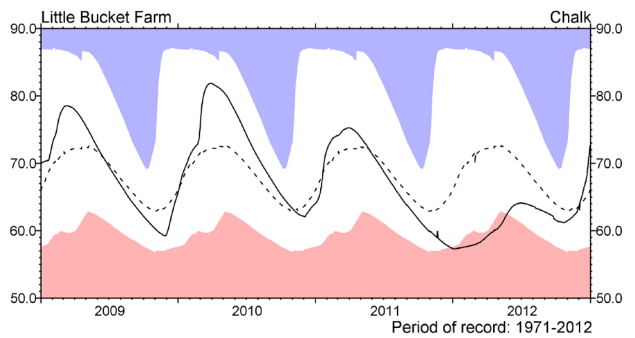


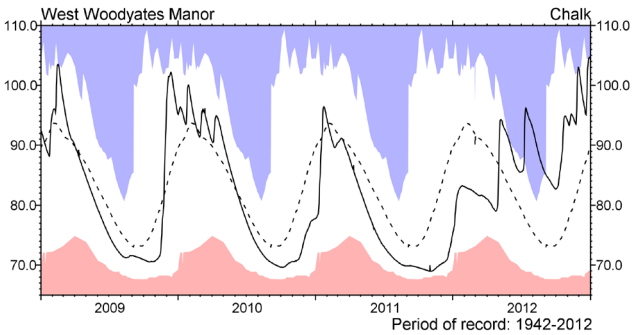


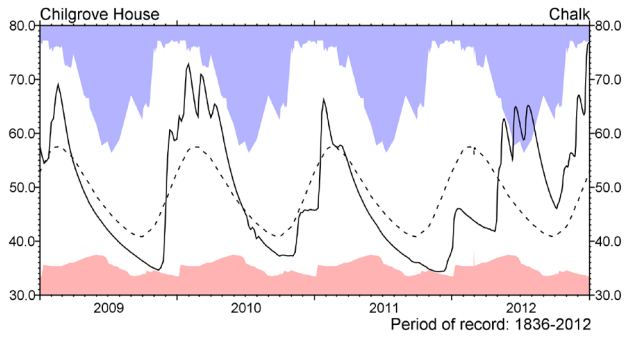


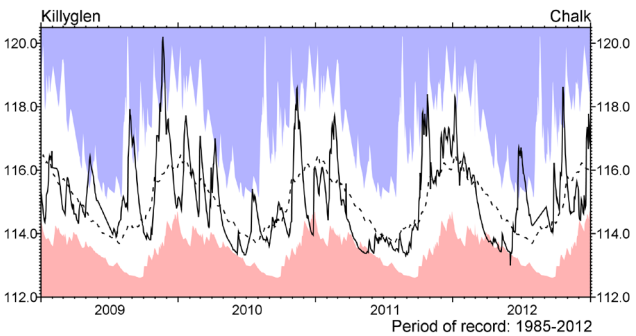


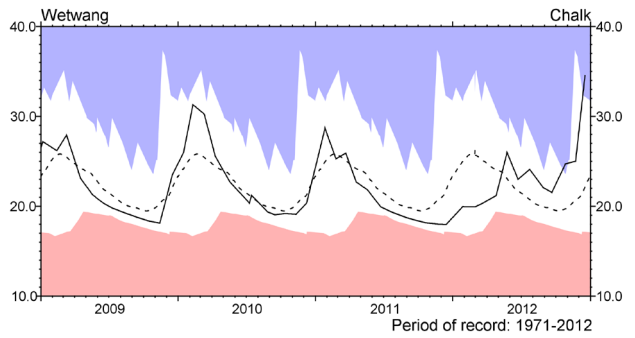






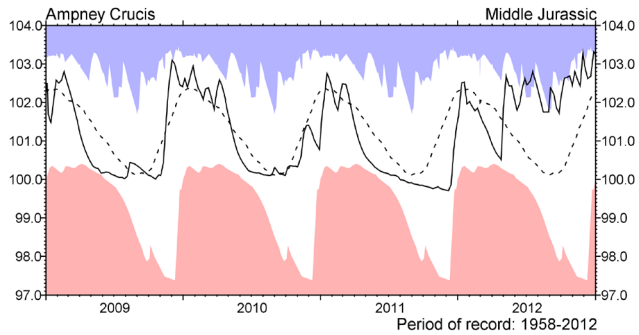


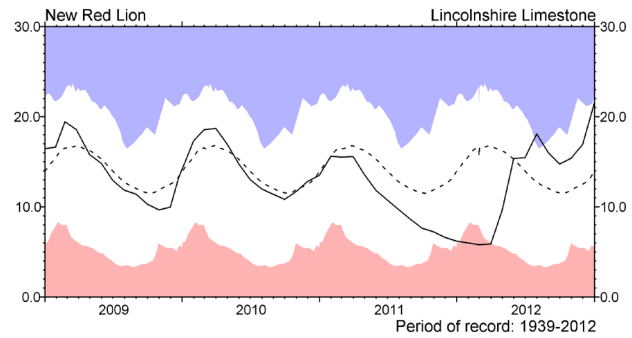


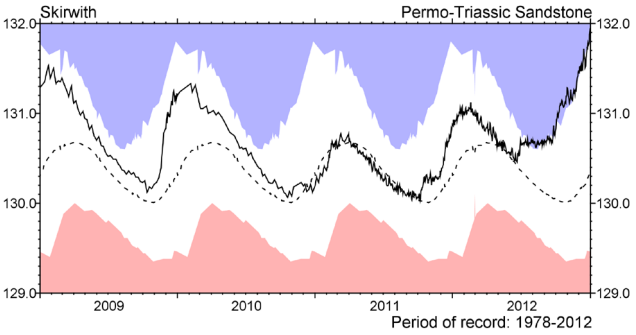


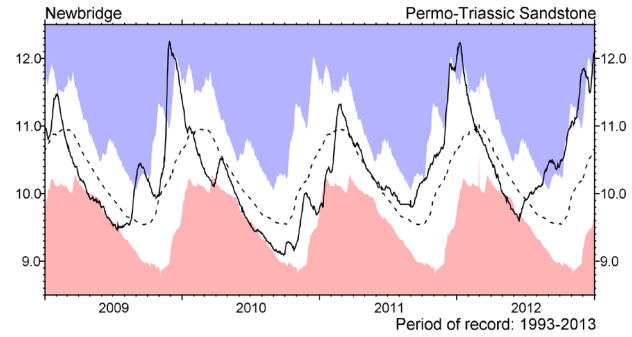
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

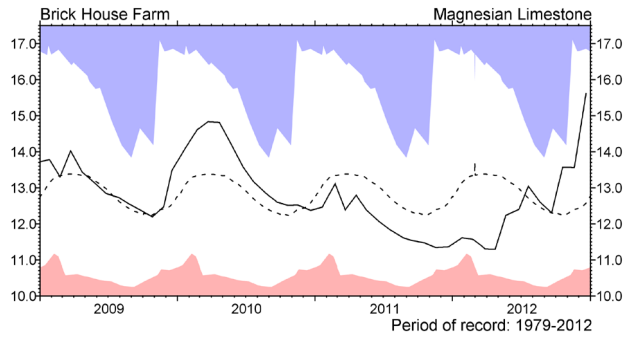
Groundwater... Groundwater

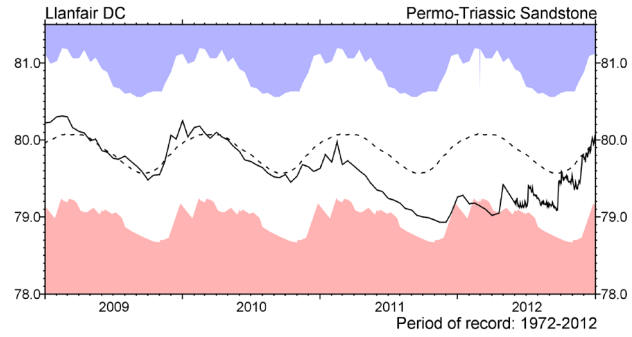


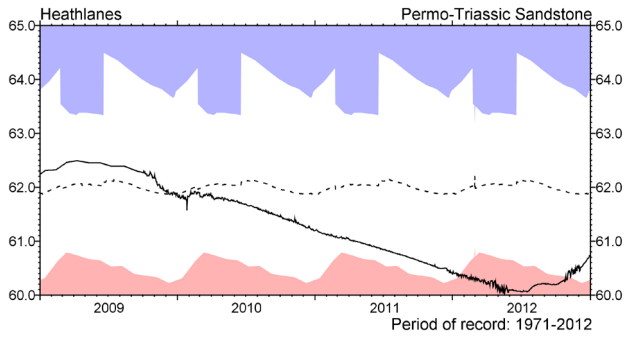


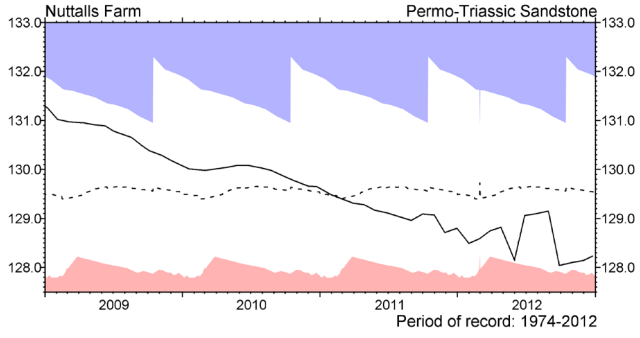


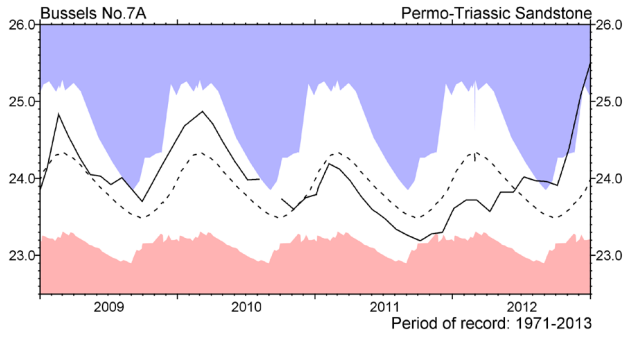


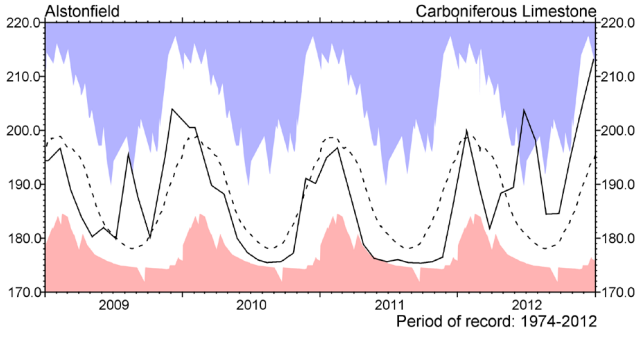








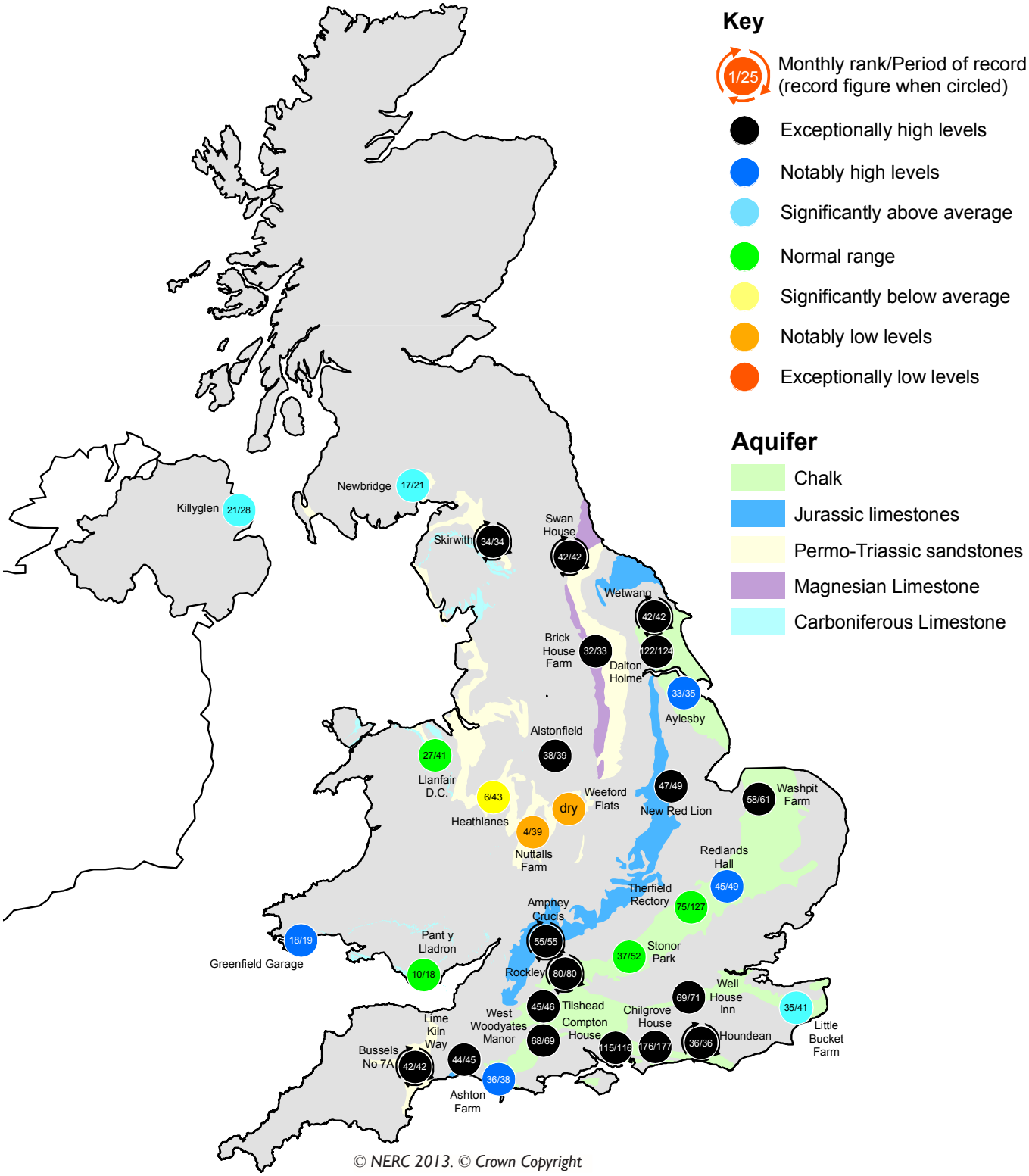




Groundwater levels December 2012 / January 2013

Borehole	Level	Date	Dec av.	Borehole	Level	Date	Dec av.	Borehole	Level	Date	Dec av.
Dalton Holme	22.94	14/12	15.54	Chilgrove House	76.66	31/12	51.82	Brick House Farm	15.61	20/12	12.44
Therfield Rectory	78.57	03/01	77.72	Killyglen (NI)	116.76	31/12	116.10	Llanfair DC	80.06	31/12	79.86
Stonor Park	75.90	31/12	72.14	Wetwang	34.51	17/12	21.53	Heathlanes	60.73	30/12	61.84
Tilshead	99.61	31/12	86.56	Ampney Crucis	103.26	31/12	101.96	Nuttalls Farm	128.23	24/12	129.57
Rockley	143.51	31/12	133.79	New Red Lion	21.44	31/12	12.91	Bussels No.7a	25.60	07/01	23.82
Well House Inn	101.22	31/12	93.41	Skirwith	131.94	31/12	130.32	Alstonfield	213.16	27/12	192.80
West Woodyates	104.41	31/12	86.82	Newbridge	11.49	20/12	10.58				

Levels in metres above Ordnance Datum



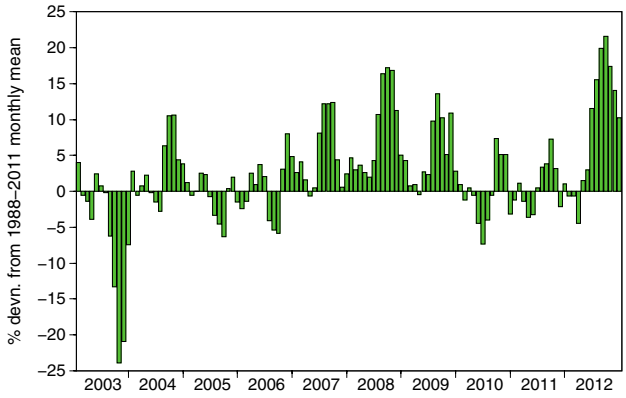
Groundwater levels - December 2012

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

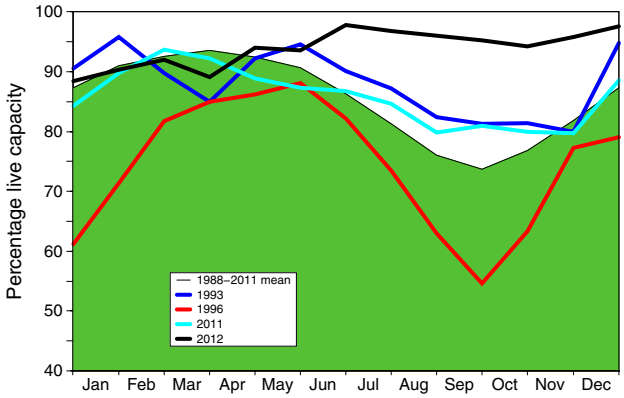
Notes: i. The outcrop areas are coloured according to British Geological Survey conventions.
ii. Yew Tree Farm levels are now received quarterly.

Reservoirs . . . Reservoirs . . .

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



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



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

Percentage live capacity of selected reservoirs at start of month

Area	Reservoir		Capacity (Ml)	2012 Nov	Dec	2013 Jan	Jan Anom.	Min Jan	Year* of min	2012 Jan	Diff 13-12
North West	N Command Zone	•	124929	96	94	97	11	51	1996	100	-3
	Vyrnwy		55146	93	98	100	10	35	1996	100	0
Northumbrian	Teesdale	•	87936	96	98	100	12	41	1996	100	0
	Kielder		(199175)	90	96	100	10	70	1990	95	5
Severn Trent	Clywedog		44922	87	90	97	13	54	1996	86	11
	Derwent Valley	•	39525	98	100	100	10	10	1996	100	0
Yorkshire	Washburn	•	22035	97	97	99	14	23	1996	98	1
	Bradford supply	•	41407	100	99	100	10	22	1996	100	1
Anglian	Grafham		(55490)	92	83	74	-10	57	1998	84	-10
	Rutland		(116580)	95	92	92	11	60	1991	65	27
Thames	London	•	202828	95	97	99	13	60	1991	78	20
	Farmoor	•	13822	83	80	79	-12	71	1991	99	-20
Southern	Bewl		28170	58	85	95	24	34	2006	37	58
	Ardingly**		4685	100	100	100	17	30	2012	30	70
Wessex	Clatworthy		5364	100	100	100	10	54	2004	82	19
	Bristol WW	•	(38666)	98	96	98	21	40	1991	69	29
South West	Colliford		28540	92	98	100	23	46	1996	63	37
	Roadford		34500	98	99	100	21	23	1996	72	28
	Wimbleball		21320	100	100	100	17	46	1996	71	29
	Stithians		4967	100	100	100	23	33	2002	70	30
Welsh	Celyn and Brenig	•	131155	94	96	100	7	54	1996	98	2
	Brianne		62140	99	100	100	3	76	1996	100	0
	Big Five	•	69762	99	99	100	11	67	1996	99	1
	Elan Valley	•	99106	100	100	100	3	56	1996	100	0
Scotland(E)	Edinburgh/Mid Lothian	•	97639	100	100	100	10	60	1999	100	0
	East Lothian	•	10206	100	100	100	5	48	1990	100	0
Scotland(W)	Loch Katrine	•	111363	92	91	91	2	75	2008	96	-5
	Daer		22412	99	100	99	2	83	1996	100	-1
	Loch Thom	•	11840	100	100	100	4	80	2008	100	0
Northern Ireland	Total+	•	56920	97	98	100	14	61	2002	98	2
	Silent Valley	•	20634	95	98	100	16	39	2002	96	4

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

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

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-1990s. In some gravity-fed reservoirs (e.g. Clywedog) stocks are kept below capacity during the winter to provide scope for flood attenuation purposes.

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), the Environment Agency Wales, 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

Enquiries should be addressed to:

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Wallingford
Oxfordshire
OX10 8BB

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Email: nhmp@ceh.ac.uk

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

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iii. Met Office rainfall data. © Crown copyright.

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