Hydrological Summary

for the United Kingdom

December 2013

General

After a dry start, December was exceptionally stormy, with wet and very windy conditions intensifying towards year-end. The storms caused widespread disruption, particularly to transport networks and power supply infrastructure over the final ten days of the month. Scotland recorded its wettest December on record and the predominance of low pressure exacerbated the risk of coastal flooding. Eastern and southern England experienced its highest storm surge since 1953. The multiple manifestations of flooding were all witnessed in December 2013, though the relative impacts of tidal, flash, fluvial and groundwater flooding varied across the country. Provisional data indicate that the Medway and the Mole in south-east England, the Piddle in south-west England and the Nith in Scotland recorded their largest flows on record for any month. More generally, floodplain inundations were widespread and remarkably sustained. The December rainfall transformed the groundwater outlook in parts of the Chalk aquifer, leading to exceptional rises in water levels, and bringing localised groundwater flooding to vulnerable areas in southern England. Reservoir stocks increased to very healthy levels and the overall water resource situation is good. The stormy conditions continued into early January, with a continuing risk of fluvial and groundwater flooding, particularly across southern England.

Rainfall

December began fine and dry, but a vigorous Jet Stream steered a succession of exceptionally deep low pressure systems across the UK, with associated pulses of frontal rainfall and severe gales. Monthly rainfall totals were notable; it was the wettest December for more than 50 years in southern England, and, away from the coastal strip, most of Scotland received >200% of average rainfall, the wettest December by a wide margin in a series from 1910. Some rain gauges in Scotland registered >10mm every day from the 12th to the 28th. On the 23rd/24th, a depression swept across Scotland, registering 936.8mb pressure at Stornoway, Western Isles; this is the lowest pressure recorded in the UK since 1886. Correspondingly, the 23rd was the wettest day of the month across southern Britain, and in some areas the wettest day of 2013. Postbridge on Dartmoor registered 156mm, and Boscombe Down (Wiltshire) recorded 67mm, a new daily maximum for any month in the period of record from 1931. Conversely, drier exceptions to the persistent wet weather occurred in eastern, central and north-eastern England; parts of Humberside received less than 50% of average monthly rainfall. 2013 rainfall totals were close to average at the national and regional scales, with moderately dry conditions over the first nine months counterbalanced by a wet last three months, although there were considerable local variations.

River flows

In many parts of the UK, late-November river flow recessions continued through early parts of December. However, catchments rapidly became saturated from mid-month and flood risk thence remained high in many areas. The number and distribution of flood warnings and alerts was exceptional, and floodplain inundations were very protracted, although their impact was greatly moderated by flood defences. On the 21st, flash flooding occurred in the Borders town of Jedburgh; despite unprecedented December rainfall in Scotland, there are few examples of extreme fluvial flood events. On the 23rd/24th, many homes were evacuated and flooded in Surrey, Sussex and Kent, and there was significant transport disruption across southern Britain. Late-December river flows were typically very sustained at levels at, or above, bankfull, with very extensive floodplain inundations. Provisionally, new flow records for December were established for a number of rivers in southern and south-western England, and south Wales, many of which were also amongst the highest ever recorded. Exceptional runoff rates continued well into January, most notably in the Thames catchment. Conversely, river flows were below average in some areas of East Anglia, Yorkshire and the Midlands; flows in the groundwater-dominated Lud continued to track downwards, recording only a third of the average December flow. Outflows from Great Britain approached year-end maxima, underlining the widespread nature of bankfull flows and floodplain inundations. Notwithstanding the cluster of rivers experiencing above average annual flows in south-east England (a product of the remarkably wet December), for 2013 overall, runoff was close to average across most of the UK.

Groundwater

Across much of the Chalk the exceptional December rainfall triggered very steep groundwater recoveries – exceeding 25m at West Woodyates and Chilgrove House, leaving levels close to monthly maxima. Groundwater flood alerts were issued for vulnerable areas across southern England (e.g. in Dorset and Hampshire); the magnitude and persistence of groundwater flooding will be heavily influenced by the late winter rainfall. In parts of the slower responding eastern Chalk, December recharge was modest and groundwater levels remain low or closer to seasonal norms. In the Permo-Triassic sandstones, water levels are generally now rising, and are in the normal range or higher. Levels are particularly high in the north-west and south-west, rising from average to exceptionally high at Newbridge, in Scotland. In the Magnesian Limestone, water levels remain above average, and are well above normal December levels at Swan House. In the Jurassic limestone, borehole levels are rising, but remain within the normal range at New Red Lion in the Lincolnshire Limestone, and are notably high at Ampney Crucis in the Cotswolds. In the fast responding Carboniferous Limestone there is a mixed picture; levels are currently normal in both the Peak District, where levels fell by 5m at Alstonfield, and south Wales, where levels rose by 10m at Pant y Lladron.

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Rainfall . . . Rainfall . . .

Rainfall accumulations and return period estimates

Percentages are from the 1971-2000 average.

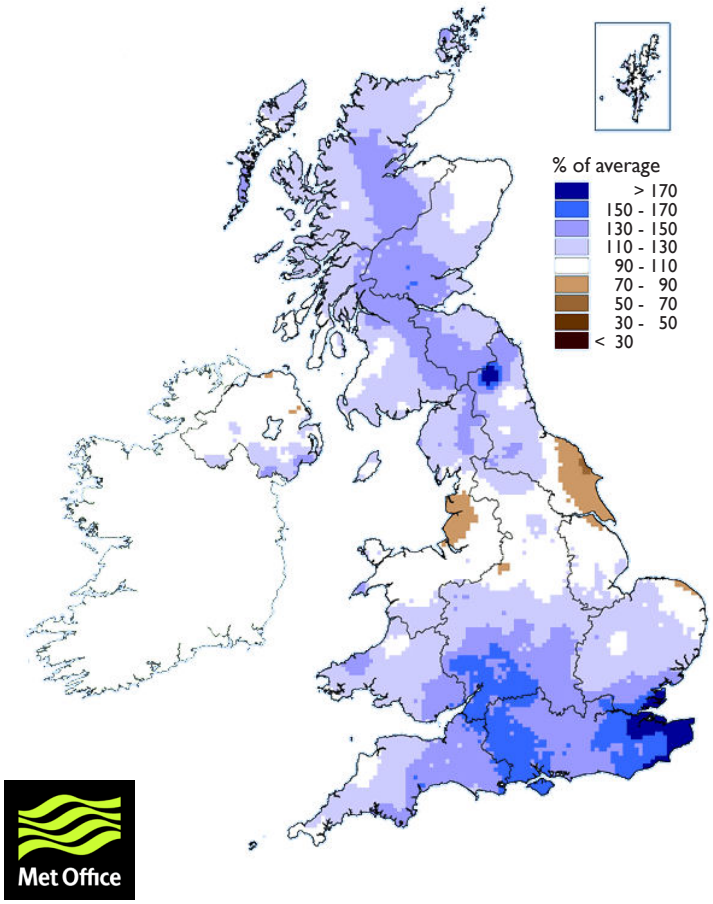
Area	Rainfall	Dec 2013	Oct 13 – Dec 13	RP	Jul 13 – Dec 13	RP	Apr 13 – Dec 13	RP	Jan 13 – Dec 13	RP
United Kingdom	mm	**185**	438		647		852		1086	
	%	**153**	126	10-15	110	2-5	108	2-5	100	2-5
England	mm	**117**	323		492		630		817	
	%	**131**	128	5-10	112	2-5	103	2-5	100	2-5
Scotland	mm	**296**	610		876		1172		1455	
	%	**184**	129	15-25	111	2-5	114	5-10	101	2-5
Wales	mm	**222**	562		813		1042		1346	
	%	**135**	121	5-10	107	2-5	105	2-5	98	2-5
Northern Ireland	mm	**137**	361		560		826		1131	
	%	**117**	105	2-5	93	2-5	102	2-5	102	2-5
England & Wales	mm	**131**	356		536		687		890	
	%	**132**	127	5-10	111	2-5	103	2-5	99	2-5
North West	mm	**182**	443		738		946		1154	
	%	**138**	116	2-5	112	2-5	109	2-5	98	2-5
Northumbria	mm	**128**	328		551		710		901	
	%	**149**	134	8-12	124	2-5	114	2-5	109	2-5
Midlands	mm	**80**	274		437		580		756	
	%	**99**	123	5-10	109	2-5	102	2-5	100	2-5
Yorkshire	mm	**86**	265		433		577		750	
	%	**97**	108	2-5	100	2-5	95	2-5	92	2-5
Anglian	mm	**51**	203		324		424		557	
	%	**91**	119	2-5	101	2-5	91	2-5	92	2-5
Thames	mm	**125**	306		439		554		727	
	%	**173**	146	10-15	119	2-5	104	2-5	104	2-5
Southern	mm	**174**	412		533		654		847	
	%	**198**	159	15-25	124	2-5	112	2-5	108	2-5
Wessex	mm	**167**	407		548		677		896	
	%	**164**	148	10-15	118	2-5	106	2-5	103	2-5
South West	mm	**189**	506		711		885		1204	
	%	**126**	124	5-10	109	2-5	102	2-5	100	2-5
Welsh	mm	**215**	544		790		1010		1307	
	%	**136**	122	5-10	108	2-5	105	2-5	99	2-5
Highland	mm	**374**	746		1036		1416		1724	
	%	**189**	128	15-25	110	2-5	118	5-10	101	2-5
North East	mm	**155**	364		542		736		937	
	%	**170**	125	2-5	105	2-5	104	2-5	99	2-5
Tay	mm	**291**	561		764		1005		1284	
	%	**207**	138	10-20	113	2-5	113	2-5	101	2-5
Forth	mm	**252**	500		724		917		1150	
	%	**204**	141	20-35	118	5-10	113	2-5	102	2-5
Tweed	mm	**210**	422		644		826		1029	
	%	**202**	144	15-25	126	5-10	118	2-5	108	2-5
Solway	mm	**289**	583		876		1181		1485	
	%	**180**	125	8-12	112	2-5	116	5-10	106	2-5
Clyde	mm	**336**	716		1042		1389		1730	
	%	**171**	125	8-12	107	2-5	113	5-10	100	2-5

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

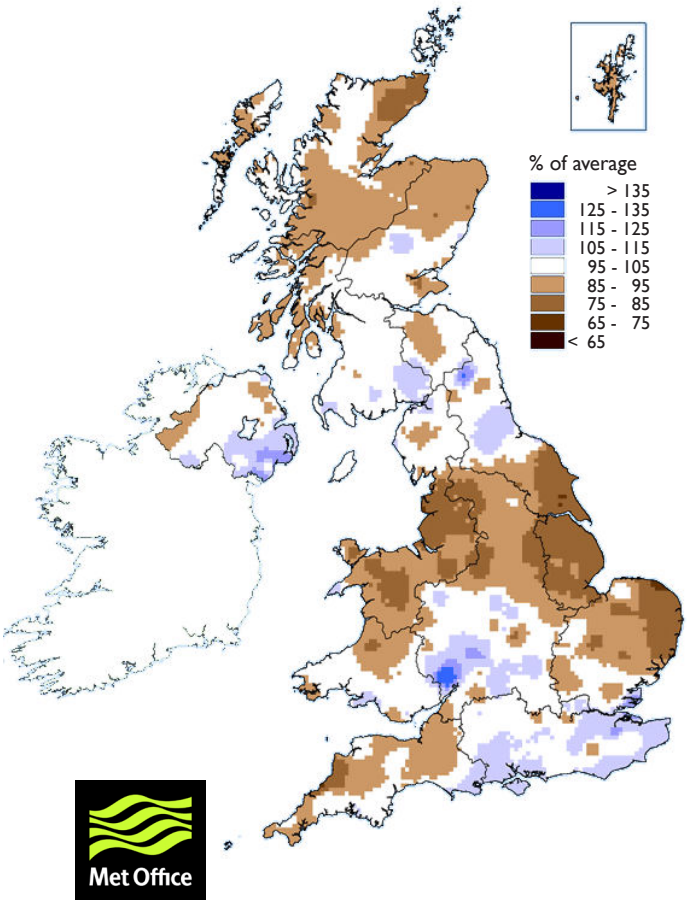
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic variability since 1910; they also assume a stable climate. The quoted RPs relate to the specific timespans only; for the same timespans, but beginning in any month the RPs would be substantially shorter. The timespans featured do not purport to represent the critical periods for any particular water resource management zone. For hydrological or water resources assessments of drought severity, river flows and/or groundwater levels normally provide a better guide than return periods based on regional rainfall totals. Note that precipitation totals in winter months may be underestimated due to snowfall undercatch. All monthly rainfall totals since August 2013 are provisional.

Rainfall . . . Rainfall . . .

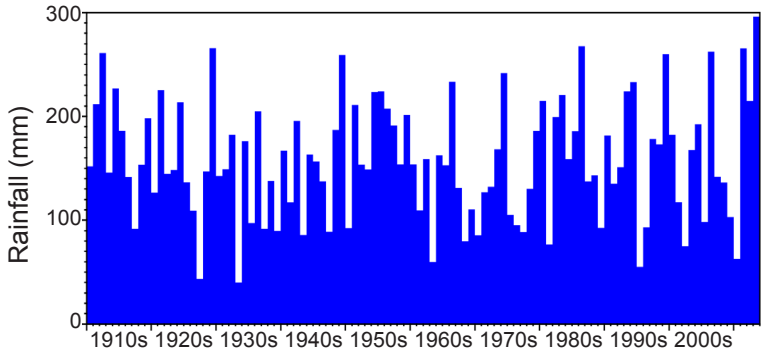
October 2013 - December 2013 rainfall as % of 1971-2000 average



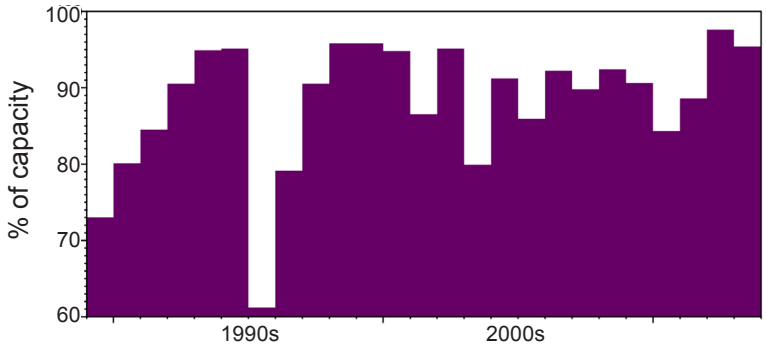
January 2013 - December 2013 rainfall as % of 1971-2000 average



December rainfall totals for Scotland



End of December reservoir stocks for England & Wales



Met Office 3-month outlook Updated: December 2013

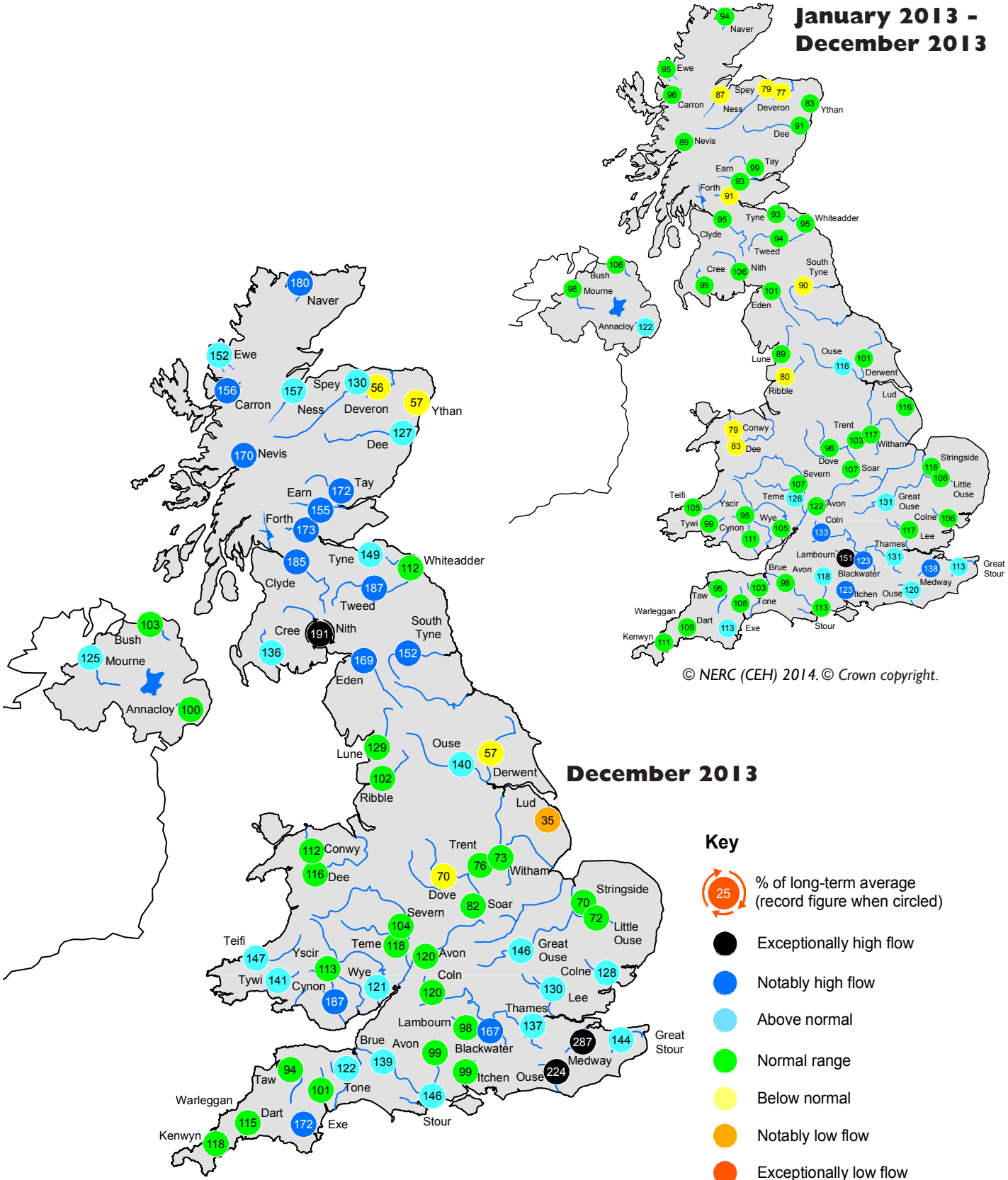
Latest predictions for UK-precipitation show a slight signal for near or just above average rainfall during January-February-March as a whole.

The probability that UK precipitation for January-February-March will fall into the driest of our five categories is around 20% and the probability that it will fall into the wettest category is between 10 and 15% (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.

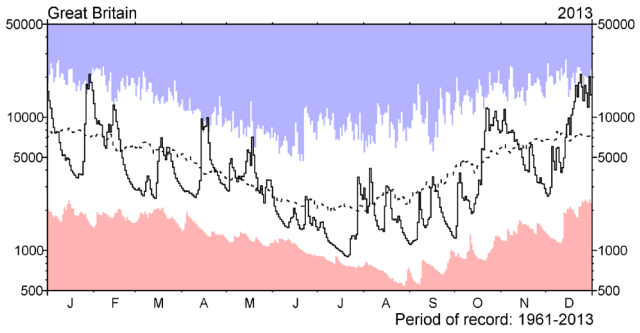
River flow . . . River flow . . .

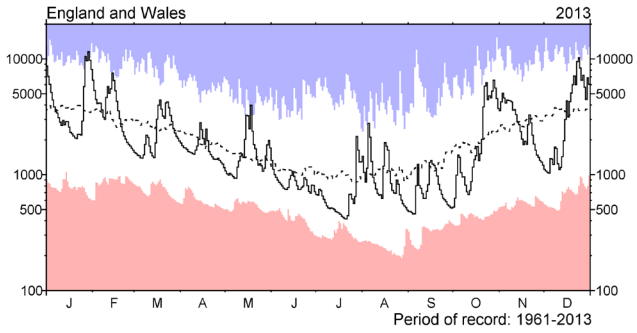


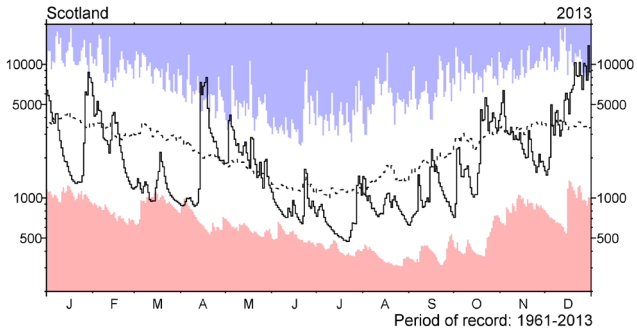
River flows

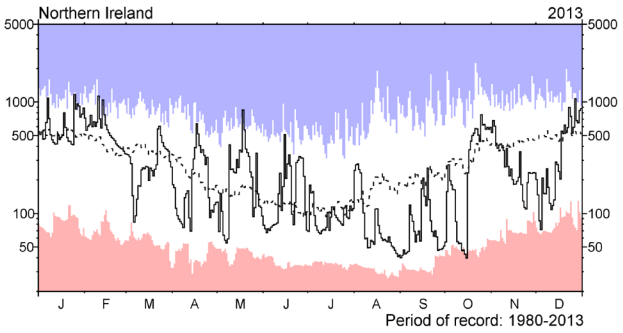
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

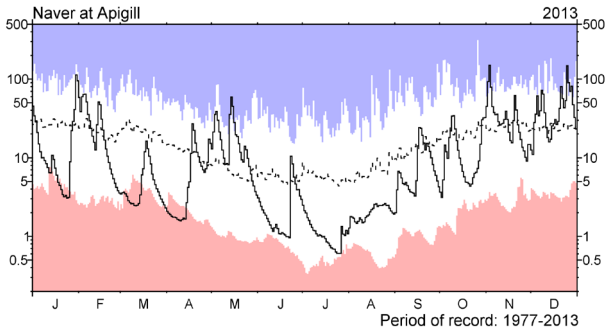
River flow . . . River flow . . .

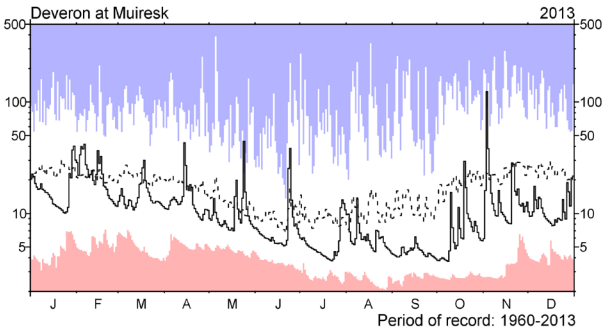


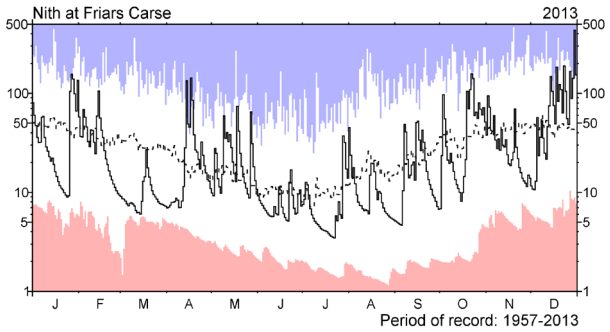


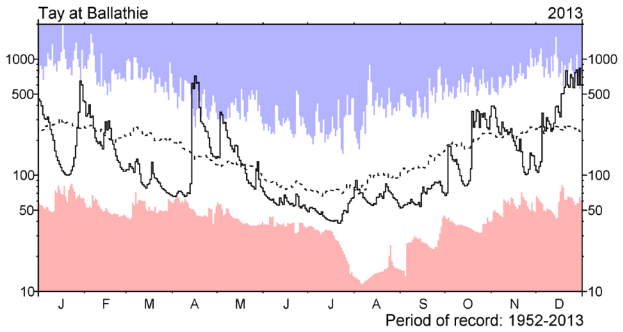


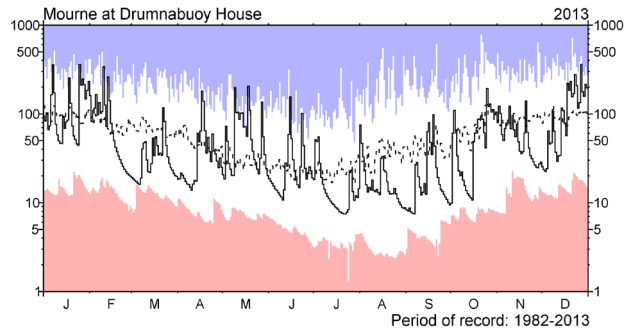


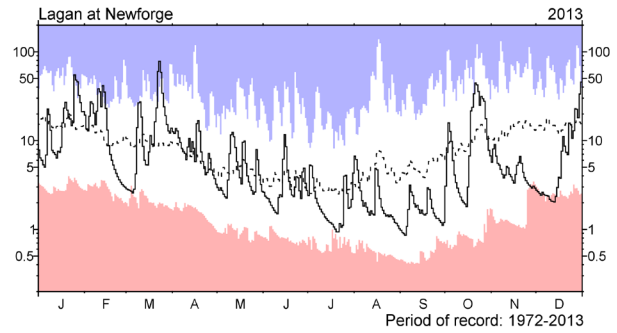








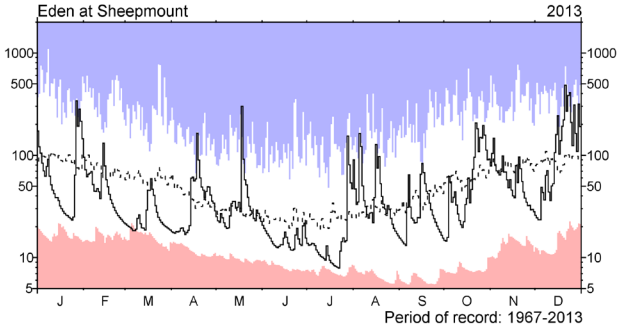


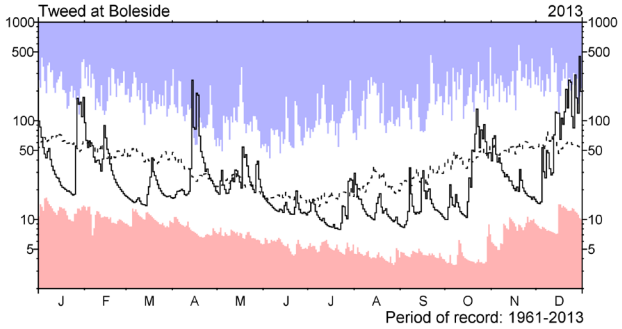


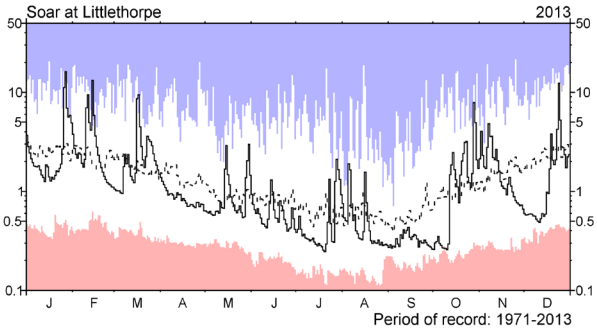
River flow hydrographs

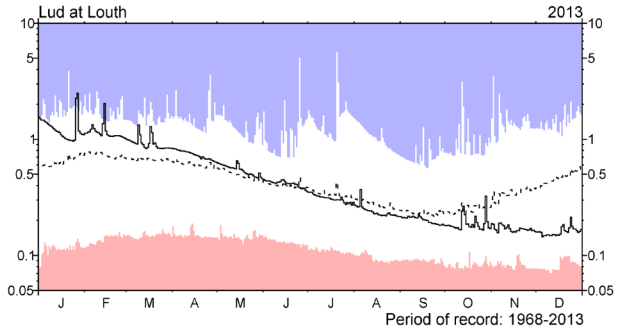
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to January 2013 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas. Mean daily flows are shown as the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

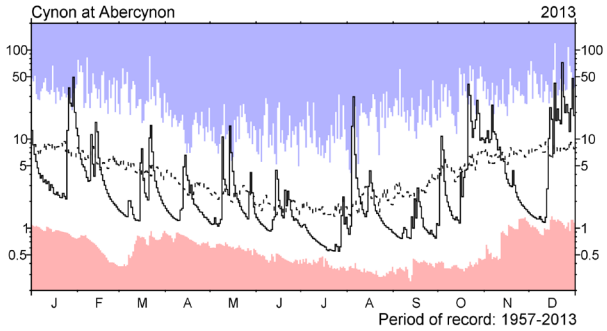
River flow ... River flow ...

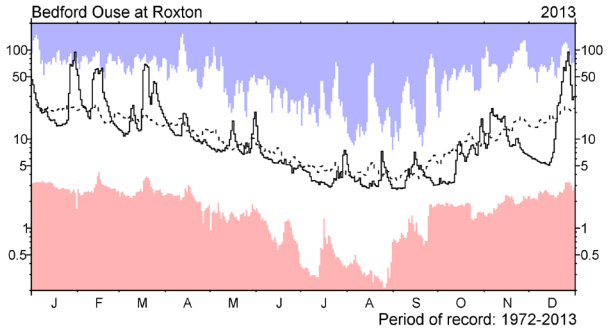


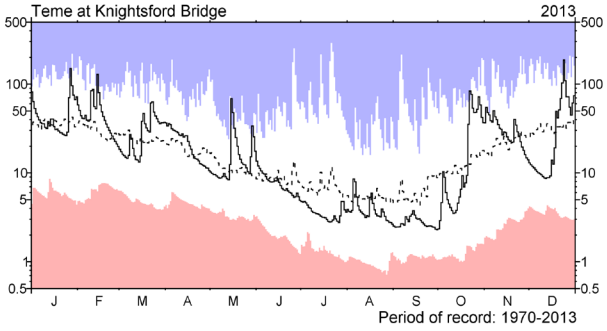


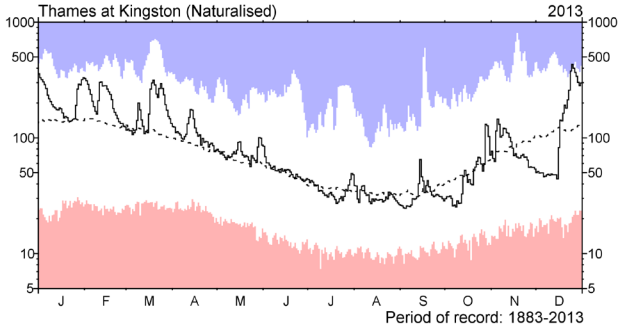


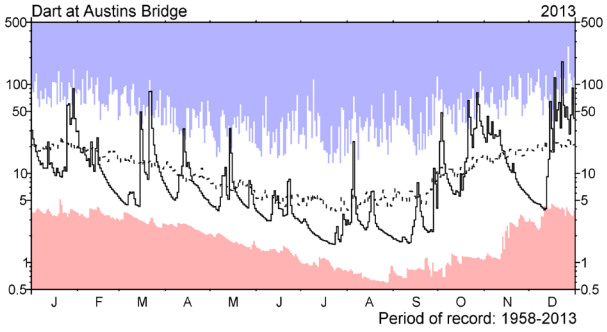


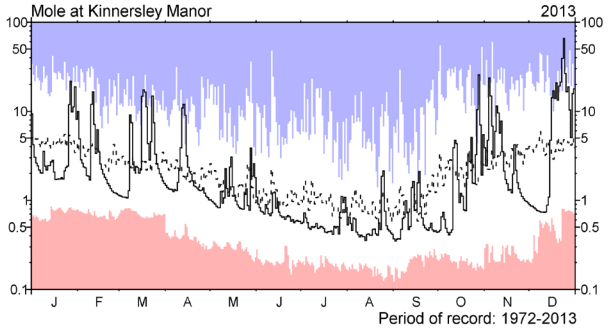


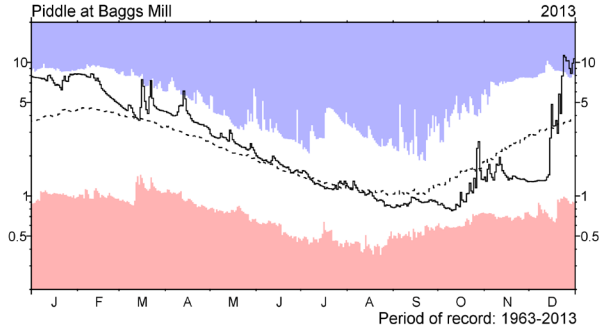


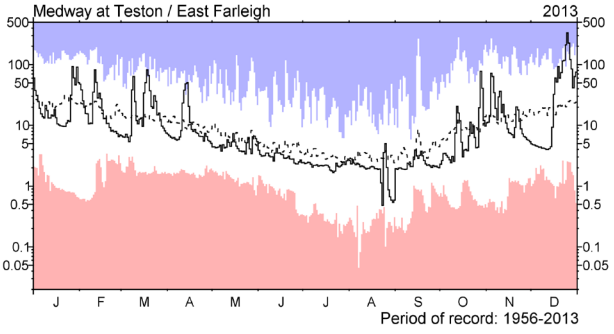




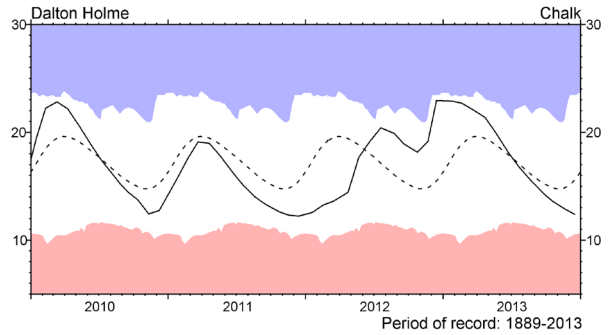


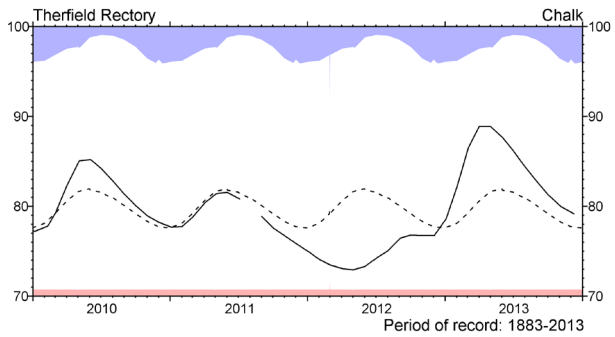


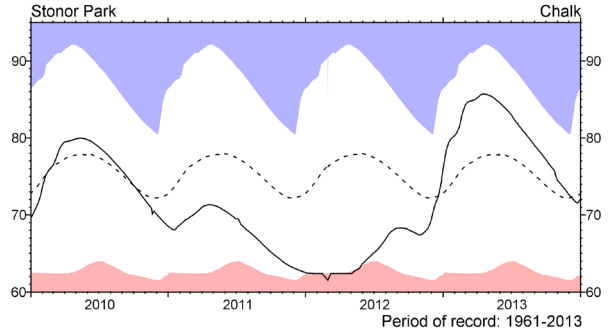


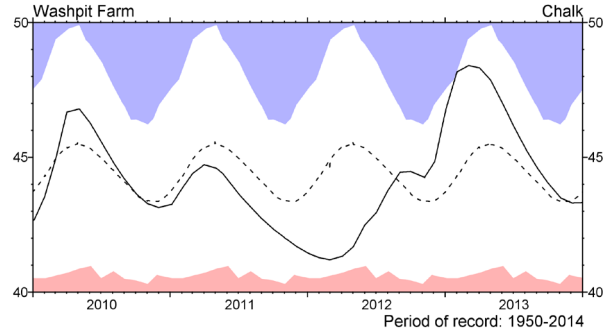


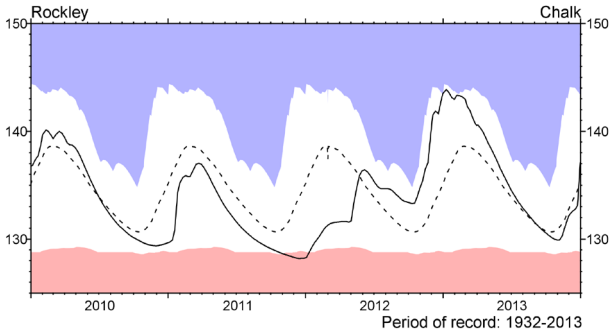
Groundwater…Groundwater

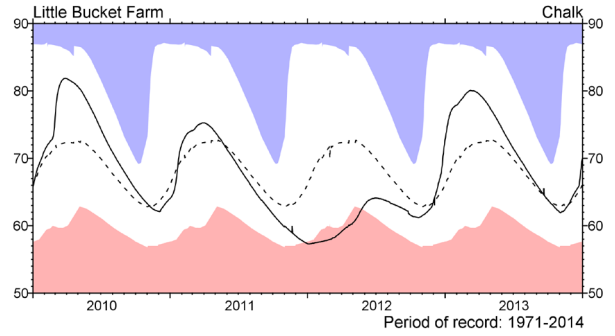


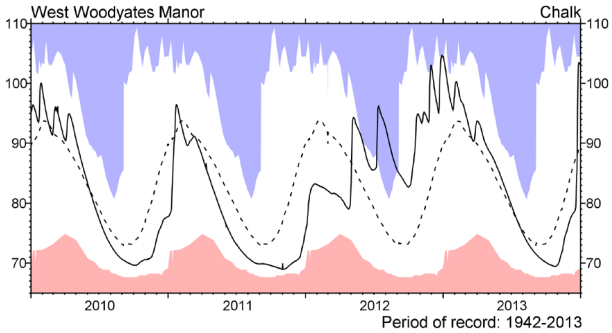


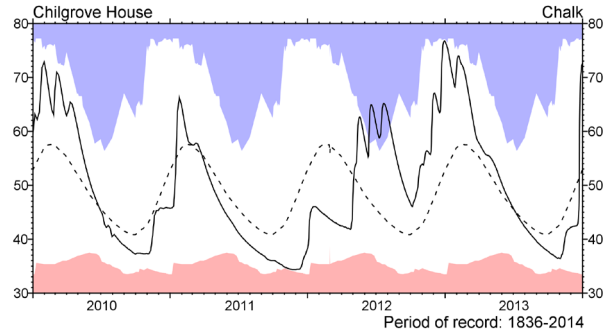


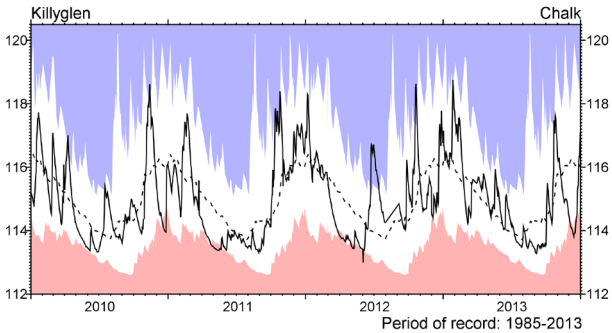


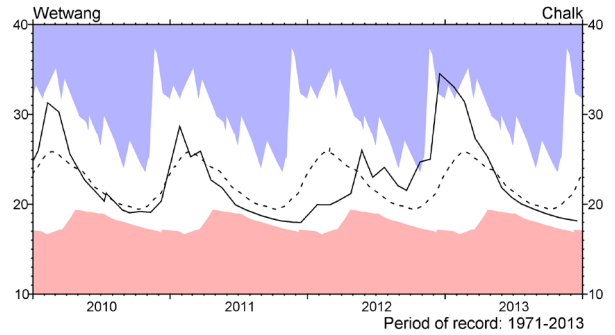






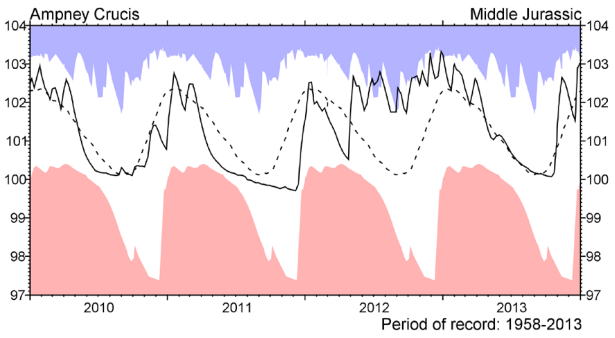


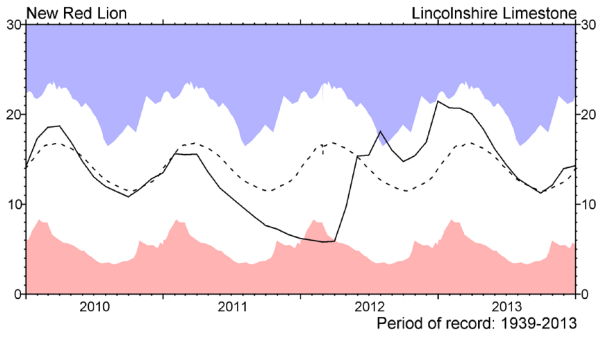


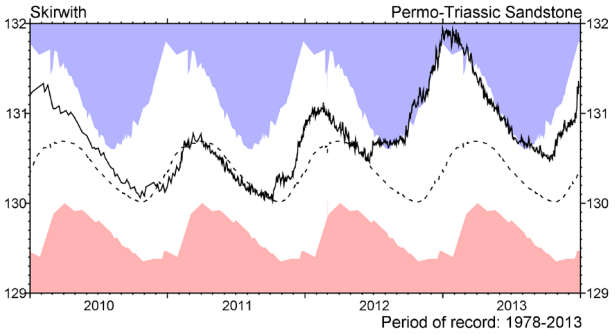


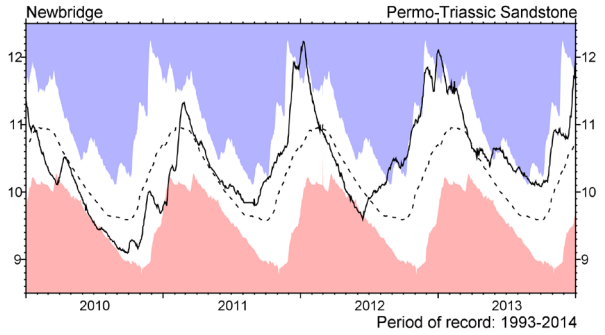
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined below overlying impermeable strata. The monthly mean and the highest and lowest levels recorded for each month are displayed in a similar style to the river flow hydrographs. Note that most groundwater levels are not measured continuously and, for some index wells, the greater frequency of contemporary measurements may, in itself, contribute to an increased range of variation. The latest recorded levels are listed overleaf.

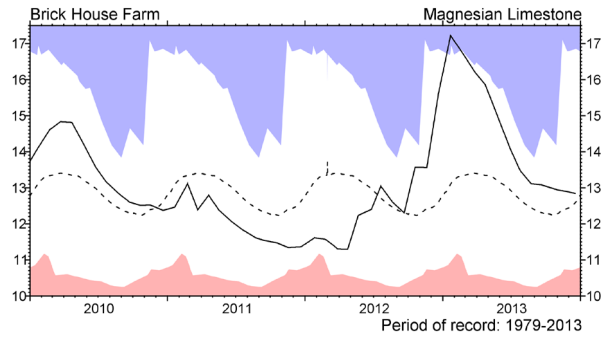
Groundwater ... Groundwater

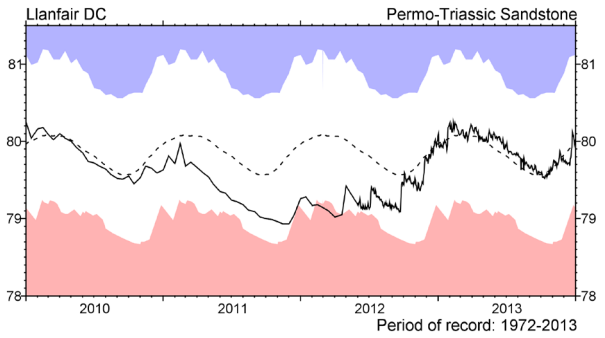


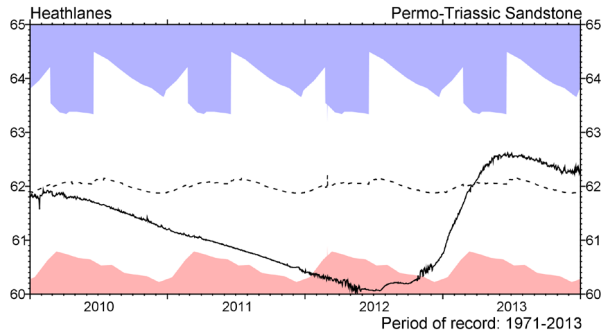


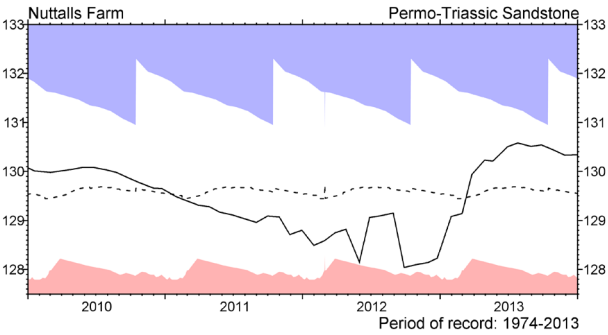


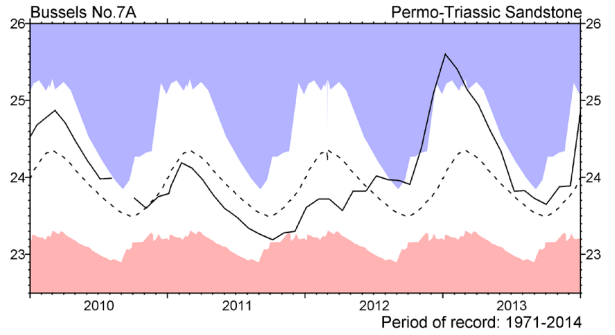


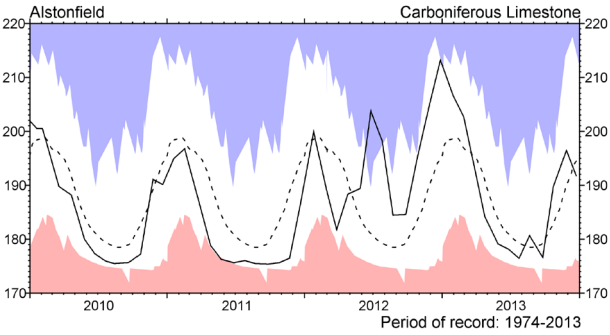








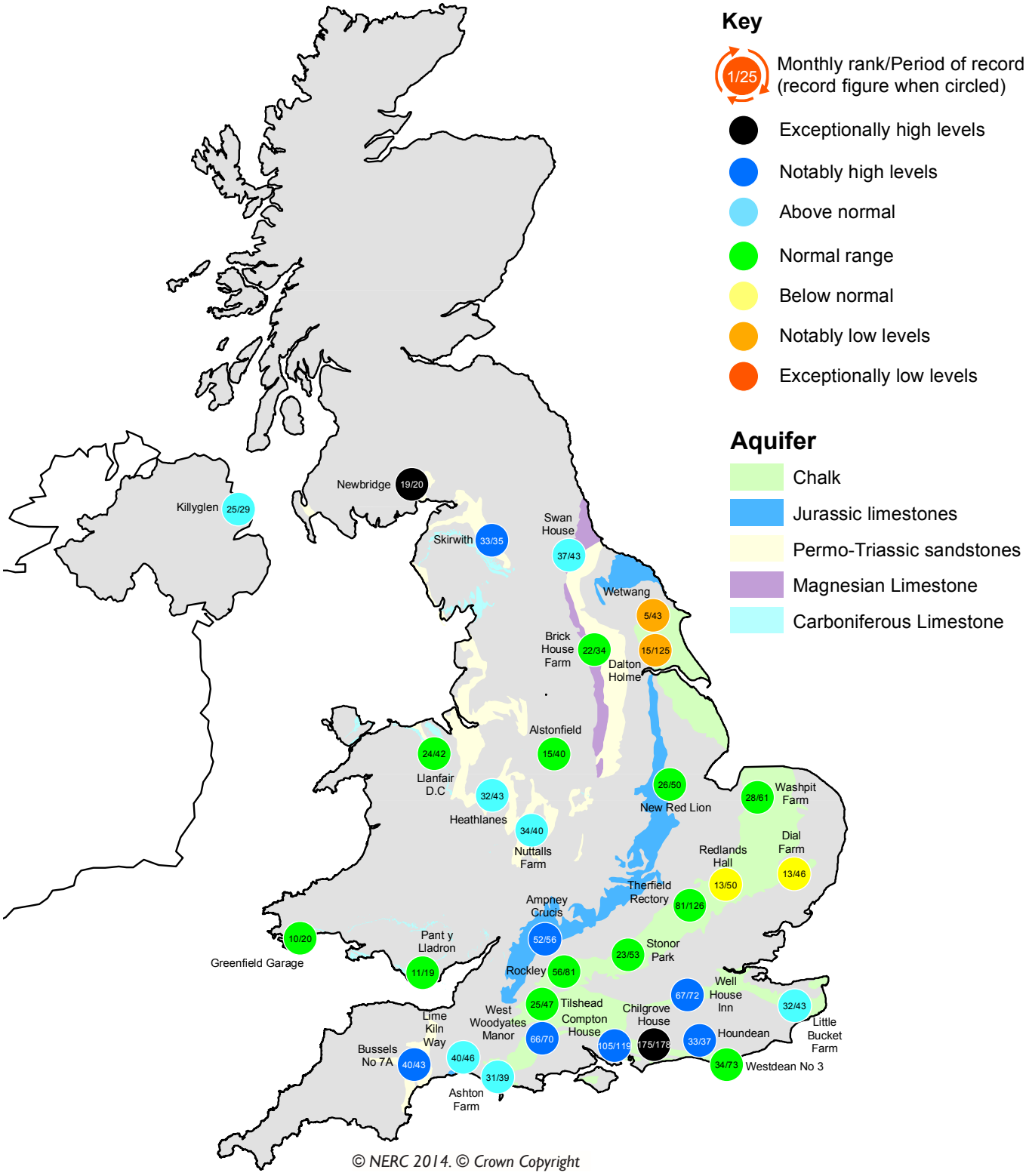




Groundwater levels December 2013 / January 2014

Borehole	Level	Date	Dec av.	Borehole	Level	Date	Dec av.	Borehole	Level	Date	Dec av.
Dalton Holme	12.39	16/12	15.60	Chilgrove House	76.33	07/01	51.92	Brick House Farm	12.84	18/12	12.54
Therfield Rectory	79.14	09/12	77.71	Killyglen (NI)	117.07	31/12	116.08	Llanfair DC	80.02	31/12	79.86
Stonor Park	72.01	31/12	72.15	Wetwang	18.14	17/12	21.86	Heathlanes	62.24	31/12	61.81
Tilshead	90.57	31/12	86.84	Ampney Crucis	103.02	31/12	101.98	Nuttalls Farm	130.34	31/12	129.53
Rockley	137.07	31/12	133.89	New Red Lion	14.27	31/12	13.08	Bussels No.7a	25.03	06/01	23.85
Well House Inn	100.80	31/12	93.49	Skirwith	131.26	28/12	130.36	Alstonfield	191.73	23/12	193.32
West Woodyates	103.10	31/12	87.02	Newbridge	12.04	01/01	10.64				

Levels in metres above Ordnance Datum

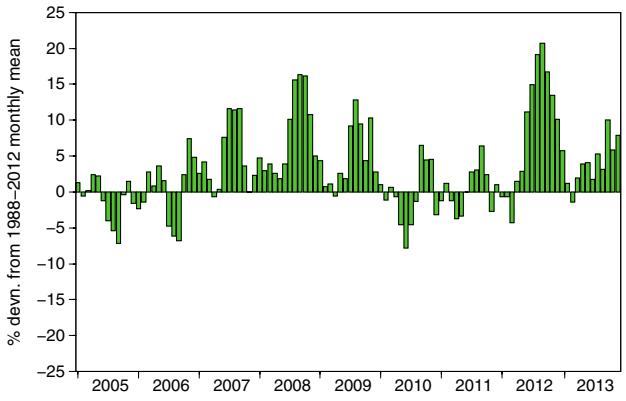


Groundwater levels - December 2013

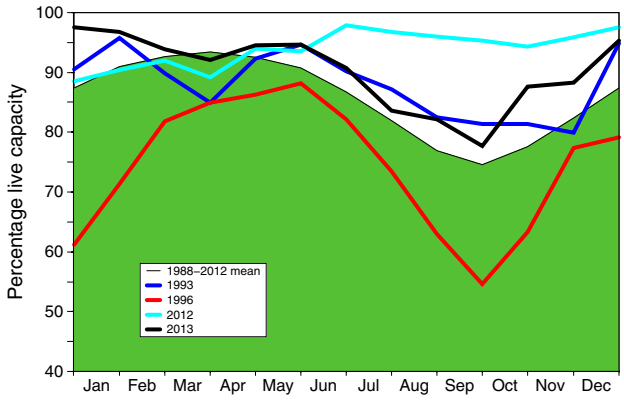
The calculation of ranking has been modified from that used in summaries published prior to October 2012. It is now based on a comparison between the most recent level and levels for the same date during previous years of record. Where appropriate, levels for earlier years may have been interpolated.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

Reservoirs . . . Reservoirs . . .

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



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



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

Percentage live capacity of selected reservoirs at end of month

Area	Reservoir		Capacity (Ml)	2013 Oct	2013 Nov	2013 Dec	Dec Anom.	Min Dec	Year* of min	2012 Dec	Diff 13-12
North West	N Command Zone	•	124929	86	81	94	8	51	1995	97	-3
	Vyrnwy		55146	95	83	100	9	35	1995	100	0
Northumbrian	Teesdale	•	87936	100	97	100	11	41	1995	100	0
	Kielder		(199175)	95	89	100	9	70	1989	100	0
Severn Trent	Clywedog		44922	85	87	87	3	54	1995	97	-10
	Derwent Valley	•	39525	79	89	98	9	10	1995	100	-2
Yorkshire	Washburn	•	22035	83	92	95	10	23	1995	99	-4
	Bradford Supply	•	41407	77	79	91	0	22	1995	100	-9
Anglian	Grafham		(55490)	88	89	89	5	57	1997	74	15
	Rutland		(116580)	78	86	89	7	60	1990	92	-3
Thames	London	•	202828	92	94	96	10	60	1990	99	-2
	Farmoor	•	13822	83	92	84	-7	71	1990	79	5
Southern	Bewl		28170	70	80	91	19	34	2005	95	-4
	Ardingly**		4685	68	84	100	16	30	2011	100	0
Wessex	Clatworthy		5364	83	100	100	9	54	2003	100	0
	Bristol	•	(38666)	56	69	83	5	40	1990	98	-15
South West	Colliford		28540	71	75	83	5	46	1995	100	-17
	Roadford		34500	77	81	91	14	20	1989	100	-9
	Wimbleball		21320	54	66	76	-8	46	1995	100	-24
	Stithians		4967	68	81	100	23	33	2001	100	0
Welsh	Celyn & Brenig	•	131155	88	89	100	7	54	1995	100	0
	Brianne		62140	100	91	100	3	76	1995	100	0
	Big Five	•	69762	89	92	98	8	67	1995	100	-2
	Elan Valley	•	99106	100	100	100	4	56	1995	100	0
Scotland(E)	Edinburgh/Mid-Lothian	•	97639	77	81	100	9	60	1998	100	0
	East Lothian	•	10206	82	73	100	4	48	1989	100	0
Scotland(W)	Loch Katrine	•	111363	87	87	94	5	75	2007	91	3
	Daer		22412	75	100	100	3	83	1995	99	1
	Loch Thom	•	11840	83	100	100	3	80	2007	100	0
Northern Ireland	Total+	•	56800	92	87	89	2	61	2001	100	-11
	Silent Valley	•	20634	92	85	89	5	39	2001	100	-11

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

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

+ excludes Lough Neagh

Details of the individual reservoirs in each of the groupings listed above are available on request. The percentages given in the Average and Minimum storage columns relate to the 1988-2012 period except for West of Scotland and Northern Ireland where data commence in the mid-1990s. In some gravity-fed reservoirs (e.g. Clywedog) stocks are kept below capacity during the winter to provide scope for flood attenuation purposes. Monthly figures may be artificially low due to routine maintenance or turbidity effects in feeder rivers.

Location map…Location map

National Hydrological Monitoring Programme

The National Hydrological Monitoring Programme (NHMP) was instigated in 1988 and is undertaken jointly by the Centre for Ecology & Hydrology (CEH) and the British Geological Survey (BGS) – both are component bodies of the Natural Environment Research Council (NERC). The National River Flow Archive (maintained by CEH) and the National Groundwater Level Archive (maintained by BGS) provide the historical perspective within which to examine contemporary hydrological conditions.

Data Sources

River flow and groundwater level data are provided by the Environment Agency (EA), Natural Resources Wales - Cyfoeth Naturiol Cymru, the Scottish Environment Protection Agency (SEPA) and, for Northern Ireland, the Rivers Agency and the Northern Ireland Environment Agency. In all cases the data are subject to revision following validation (high flow and low flow data in particular may be subject to significant revision).

Reservoir level information is provided by the Water Service Companies, the EA, Scottish Water and Northern Ireland Water.

Most rainfall data are provided by the Met Office (address opposite).

To allow better spatial differentiation the monthly rainfall data for Britain are presented for the regional divisions of the precursor organisations of the EA and SEPA.

The monthly, and n-month, rainfall figures have been produced by the Met Office, National Climate Information Centre (NCIC) and are based on gridded data from raingauges. They include a significant number of monthly raingauge totals provided by the EA and SEPA. The Met Office NCIC monthly rainfall series extends back to 1910 and forms the official source of UK areal rainfall statistics which have been adopted by the NHMP. The gridding technique used is described in Perry MC and Hollis DM (2005) available at http://www.metoffice.gov.uk/climate/uk/about/Monthly_gridded_datasets_UK.pdf

The regional figures for the current month are based on limited raingauge networks so these (and the return periods associated with them) should be regarded as a guide only.

The Met Office NCIC monthly rainfall series are Crown Copyright and may not be passed on to, or published by, any unauthorised person or organisation.

From time to time the Hydrological Summary may also refer to evaporation and soil moisture figures. These are obtained from MORECS, the Met Office services involving the routine calculation of evaporation and soil moisture throughout the UK.

For further details please contact:

The Met Office
FitzRoy Road
Exeter
Devon
EX1 3PB

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

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

Enquiries

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

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iii. Met Office rainfall data. © Crown copyright.

01/2014