Hydrological Summary *for the United Kingdom*

September 2011

General

September saw a continuation of the marked spatial variation in rainfall which has been a feature of 2011 so far. The lowest monthly rainfall totals coincided with those areas for which long-term rainfall deficiencies were already substantial; there was, therefore, little amelioration of drought conditions in affected areas of England. September river flows and groundwater levels were below average across much of the English lowlands, and substantial long-term runoff deficiencies continue to develop in many index rivers, particularly in the Midlands and south west. The drought continues to exert stress on the aquatic environment: dry wells, springs and ponds were reported from parts of the Midlands and East Anglia, whilst the dry soils posed problems to farmers lifting crops. Impacts on navigation were reported, e.g. restrictions on the Oxford and Grand Union canals. The spatial contrast in long-term rainfall receipt is reflected in reservoir stocks – stocks are healthy in Scotland and Wales (with stocks >20% and 15% above average respectively), whilst early October stocks were substantially below average in parts of southern England (over 20% below average in some reservoirs in the southwest) and the Midlands (with the Charnwood reservoirs dropping below 40% of capacity). With the dry episode of the last week persisting into October, and notably dry soils for the time of year across much of England, the seasonal recovery in river flows and groundwater levels is likely to be delayed into the winter unless significantly above average rainfall occurs in the late autumn.

Rainfall

With the exception of the last week, when anticylonic conditions brought fine weather and exceptionally warm temperatures for the time of year, westerly weather patterns dominated for much of September. Frontal showers brought prolonged and occasionally heavy rainfall, but this was largely confined to northern and western districts: a vigorous depression, incorporating the remnants of Hurricane Katia, crossed northern Britain on the 12th, bringing heavy rain to upland areas, with 72mm and 70mm recorded on consecutive days at Invergulas (W. Scotland) on the 11th/12th. The prevalence of cyclonic, westerly conditions yielded above average rainfall for the month in Northern Ireland and northwest Britain; appreciably so in mountainous areas, with over 70% more than the average in parts of the western Highlands of Scotland. This contrasts markedly with the situation in the English lowlands: September saw a return to dry conditions in some areas which had a wetter-than-average summer, and a continuation of the persistent dryness in the Midlands. Monthly totals were below 60% of average across much of England, with <35% received in parts of the east and the Midlands. The north-south gradient reflects long-term rainfall patterns, with notably low 12-month rainfall deficiencies south of the Humber contrasting with high accumulations in Scotland: Midlands registered its second driest water year (Oct - Sep) on record whilst east Scotland registered its fourth wettest over the same timeframe.

River Flows

Throughout much of September, a succession of frontal systems brought heavy rainfall to western areas, triggering spates (and associated flood alerts), e.g. in Wales and northern England on the 5th/6th and in Scotland on the 11th - 13th. However, the majority of rain-bearing systems made little ingress into central or southeast England, so runoff patterns for the month exhibited marked spatial contrasts. September runoff was substantially above average across most of northwest Britain, with over twice the monthly average in the Conwy and the Lune (which also registered its highest ever September peak flow in a 34-year record); several Scottish rivers also yielded exceptional monthly average flow, the highest on record (starting 1982) on the Nevis, and the third highest in the Tay record from 1952, whilst September outflows from Scotland were the second highest on record. In contrast, below average runoff was characteristic of the English lowlands, with notably low September flows in a majority of index rivers, particularly in permeable catchments (e.g. the Hampshire Avon, the Lambourn and the Coln). Long-term runoff deficiencies continue to develop across southern Britain: combined outflows from the English lowlands for the March - September period are the second lowest (after 1976) in a record from 1961. Runoff over the last 12 months has been notably low in index catchments across the Midlands, south Wales and south west England: the Trent registered its fourth lowest water-year (Oct - Sep) runoff, whilst the Taw registered its second lowest, both in records since 1958.

Groundwater

The north-south contrast in rainfall is reflected in soil moisture status – soil moisture deficits were negligible across upland Britain and eliminated in western Scotland, but deficits increased in central England, in response to the dry month. Notable deficits persist in many areas, with substantially above average smds in the west Midlands and isolated patches elsewhere (e.g. Cornwall and Kent). End-of-month smds aggregated for the Anglian region were the highest on record (the 3rd highest in Thames and Midlands). With such dry soils and limited rainfall over the main aquifer areas, groundwater recessions continued to develop, leading to little change to the overall groundwater situation. Below average levels were a feature of most Chalk boreholes, with exceptionally low levels persisting at Tilshead and Chilgrove. Levels in boreholes to the far west of the Permo-Triassic sandstone were notably low, but levels in most other index boreholes were within the normal range; a further upturn in levels was registered in the Permo-Triassic Newbridge borehole (south west Scotland). With substantial smds persisting across the English lowlands, a continuation of groundwater recessions through the autumn is likely: above average late-autumn rainfall is needed to avoid substantially depressed groundwater levels entering the winter, which may have significant bearing on the long-term water resources outlook.

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

Rainfall accumulations and return period estimates

Percentages are from the 1971-2000 average.

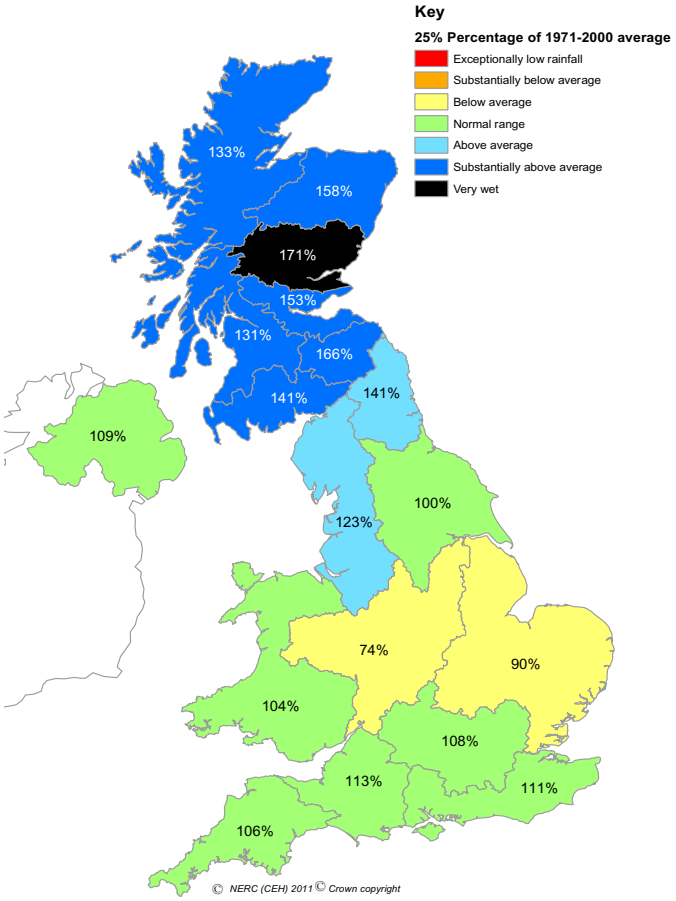
Area	Rainfall	Sep 2011	Jun11 - Sep11		Mar11 - Sep11		Oct10 - Sep11		Dec09 - Sep11	
				RP		*RP*		*RP*		*RP*
United Kingdom	mm	**107**	372		559		1048		1827	
	%	**110**	119	2-5	104	2-5	97	2-5	94	5-10
England	mm	**53**	259		338		694		1315	
	%	**74**	104	2-5	79	10-15	85	8-12	89	10-15
Scotland	mm	**189**	555		929		1611		2591	
	%	**143**	140	15-20	136	>100	112	8-12	101	2-5
Wales	mm	**121**	394		543		1134		2104	
	%	**103**	105	2-5	84	5-10	83	12-16	86	15-20
Northern Ireland	mm	**121**	360		556		1040		1884	
	%	**129**	109	2-5	99	2-5	94	2-5	94	5-10
England & Wales	mm	**62**	278		366		755		1424	
	%	**80**	104	2-5	80	10-15	84	10-15	89	10-15
North West	mm	**137**	434		635		1198		2013	
	%	**133**	123	2-5	108	2-5	102	2-5	96	2-5
Northumbria	mm	**66**	363		494		954		1637	
	%	**95**	141	5-10	111	2-5	115	2-5	109	2-5
Midlands	mm	**35**	179		251		532		1077	
	%	**53**	74	5-10	61	60-90	70	>100	78	>100
Yorkshire	mm	**43**	249		325		715		1313	
	%	**63**	100	2-5	76	10-20	88	5-10	89	8-12
Anglian	mm	**25**	186		218		452		978	
	%	**46**	90	2-5	64	20-35	75	20-30	90	5-10
Thames	mm	**37**	234		284		566		1113	
	%	**59**	108	2-5	76	5-15	81	8-12	88	5-10
Southern	mm	**41**	249		291		679		1318	
	%	**57**	111	2-5	75	5-15	87	5-10	95	2-5
Wessex	mm	**56**	283		356		705		1308	
	%	**73**	113	2-5	83	5-10	81	10-15	84	15-25
South West	mm	**84**	336		421		937		1780	
	%	**85**	106	2-5	76	10-15	78	20-30	83	20-35
Welsh	mm	**114**	378		520		1081		2026	
	%	**100**	104	2-5	83	5-10	82	14-18	86	15-25
Highland	mm	**236**	602		1091		1807		2881	
	%	**150**	133	10-15	139	80-120	105	2-5	95	2-5
North East	mm	**94**	457		668		1145		2071	
	%	**107**	158	15-20	135	15-25	121	5-10	122	14-18
Tay	mm	**159**	579		901		1578		2474	
	%	**141**	171	33-50	151	>100	124	25-40	109	2-5
Forth	mm	**130**	502		776		1398		2219	
	%	**124**	153	10-20	139	30-50	123	25-40	109	5-10
Tweed	mm	**105**	471		677		1216		2000	
	%	**130**	166	15-20	138	10-20	127	20-35	116	5-10
Solway	mm	**178**	560		885		1637		2616	
	%	**143**	141	8-12	131	15-25	116	12-16	104	2-5
Clyde	mm	**256**	637		1090		1936		3002	
	%	**156**	131	8-12	133	40-60	112	8-12	97	2-5

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

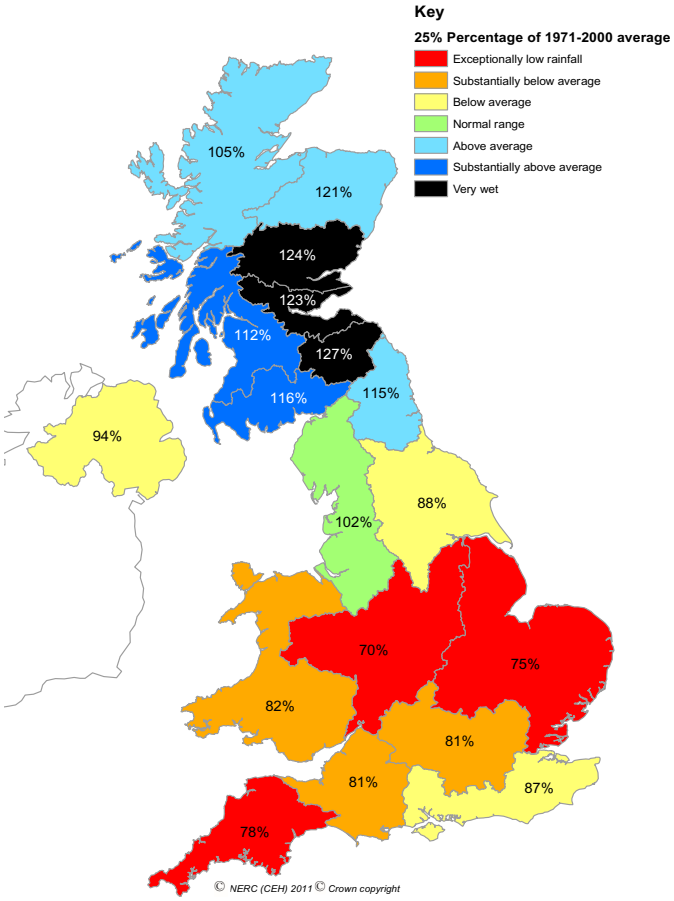
Important note: Figures in the above table may be quoted provided their source is acknowledged (see page 12). Where appropriate, specific mention must be made of the uncertainties associated with the return period estimates. The RP estimates are based on data provided by the Met Office and reflect climatic 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. All monthly rainfall totals since April 2011 are provisional.

Rainfall . . . Rainfall . . .

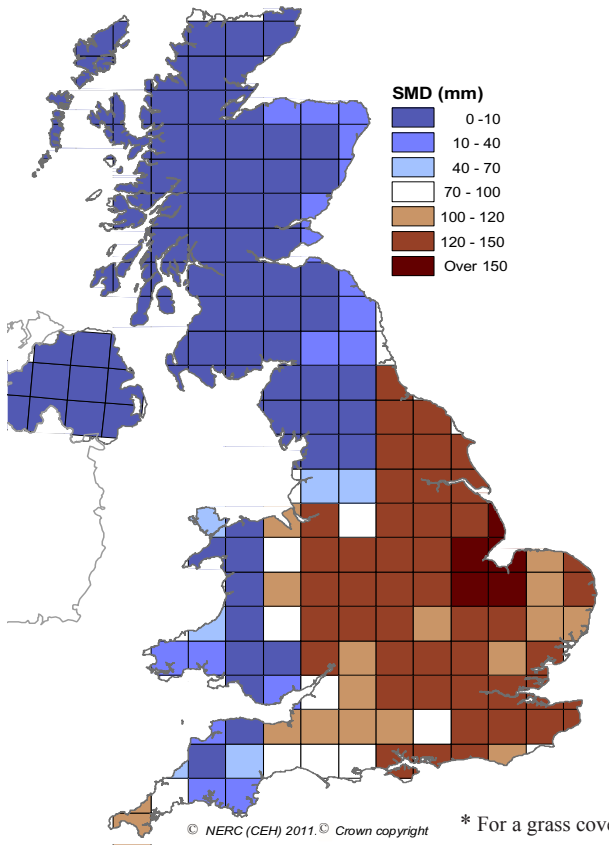
June - September 2011



October 2010 - September 2011

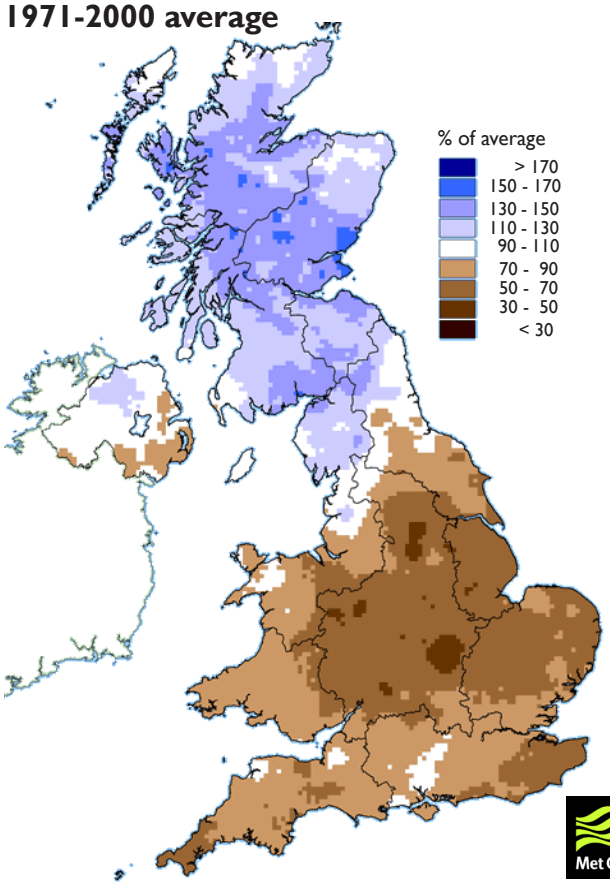


Soil Moisture Deficits* September 2011



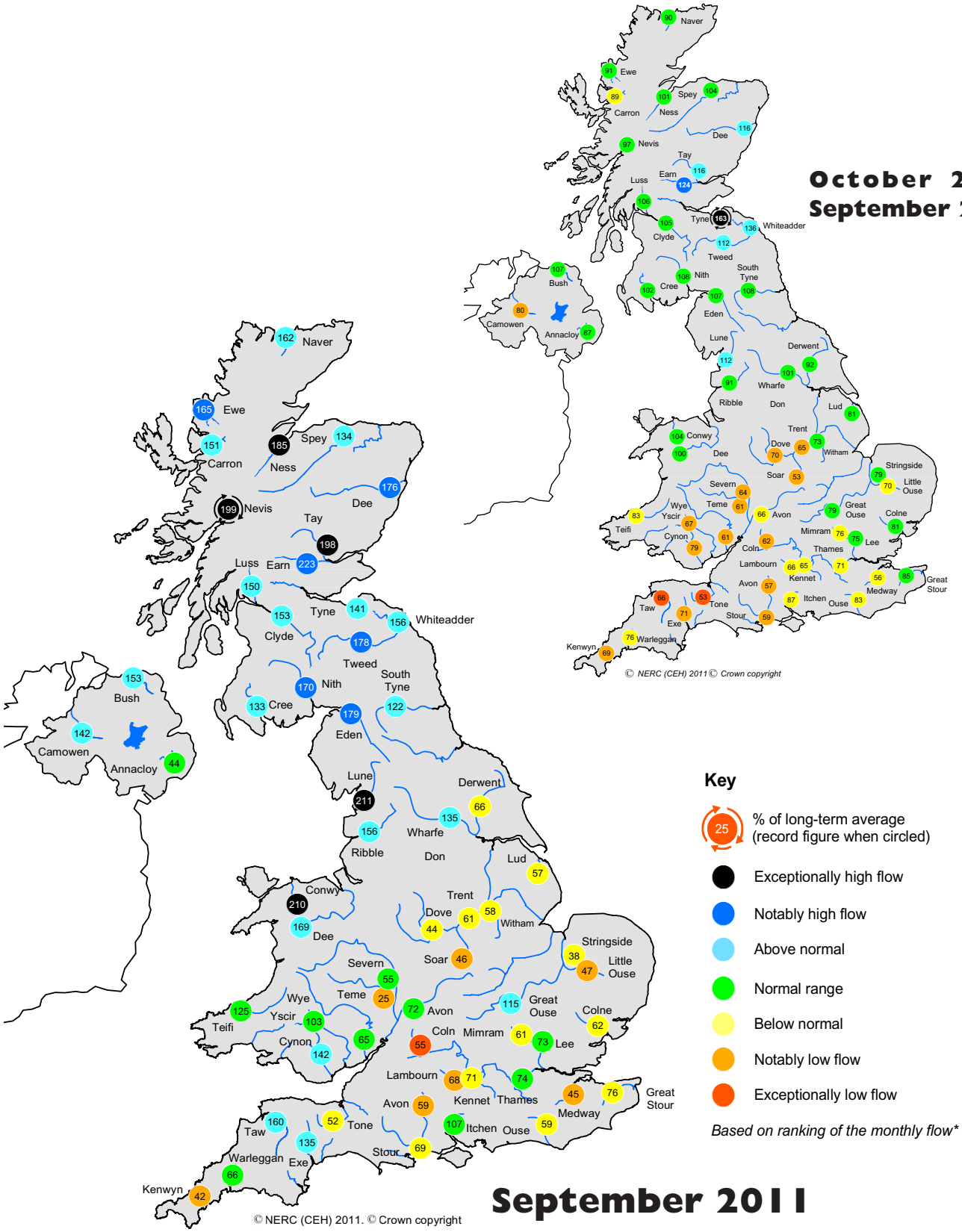
* For a grass cover

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



Met Office

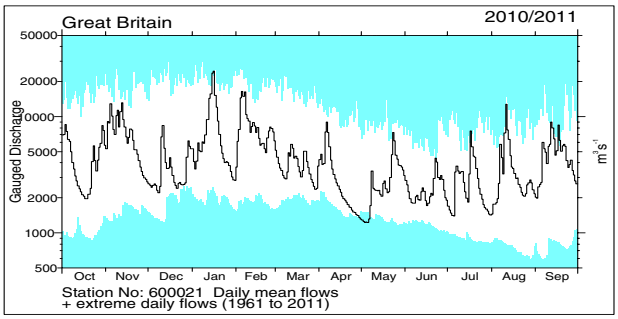
River flow . . . River flow . . .

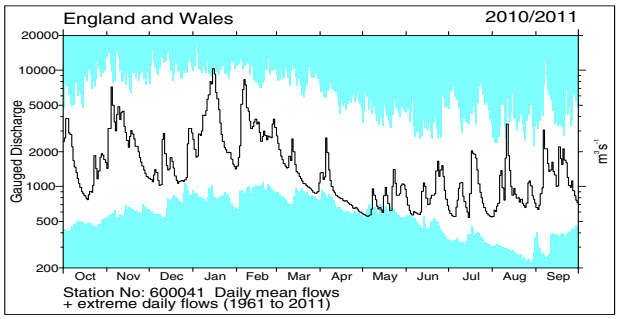


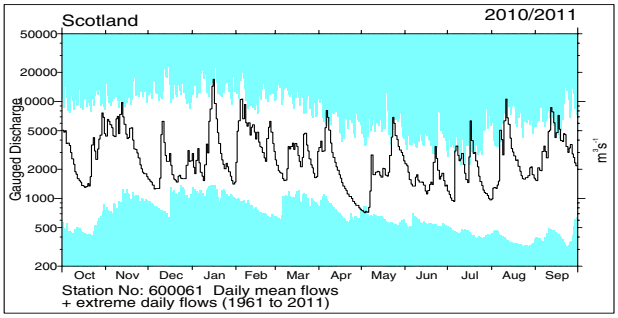
River flows

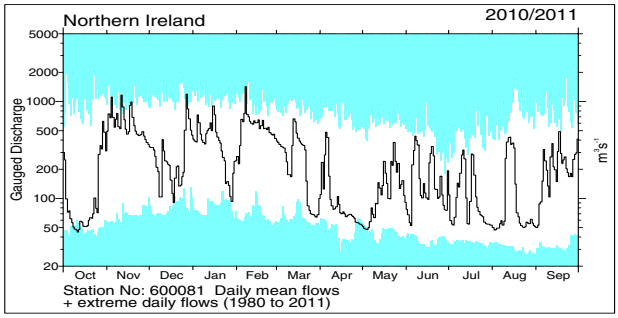
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

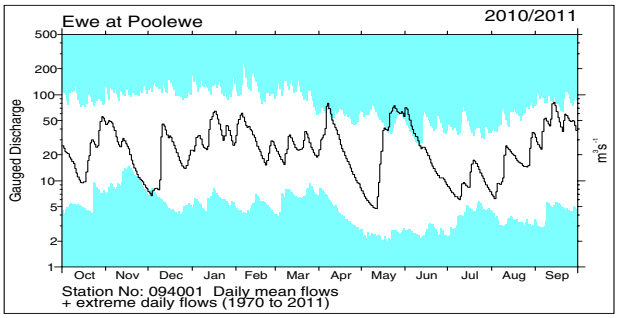
River flow . . . River flow . . .

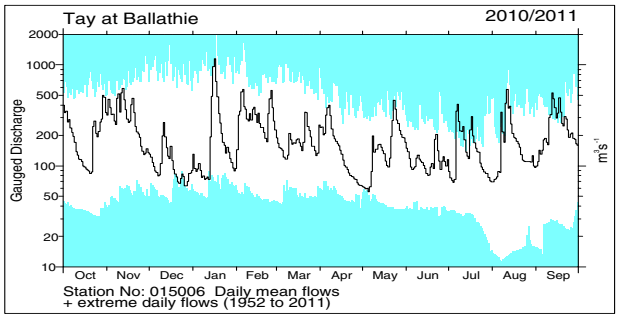


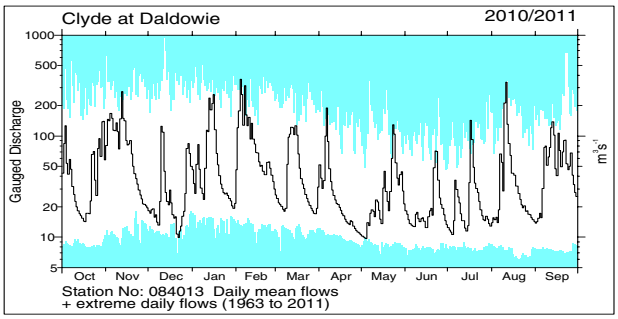


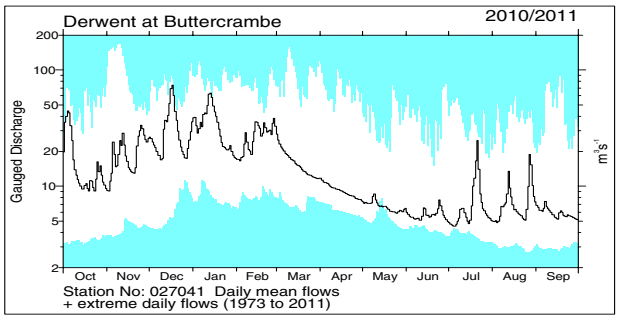


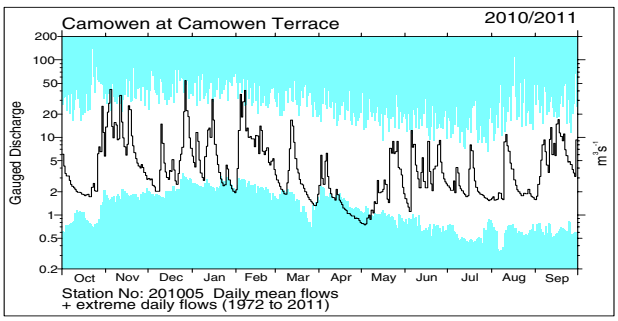


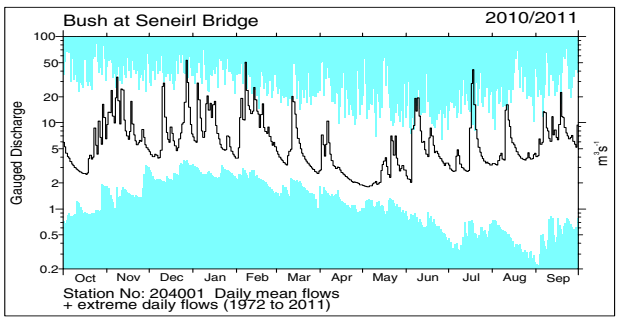








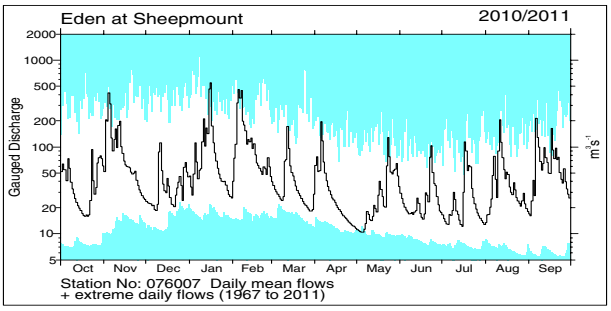


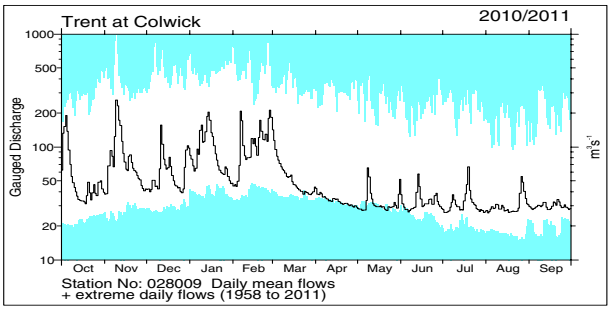


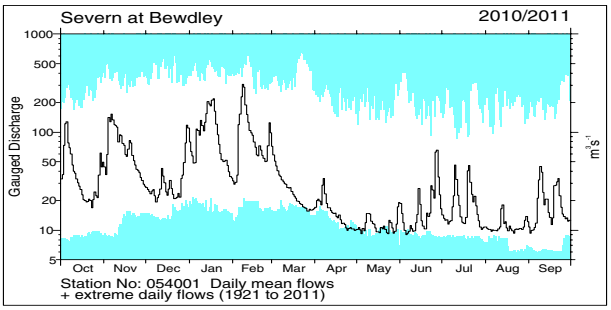
River flow hydrographs

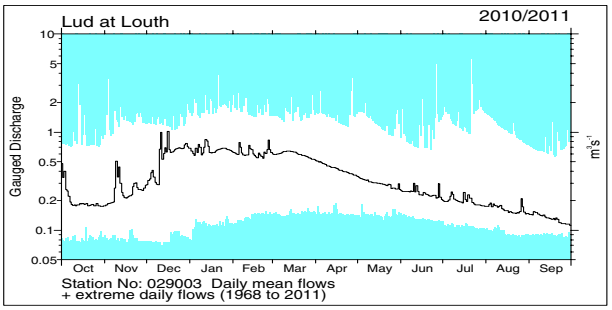
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to October 2010 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

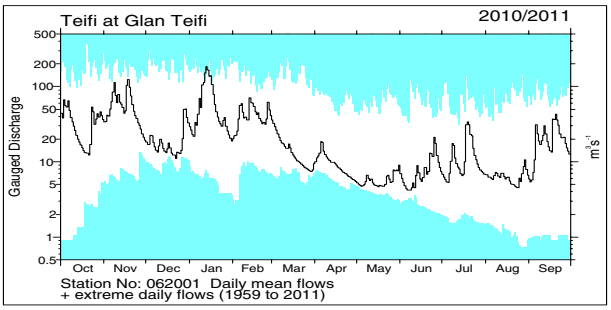
River flow . . . River flow . . .

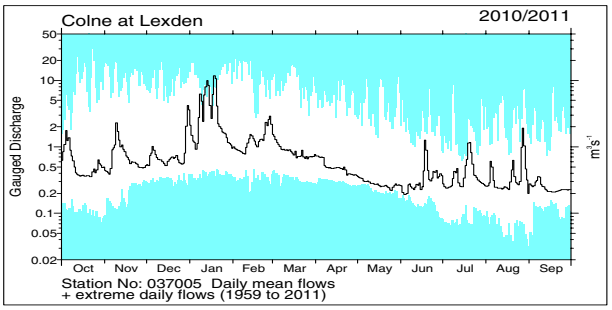


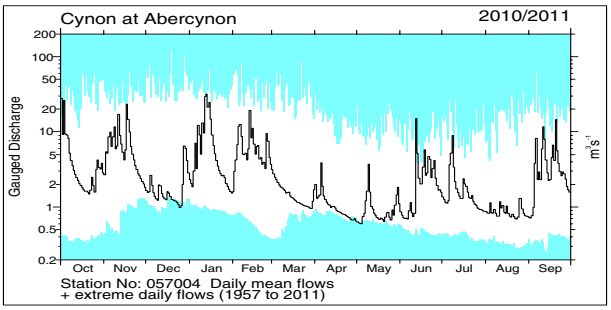


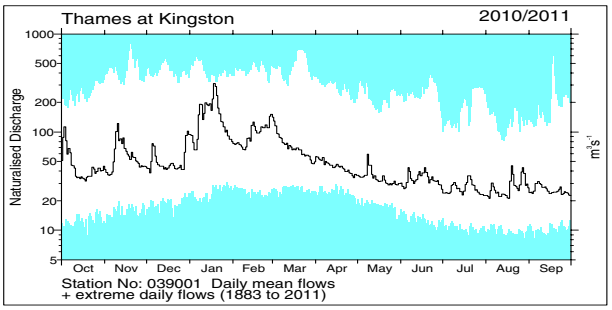


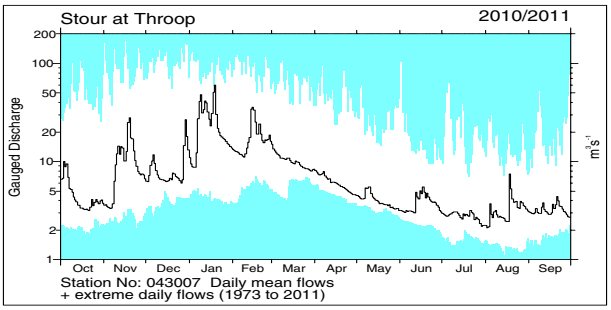


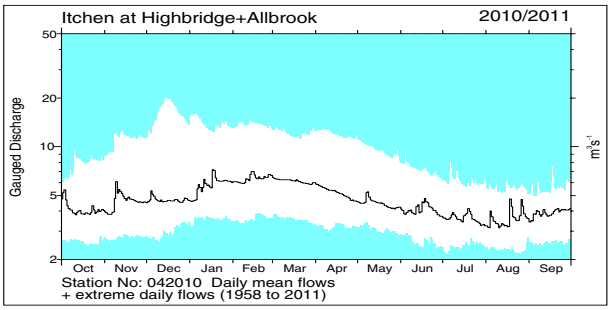












Notable runoff accumulations (a) Jun - Sep 2011 (b) Mar - Sep 2011

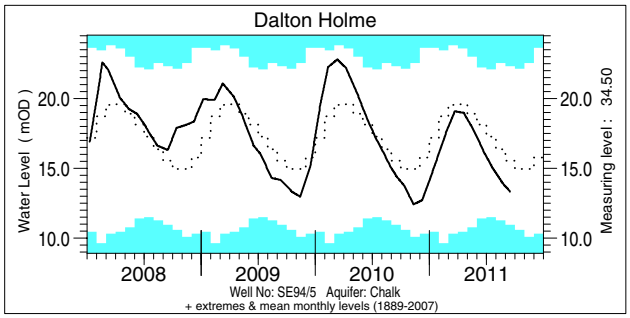
	River	%lta	Rank
a)	Ness	185	39/39
	Dee (Woodend)	175	80/82
	Tay	186	58/59
	Little Ouse	51	3/41
	Coln	52	2/48
	Avon (Amesbury)	56	3/47
	Naver	154	32/34

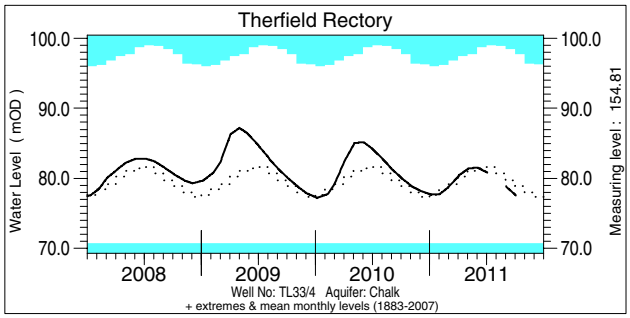
	River	%lta	Rank
b)	Earn	148	62/64
	Trent	55	3/53
	Dove	50	3/50
	Soar	43	2/40
	Mole	57	1/37
	Medway	40	2/51
	Stour	54	3/39
	Otter	59	2/49
	Warleggan	56	2/42

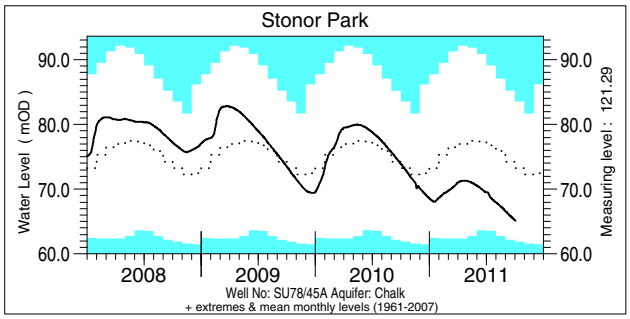
River	%lta	Rank
Kenwyn	53	1/43
Tone	44	1/51
Brue	40	1/46
Severn	44	1/90
Teme	38	1/41
Leven	156	47/47
Lagan	46	3/39
Annacloy	36	1/32

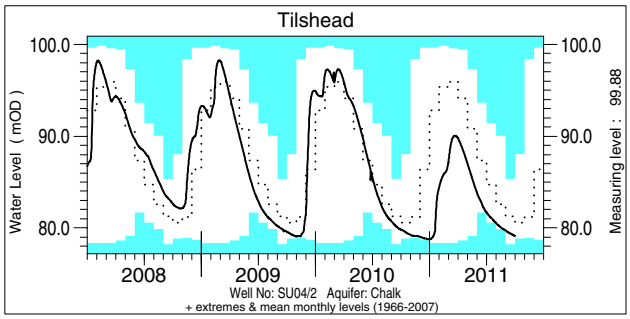
lta = long term average
Rank 1 = lowest on record

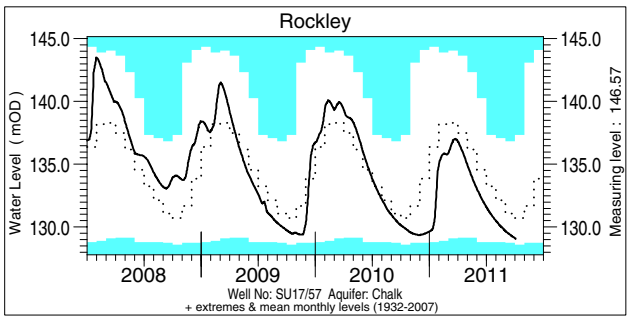
Groundwater . . . Groundwater

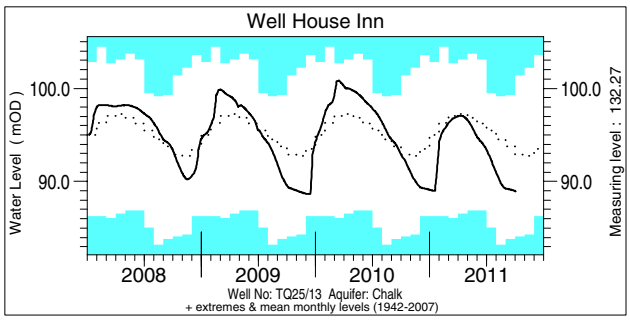


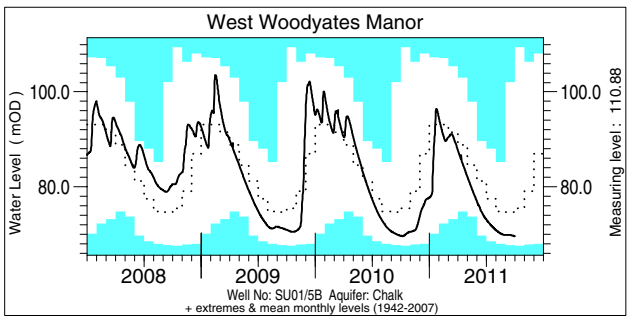


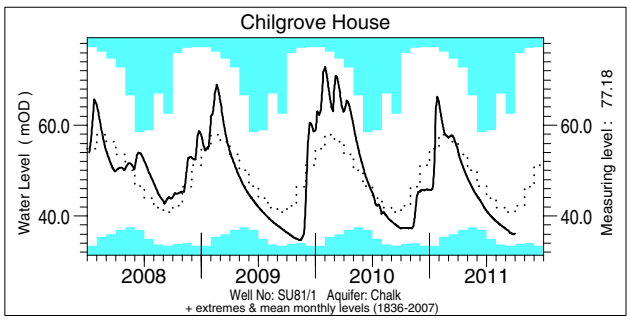


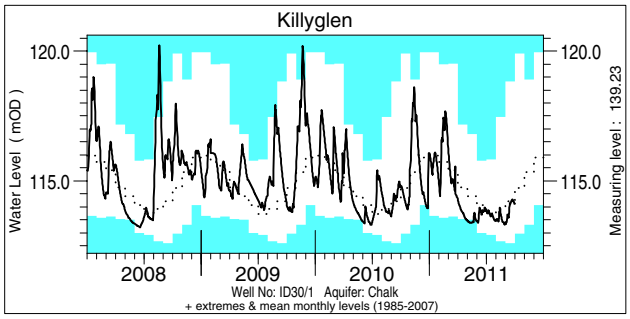


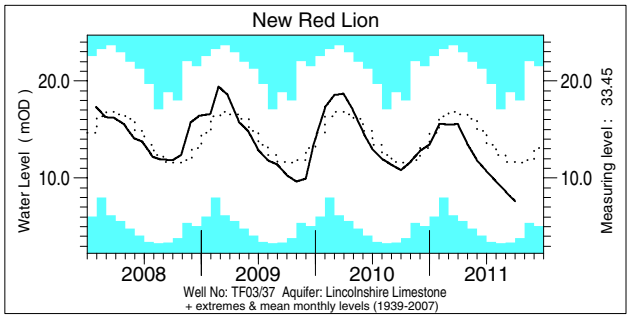






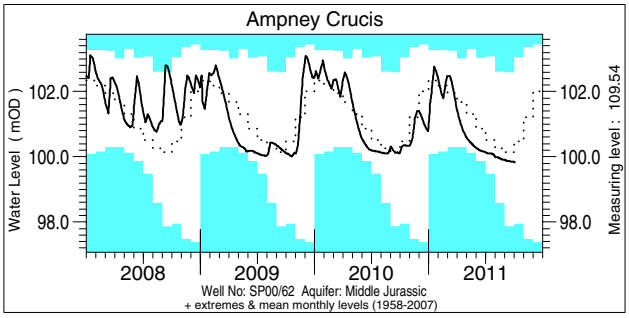


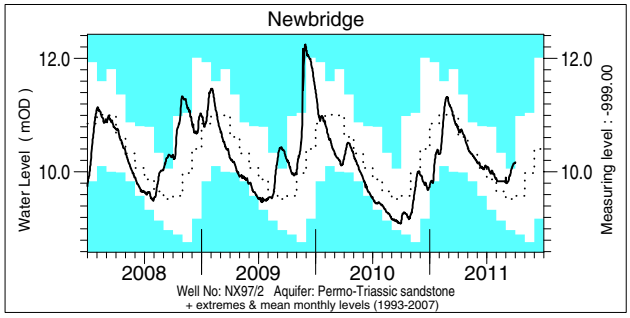


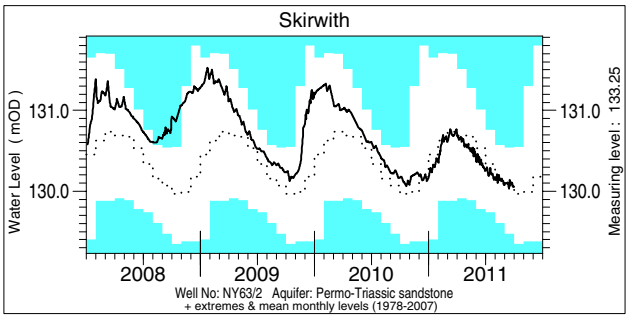


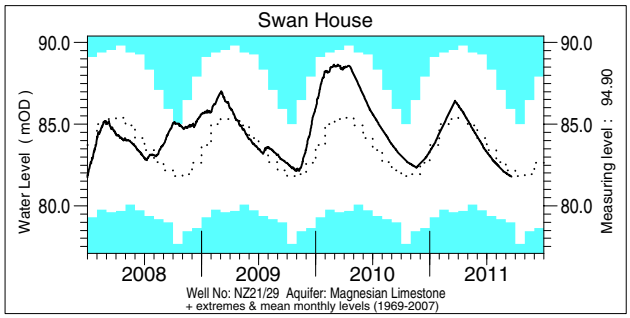
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

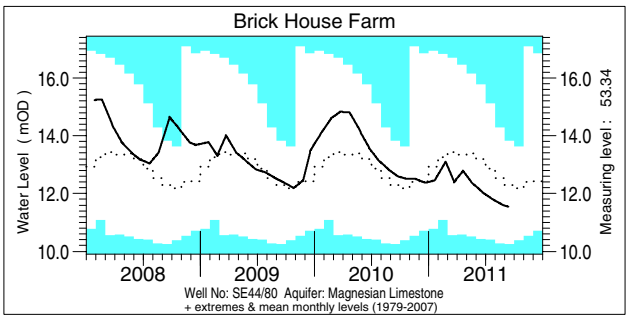
Groundwater . . . Groundwater

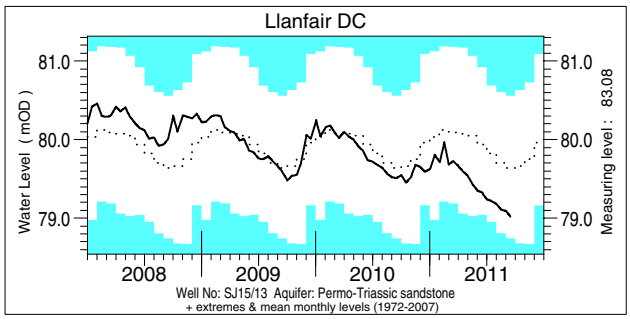


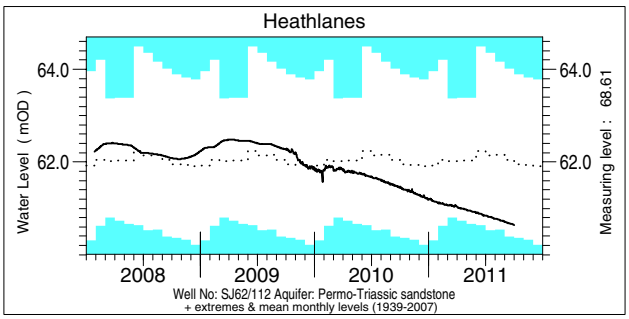


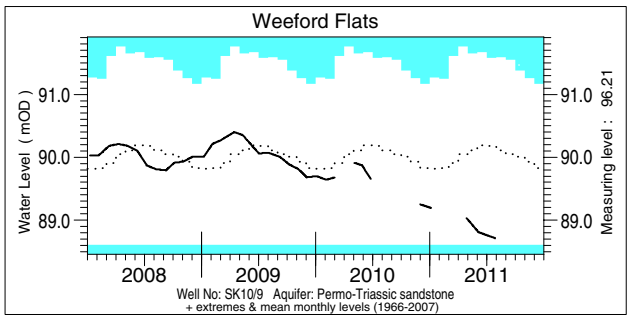


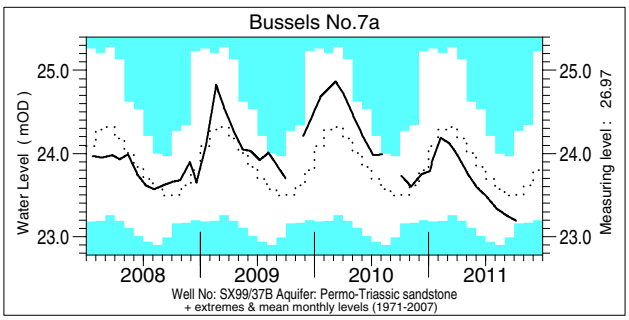


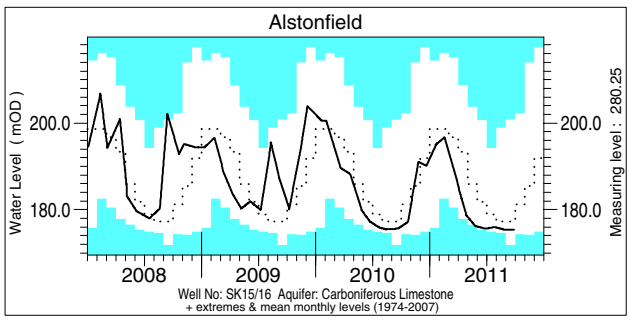








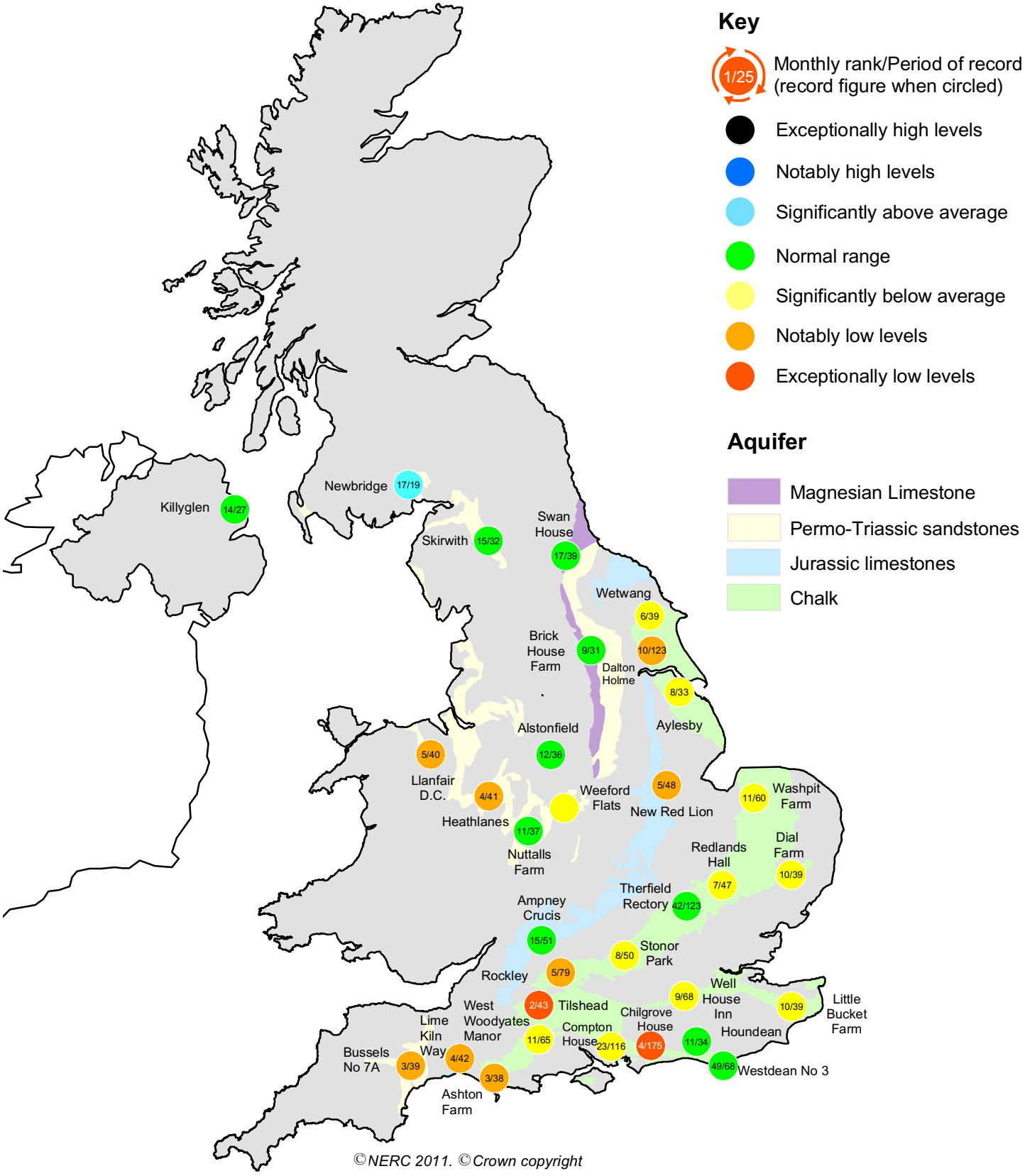




Groundwater levels September / October 2011

Borehole	Level	Date	Sep av.	Borehole	Level	Date	Sep av.	Borehole	Level	Date	Sep av.
Dalton Holme	13.34	15/09	15.45	Chilgrove House	36.03	30/09	40.73	Brick House Farm	11.54	13/09	12.36
Therfield Rectory	77.52	03/10	79.99	Killyglen (NI)	114.11	30/09	114.42	Llanfair DC	79.02	15/09	79.57
Stonor Park	65.09	03/10	74.52	New Red Lion	7.62	30/09	11.69	Heathlanes	60.64	30/09	62.00
Tilshead	79.15	30/09	81.20	Ampney Crucis	99.83	03/10	100.14	Weeford Flats	88.71	28/07	89.78
Rockley	129.07	03/10	131.08	Newbridge	10.16	01/10	9.58	Bussels No.7a	23.19	07/10	23.52
Well House Inn	88.95	02/10	93.95	Skirwith	130.05	30/09	130.11	Alstonfield	175.45	26/09	178.59
West Woodyates	69.59	30/09	73.10	Swan House	81.77	19/09	82.18	*Levels in metres above Ordnance Datum*			

Groundwater . . .Groundwater



Groundwater levels - September 2011

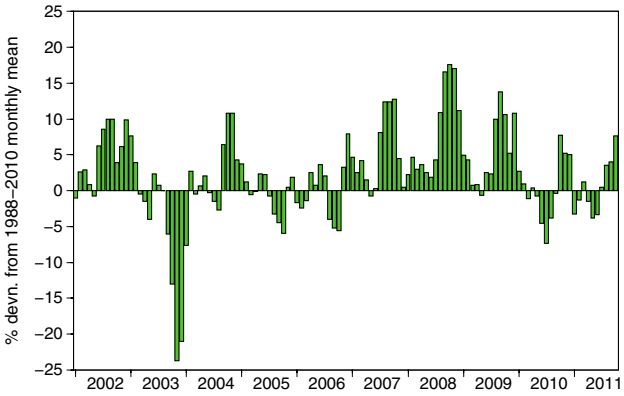
The rankings are based on a comparison between the average level in the featured month (but often only single readings are available) and the average level in each corresponding month on record. They need to be interpreted with caution especially when groundwater levels are changing rapidly or when comparing wells with very different periods of record. Rankings may be omitted where they are considered misleading.

Notes: i. The outcrop areas are coloured according to British Geological Survey conventions.

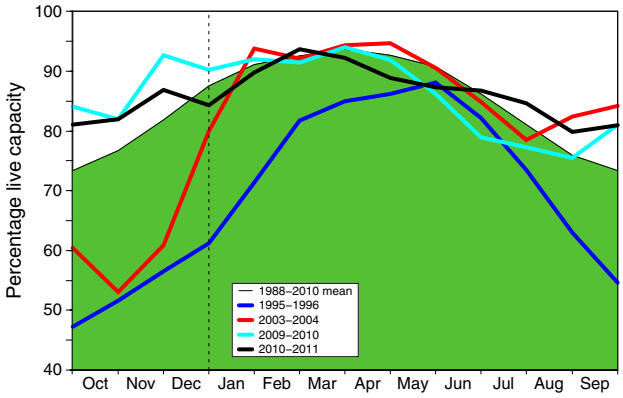
ii. Yew Tree Farm levels are now received quarterly.

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)	2011 Aug	Sep	Oct	Oct Anom.	Min Oct	Year* of min	2010 Oct	Diff 11-10
North West	N Command Zone	•	124929	75	66	**78**	21	13	1995	69	9
	Vyrnwy		55146	85	77	**86**	17	26	1995	81	5
Northumbrian	Teesdale	•	87936	94	91	**93**	27	31	1995	80	13
	Kielder		(199175)	(94)	(93)	**(91)**	7	59	1989	89	2
Severn Trent	Clywedog		44922	98	80	**87**	16	24	1989	90	-3
	Derwent Valley	•	39525	62	56	**53**	-11	24	1989	63	-10
Yorkshire	Washburn	•	22035	67	69	**71**	5	24	1995	81	-10
	Bradford supply	•	41407	68	73	**76**	10	15	1995	72	4
Anglian	Grafham		(55490)	(93)	(90)	**(89)**	6	46	1997	92	-3
	Rutland		(116580)	(76)	(73)	**(70)**	-8	61	1995	75	-5
Thames	London	•	202828	89	86	**80**	4	53	1997	87	-7
	Farmoor	•	13822	99	98	**93**	3	54	2003	97	-4
Southern	Bewl		28170	63	57	**50**	-13	32	1990	55	-5
	Ardingly		4685	75	61	**48**	-18	32	2003	71	-23
Wessex	Clatworthy		5364	63	49	**37**	-20	25	2003	39	-2
	Bristol WW	•	(38666)	(67)	(62)	**(57)**	-5	31	1990	54	3
South West	Colliford		28540	60	50	**48**	-21	38	2006	74	-26
	Roadford		34500	55	53	**54**	-17	26	1995	68	-14
	Wimbleball		21320	55	47	**44**	-21	30	1995	52	-8
	Stithians		4967	62	51	**44**	-11	22	1990	52	-8
Welsh	Celyn and Brenig	•	131155	95	94	**96**	16	39	1989	91	5
	Brianne		62140	98	94	**98**	13	48	1995	95	3
	Big Five	•	69762	87	76	**85**	18	19	1995	91	-6
	Elan Valley	•	99106	94	83	**90**	14	34	1995	81	9
Scotland(E)	Edinburgh/Mid Lothian	•	97639	92	91	**97**	20	43	1998	77	20
	East Lothian	•	10206	100	100	**100**	21	52	1989	69	31
Scotland(W)	Loch Katrine	•	111363	89	92	**96**	23	43	1995	63	33
	Daer		22412	99	99	**99**	23	32	1995	88	11
	Loch Thom	•	11840	96	96	**95**	15	56	1995	79	16
Northern Ireland	Total+	•	56920	77	72	**78**	4	29	1995	91	-13
	Silent Valley	•	20634	72	66	**73**	6	27	1995	93	-20

() 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 1988-2010 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.

Location map . . . Location map

National Hydrological Monitoring Programme

The National Hydrological Monitoring Programme (NHMP)[#] is undertaken jointly by the Centre for Ecology & Hydrology (CEH) and the British Geological Survey (BGS). Financial support for the production of the monthly Hydrological Summaries is provided by the Department for Environment, Food and Rural Affairs (Defra), the Environment Agency (EA), the Scottish Environment Protection Agency (SEPA), the Rivers Agency (RA) in Northern Ireland, and the Office of Water Services (OFWAT).

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.

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.

Rainfall

Most rainfall data are provided by the Met Office (see opposite). To allow better spatial differentiation the rainfall data for Britain are presented for the regional divisions of the precursor organisations of the EA and SEPA. Following the discontinuation of the Met Office's CARP system in July 1998, the areal rainfall figures have been derived using several procedures, including initial estimates based on MORECS[*]. Recent figures have been produced by the Met Office, National Climate Information Centre (NCIC), using a technique similar to CARP. A significant number of additional monthly raingauge totals are provided by the EA and SEPA to help derive the contemporary regional rainfalls. Revised monthly national and regional rainfall totals for the post-1960 period were made available by the Met Office in 2004; these have been adopted by the NHMP. As with all regional figures based on limited raingauge networks the monthly tables and accumulations (and the return periods associated with them) should be regarded as a guide only.
The monthly rainfall figures are provided by the Met Office (National Climate Information Centre) and are Crown Copyright and may not be passed on to, or published by, any unauthorised person or organisation.

[#] Instigated in 1988
[*]MORECS is the generic name for the Met Office services involving the routine calculation of evaporation and soil moisture throughout Great Britain.

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

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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.

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