Hydrological Summary

for the United Kingdom

May 2011

General

Remarkable rainfall patterns in May produced a decrease in the spatial extent of drought conditions but an increase in their intensity in the most severely impacted regions. Provisionally, Scotland registered its wettest May on record whilst the May rainfall contributed to England's equal driest spring in a series from 1910 (shared with 1990); it was also the warmest spring on record. As a result, late May soils were the driest on record across large parts of eastern and central England – causing substantial agricultural stress (impacting on crop yields) and an increased risk of forest and heathland fires. Currently, the most evident hydrological impact of the drought is on river flows across much of southern Britain – flows in responsive rivers were close to, or below, previous late-May minima over wide areas. This implies a major contraction in the stream network and a substantial (albeit temporary) loss of aquatic habitat – a problem also arising as ponds and wetlands dry out. Most reservoir stocks throughout northern Scotland and Northern Ireland are healthy and, for England & Wales as whole, stocks are within 4% of the early June average. Despite the rainfall deficiency, stocks remain within about 10% of capacity in a number of major pumped-storage impoundments in the English Lowlands (e.g. the London Group and Farmoor). Elsewhere, many gravity-fed reservoir stocks have fallen to, typically, 10-20% below the early summer average with the greatest deficiencies in the South West, Wales and the Midlands. The very moderate infiltration since the winter has left groundwater levels below, to well below, average across most major aquifers. Above average summer rainfall would ameliorate the drought's impact but with soils still exceptionally dry in much of southern Britain drought stress will continue with an expected substantial delay in seasonal recovery in runoff and recharge rates and, correspondingly, notably low autumn flows.

Rainfall

Following a dry start to May, a sequence of vigorous Atlantic frontal systems brought plentiful rain (and high winds) to northern regions of the UK but the blocking high – which has brought drought conditions to much of Europe – prevented most rain-bearing depressions reaching central and eastern England. As a consequence, the normal north-west/south-east rainfall gradient across the UK was heavily accentuated. A substantial proportion of eastern England registered <20% of the average May rainfall with totals falling to 4mm in parts of Kent – a dramatic contrast to north-west Scotland where some localities (e.g. Cluanie Inn) reported totals two orders of magnitude greater. Across much of the English Lowlands, the May rainfall was generally greater than that for March and April combined but, nonetheless, spring rainfall totals were only around 50% of the England & Wales average. England eclipsed its previous lowest spring rainfall total, reflecting extreme deficiencies in some eastern areas. The Anglian region registered its lowest 3-month rainfall total (for any start month) in a series from 1910 and, remarkably, the spring rainfall for Cambridge represented only around half of the previous minimum in a record from 1848. Intense spring drought conditions also characterise parts of Yorkshire, the east Midlands and Sussex/Kent (see page 3). Within the driest zones a preponderance of showery conditions over the last three months implies a significant local variation in drought intensity. The very arid spring extends a rainfall deficiency that can be traced back to December 2009. Over the full span the lowest rainfall accumulations are in a broad zone from the Midlands to south west Britain; the South West, Wessex and Midland regions each reported their lowest 18-month totals since the 1975/76 drought (see page 3).

River flows

Estimated outflows from the country as a whole for early May were the lowest in the 50-year national series but, from the second week, regional contrasts in the intensity of the hydrological drought became increasingly marked. Across most of northern Britain river flows recovered rapidly – heralding flood alerts in many rivers draining from the Scottish Highlands. The Nevis and Carron were among a number of rivers reporting new early-May minimum flows and, subsequently, new maximum May flows. In stark contrast, flows continued to decline in most rivers across southern Britain with recessions tracking previous drought minima in many rivers draining impermeable catchments. Flows matching, or eclipsing, previous end-of-May minimum flows showed a wide distribution, from the Trent basin to Cornwall (and embracing many responsive rivers in the English Lowlands). May runoff totals were exceptionally depressed throughout the South West where the Warleggan, Exe and Brue were among those rivers establishing new May runoff minima. In the English Lowlands, natural groundwater contributions sustained flows appreciably above drought minima but in vulnerable streams flow augmentation schemes (involving groundwater pumping or water transfers across catchment divides) have been activated to boost low flows. For England & Wales estimated runoff through the spring (March-May) of 2011 was only around 50% of average; only in 1976 has a lower spring runoff been recorded.

Groundwater

May rainfall totals of 10-60% of average across most major aquifer areas were insufficient to moderate the rapid increase in soil moisture deficits since the early spring. In a significant proportion of England, end-of-May smds exceeded the previous highest on record. Correspondingly, there was minimal recharge to almost all aquifer outcrop areas and groundwater level recessions continued. These began from fairly typical late-winter maxima but the spring recessions have been unusually steep, and the declines through May left levels (in major aquifers) well below average across almost the entire country. The paucity of recent recharge is most evident in the more responsive aquifers: in the Carboniferous Limestone (Alstonfield) the May level fell below previous minima and levels are also notably depressed in the Middle Jurassic (Cotswolds) and the western Chalk outcrops (including Killyglen in Northern Ireland). Levels in some eastern index wells and boreholes remain within the normal range but, with smds equivalent to around 12-15 weeks of average rainfall, continuing falls in level are to be expected through into the late autumn – when levels in some aquifer units are likely to be close to natural base levels. Groundwater resources assume an enhanced importance during drought episodes (demonstrated, for example, by the relative health of spring-fed stream and rivers) but a much delayed seasonal onset of recharge would, in the event of low rainfall next winter, raise concerns about the water resources outlook for 2012.

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.

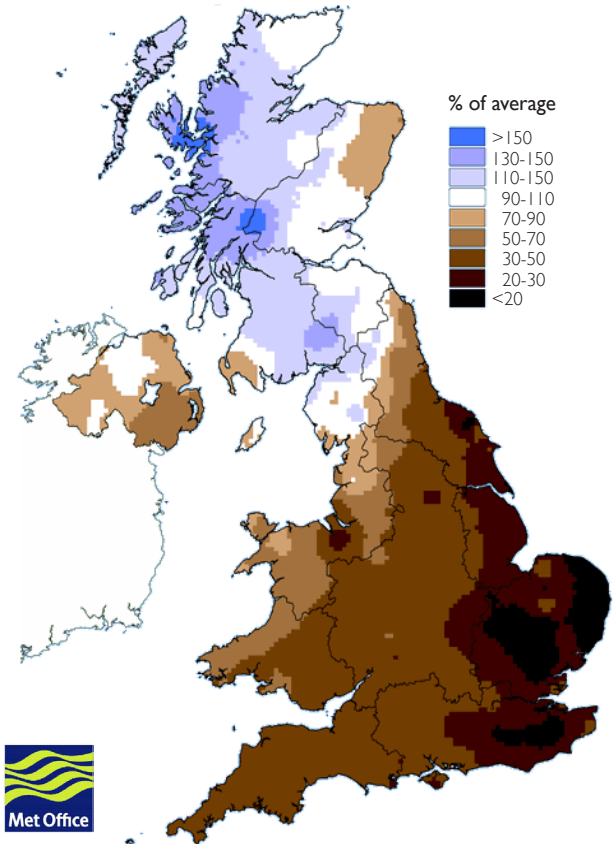
Area	Rainfall	May 2011	Mar11 - May11	RP	Dec10 - May11	RP	Jun10 - May11	RP	Dec 09 - May11	RP
United Kingdom	mm	**100**	186		447		1029		1451	
	%	**159**	84	2-5	82	5-10	95	2-5	89	5-10
England	mm	**47**	78		268		706		1054	
	%	**87**	45	>100	66	30-40	86	5-10	86	10-15
Scotland	mm	**190**	372		733		1511		2029	
	%	**260**	131	15-20	100	<2	105	2-5	94	2-5
Wales	mm	**88**	149		477		1195		1706	
	%	**115**	55	35-50	68	15-25	87	5-10	82	15-25
Northern Ireland	mm	**105**	195		458		1078		1513	
	%	**155**	84	2-5	82	5-10	97	2-5	91	5-10
England & Wales	mm	**53**	88		297		773		1143	
	%	**92**	47	>100	67	25-40	86	5-10	85	12-16
North West	mm	**109**	195		510		1192		1572	
	%	**164**	84	2-5	89	2-5	101	2-5	90	5-10
Northumbria	mm	**73**	135		356		886		1279	
	%	**126**	72	2-5	86	2-5	107	2-5	103	2-5
Midlands	mm	**55**	75		224		615		903	
	%	**102**	44	>100	60	40-60	81	8-12	80	25-35
Yorkshire	mm	**53**	74		269		725		1059	
	%	**96**	41	>100	66	25-35	89	5-10	87	8-12
Anglian	mm	**21**	31		155		511		790	
	%	**45**	23	>100	55	>100	85	5-10	89	5-10
Thames	mm	**34**	50		213		542		879	
	%	**64**	31	>100	61	20-35	77	10-15	84	8-12
Southern	mm	**21**	43		258		644		1070	
	%	**41**	27	>100	67	10-20	82	5-10	92	2-5
Wessex	mm	**44**	73		273		657		1027	
	%	**79**	40	>100	62	20-30	76	15-25	78	20-35
South West	mm	**40**	87		353		933		1431	
	%	**58**	37	>100	56	40-60	77	10-20	78	30-50
Welsh	mm	**84**	141		448		1141		1640	
	%	**113**	54	50-80	67	20-30	86	5-10	82	20-30
Highland	mm	**252**	486		895		1722		2274	
	%	**322**	146	30-40	102	2-5	100	<2	88	2-5
North East	mm	**91**	207		423		1087		1603	
	%	**144**	101	2-5	92	2-5	115	2-5	114	5-10
Tay	mm	**166**	321		643		1420		1884	
	%	**227**	124	5-10	97	2-5	112	5-10	97	2-5
Forth	mm	**123**	267		585		1258		1697	
	%	**185**	115	5-10	102	2-5	111	5-10	100	<2
Tweed	mm	**107**	209		487		1062		1525	
	%	**163**	101	2-5	101	2-5	111	2-5	106	2-5
Solway	mm	**166**	322		730		1519		2057	
	%	**220**	116	5-10	103	2-5	108	2-5	97	2-5
Clyde	mm	**235**	455		899		1821		2359	
	%	**297**	138	15-25	103	2-5	105	2-5	91	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 December 2010 are provisional.

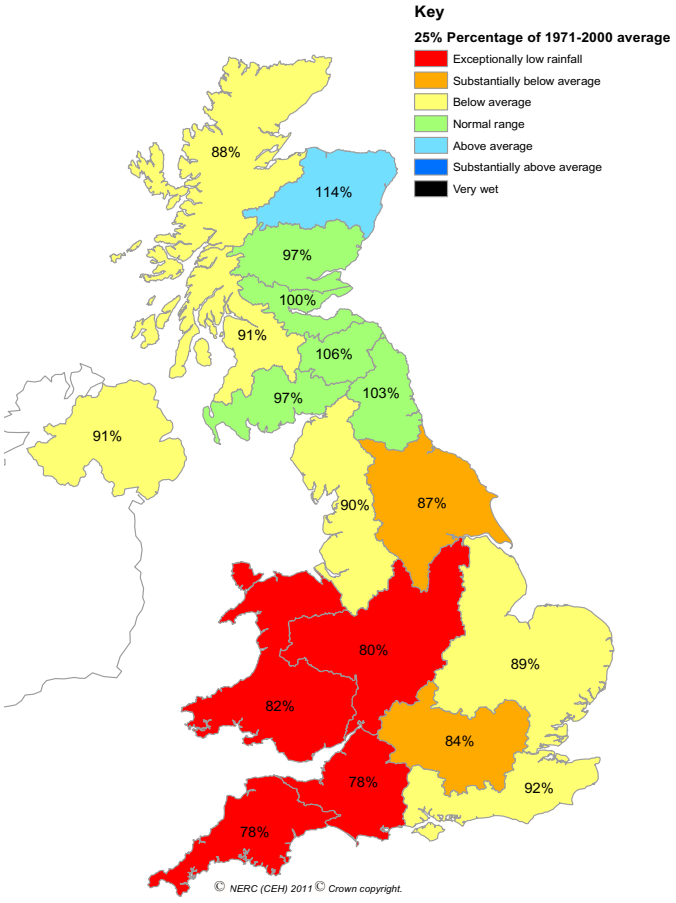
Rainfall . . . Rainfall . . .

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

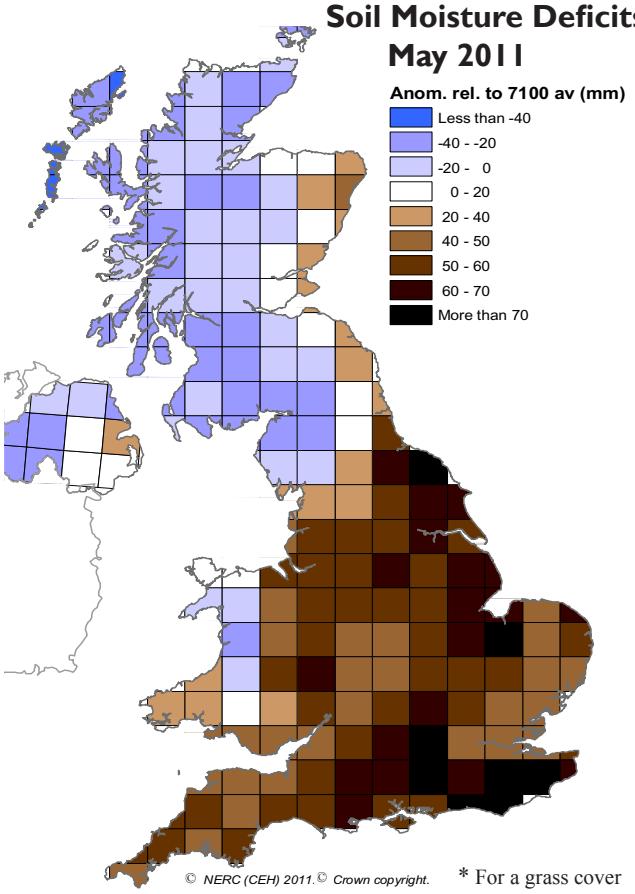


Source: Met Office National Climate Information Centre

December 2009 - May 2011



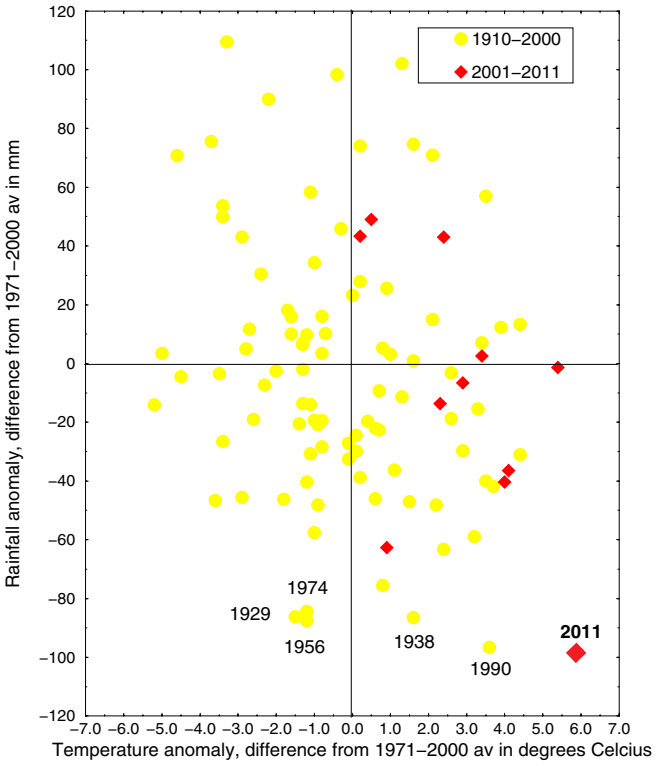
Soil Moisture Deficits May 2011



* For a grass cover

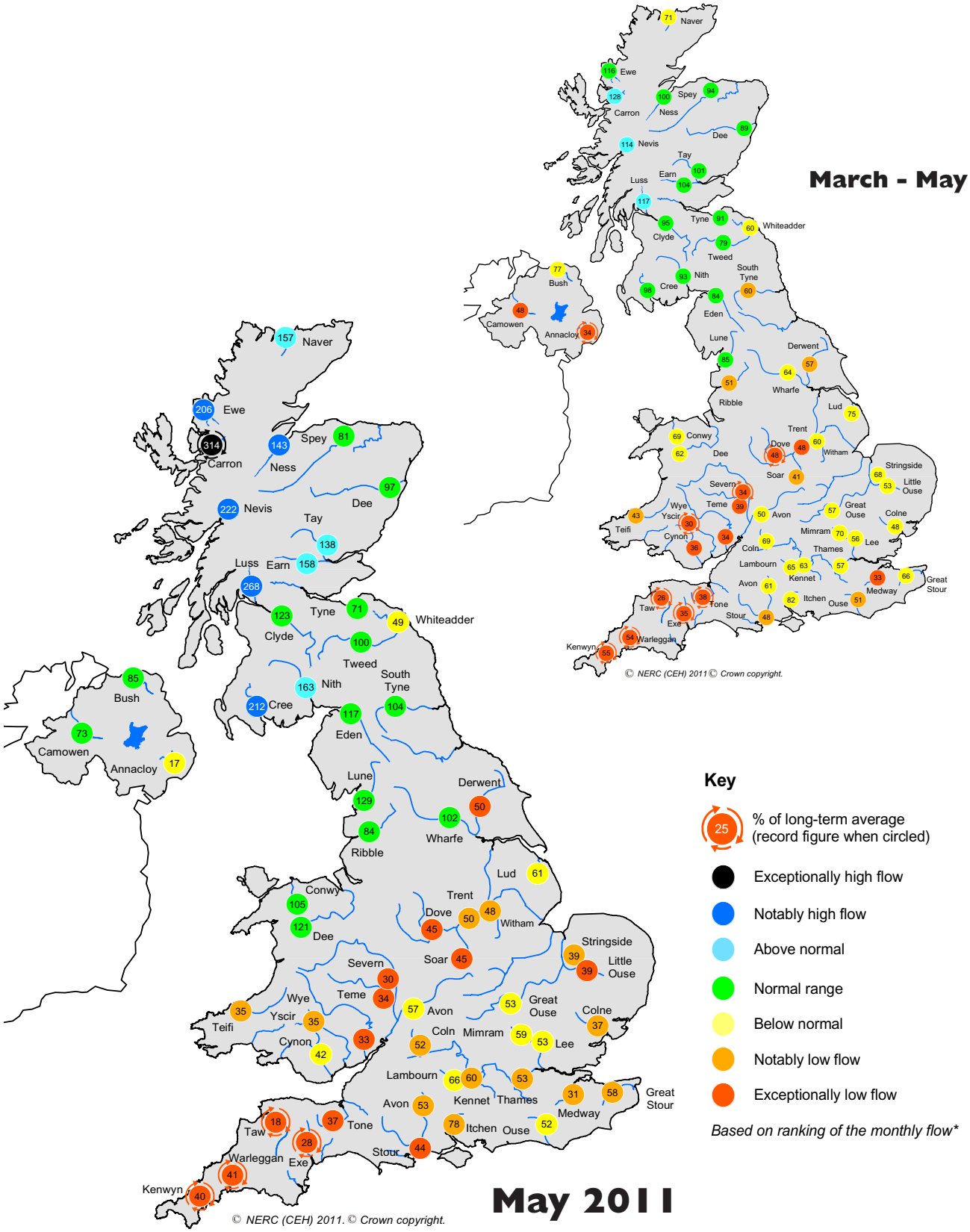
England (Spring) March - May 2011

Mean temperature and rainfall anomalies (rel. to 71-00 av)



Data from Met Office: http://www.metoffice.gov.uk/climate/uk/datasets/

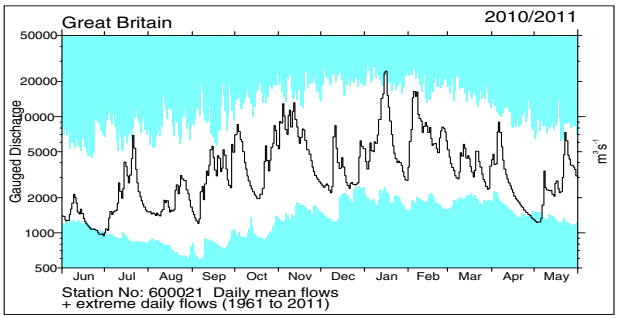
River flow . . . River flow . . .

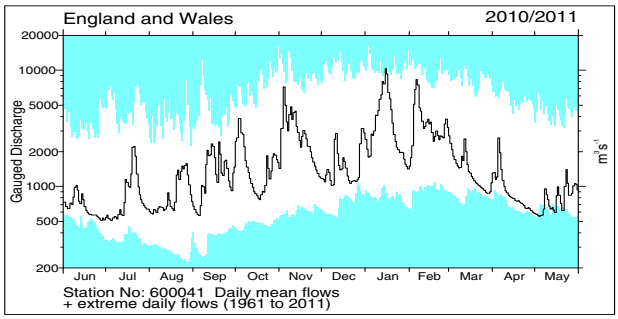


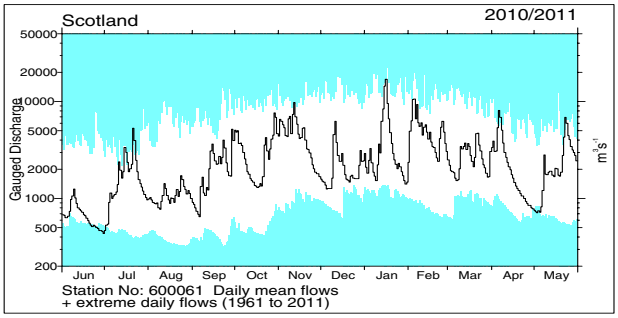
River flows

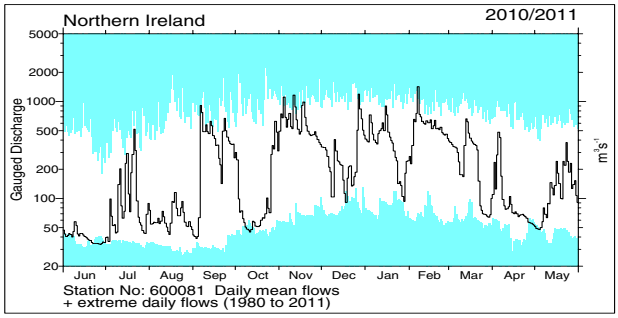
*Comparisons based on percentage flows alone can be misleading. A given percentage flow can represent extreme drought conditions in permeable catchments where flow patterns are relatively stable but be well within the normal range in impermeable catchments where the natural variation in flows is much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

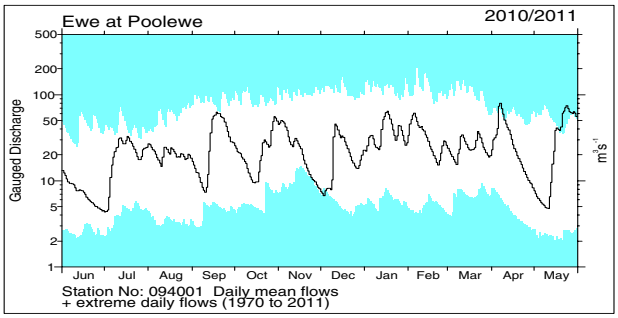
River flow . . . River flow . . .

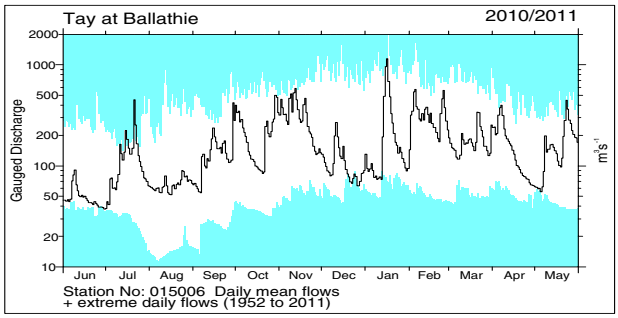


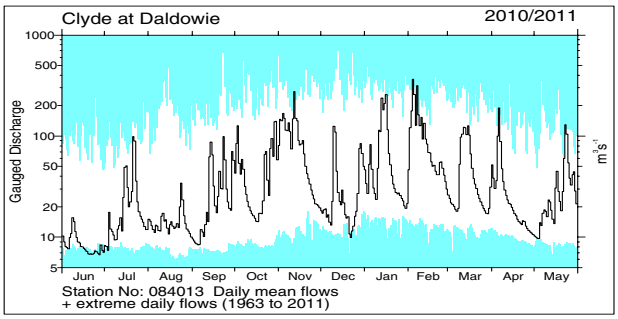


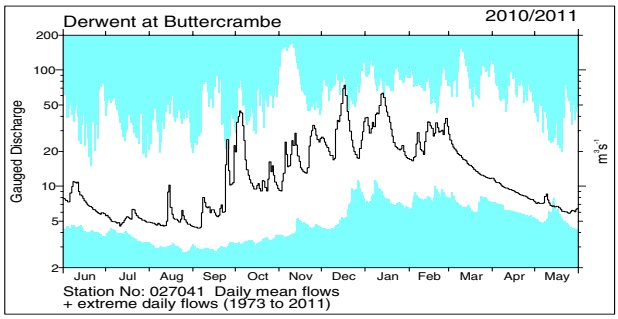


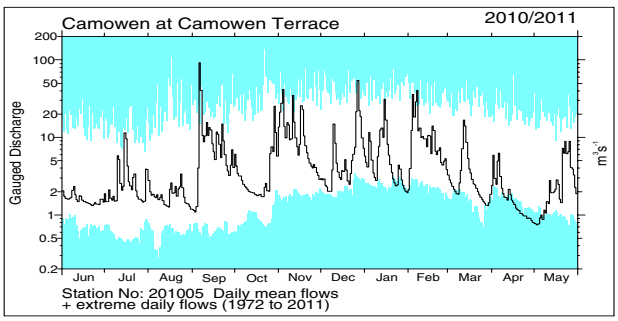


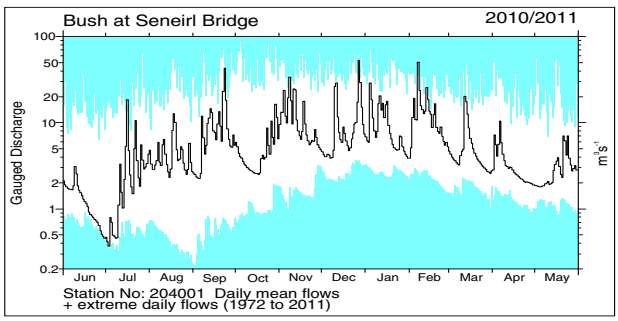








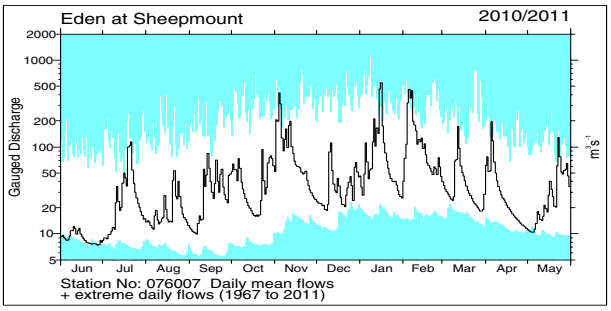


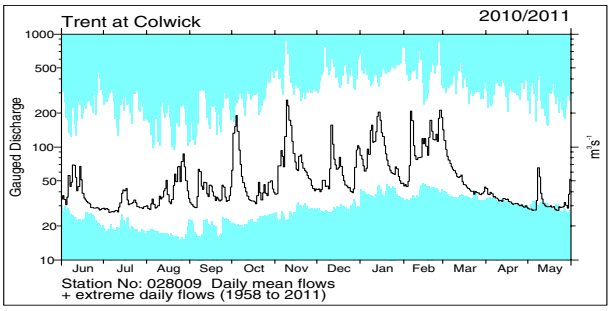


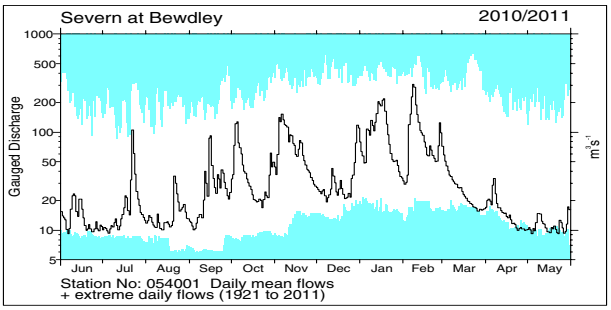
River flow hydrographs

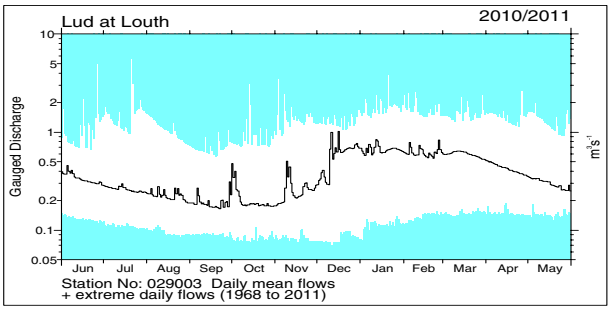
The river flow hydrographs show the daily mean flows together with the maximum and minimum daily flows prior to June 2010 (shown by the shaded areas). Daily flows falling outside the maximum/minimum range are indicated where the bold trace enters the shaded areas.

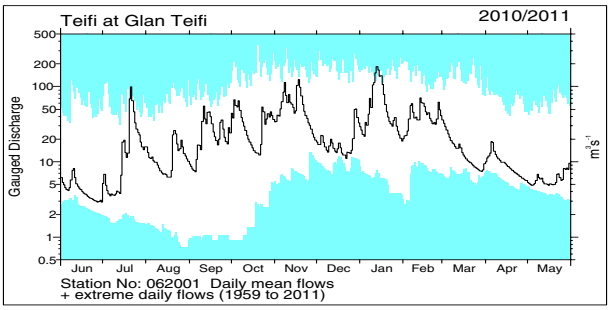
River flow . . . River flow . . .

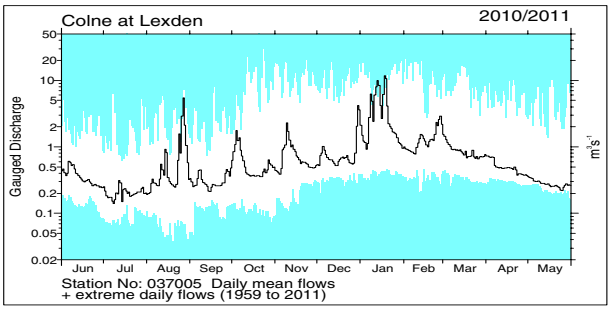


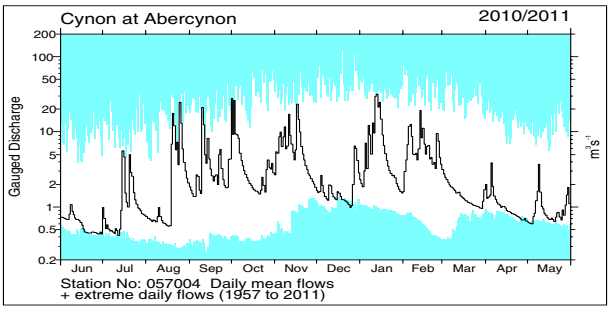


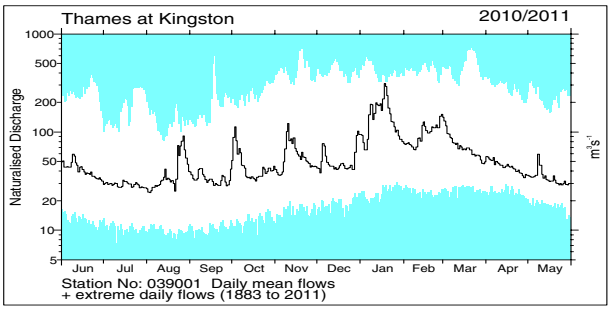


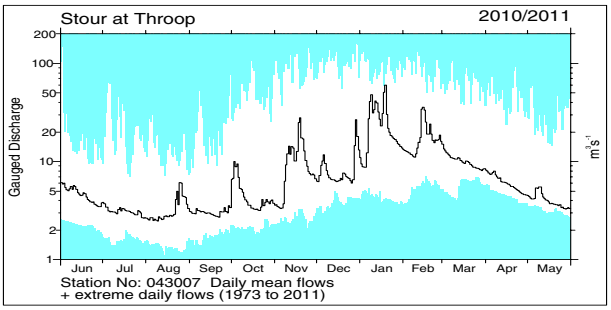


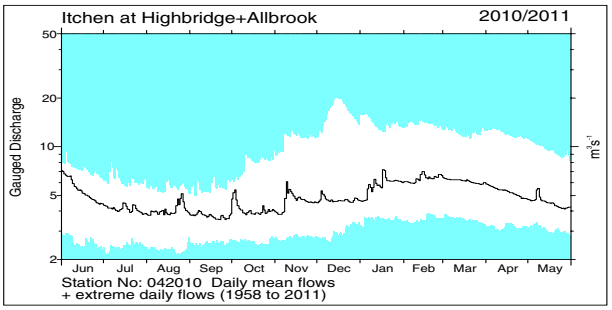












Notable runoff accumulations (a) Mar 2011 - May 2011 (b) Dec 2009 - May 2011

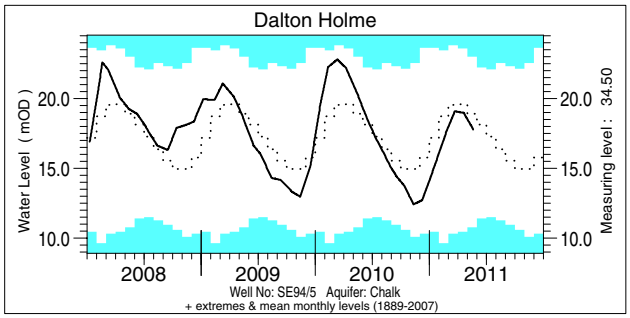
	River	%lta	Rank
a)	Trent	48	2/53
	Dove	48	1/50
	Mole	37	1/37
	Medway	33	2/51
	Exe	35	1/55
	Otter	51	1/49
	Dart	39	1/53
	Warleggan	54	1/42
	Kenwyn	55	1/43
	Taw	26	1/53
	Tone	38	1/51

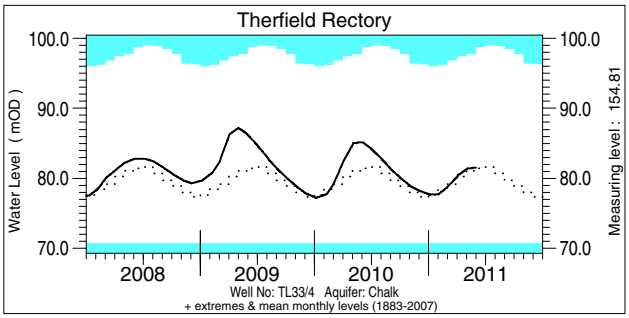
	River	%lta	Rank
a)	Brue	34	1/47
	Severn	34	1/90
	Teme	39	2/41
	Wye	34	2/75
	Yscir	30	1/39
	Cynon	36	2/53
	Tywi	41	2/53
	Camowen	48	2/39
	Annacloy	34	1/32

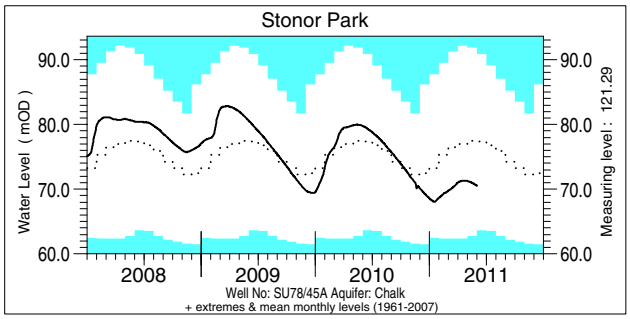
	River	%lta	Rank
b)	Tyne (Spilmersford)	149	44/44
	Whiteadder	141	41/41
	Taw	65	1/52
	Yscir	68	1/37
	Nevis	73	1/28
	Carron	69	1/31
	Ewe	76	2/40
	Camowen	80	2/36

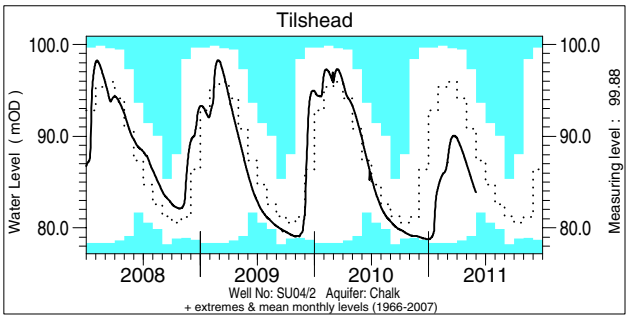
lta = long term average
Rank 1 = lowest on record

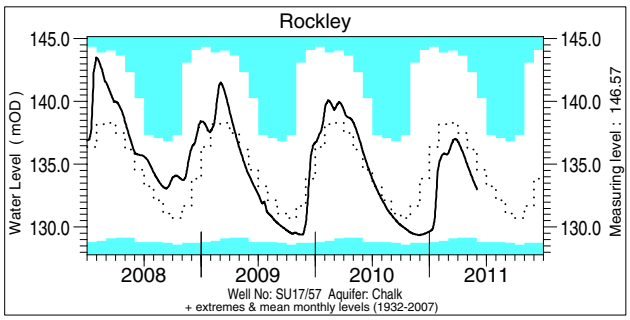
Groundwater . . . Groundwater

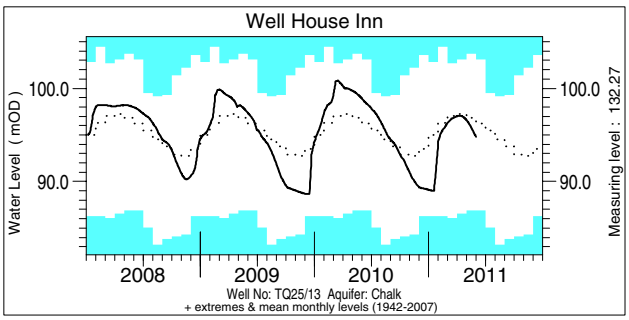


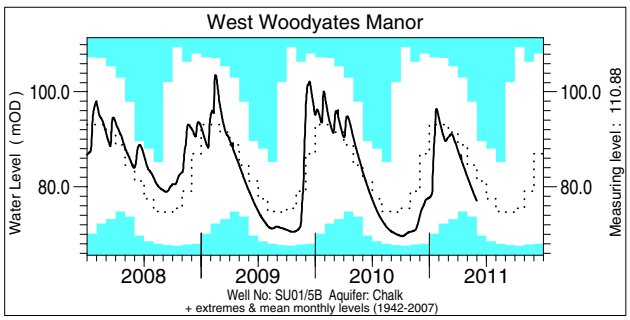


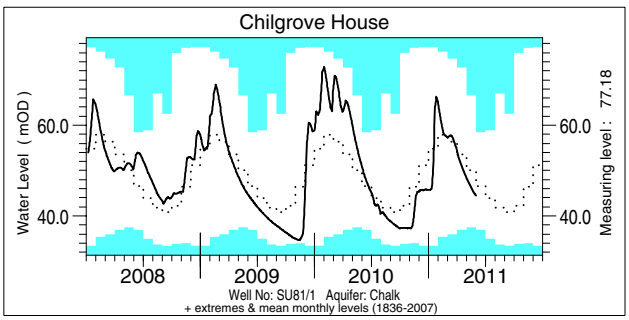


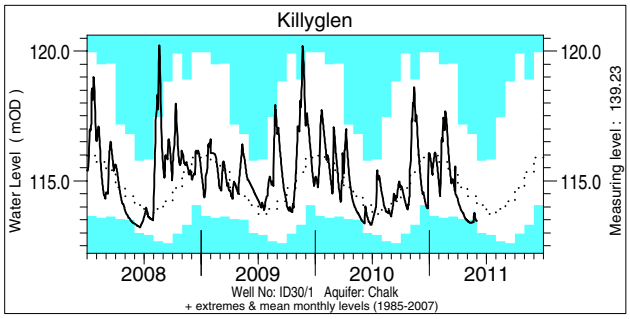


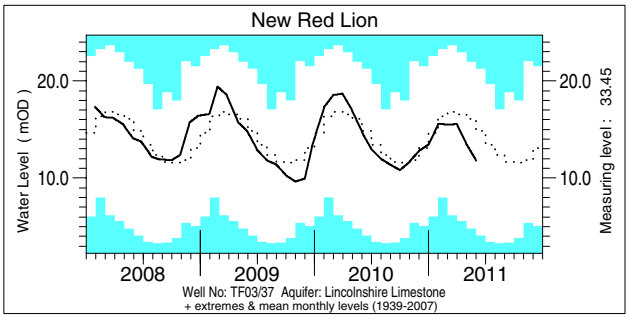






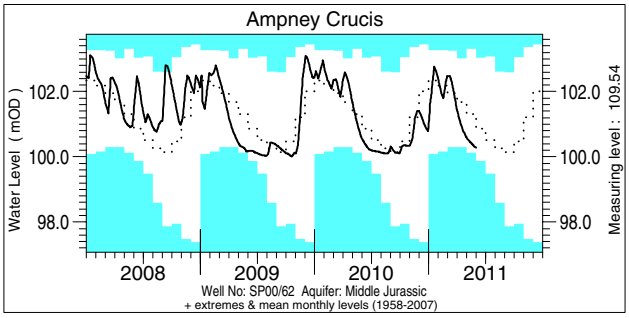


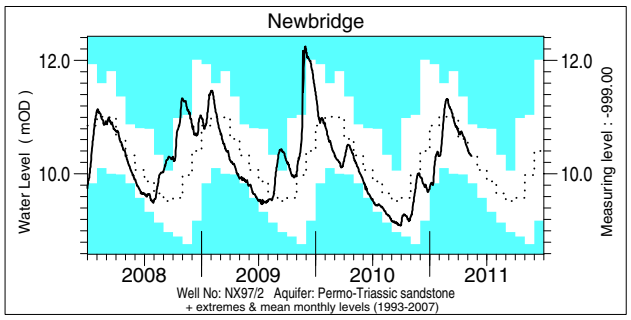


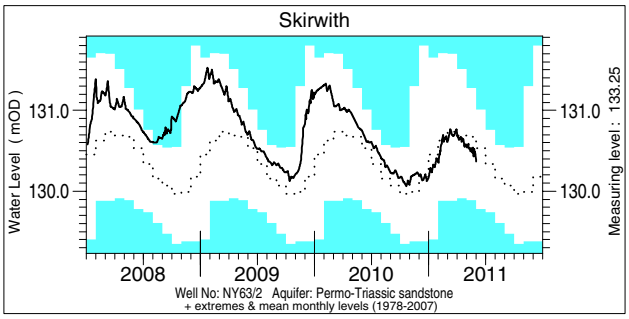


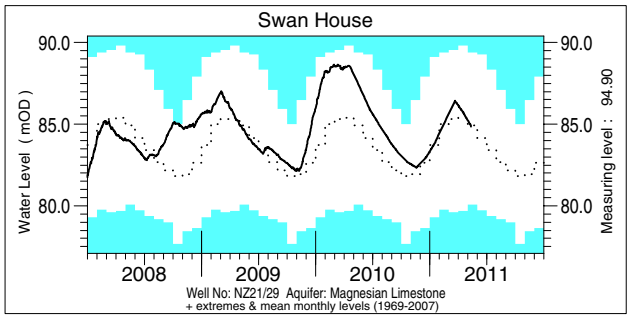
Groundwater levels normally rise and fall with the seasons, reaching a peak in the spring following replenishment through the winter (when evaporation losses are low and soil moist). They decline through the summer and early autumn. This seasonal variation is much reduced when the aquifer is confined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

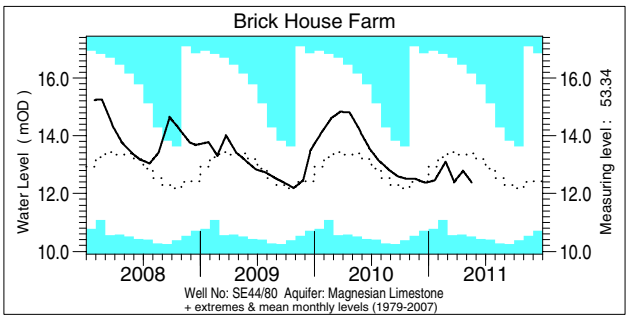
Groundwater . . . Groundwater

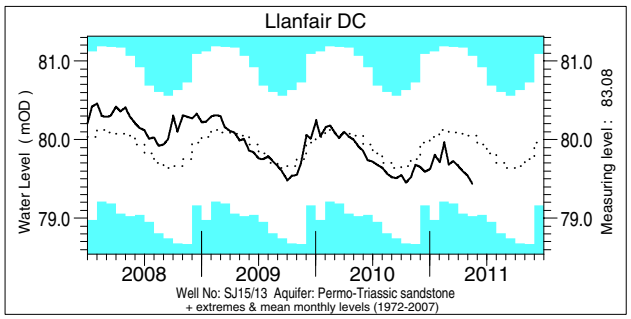


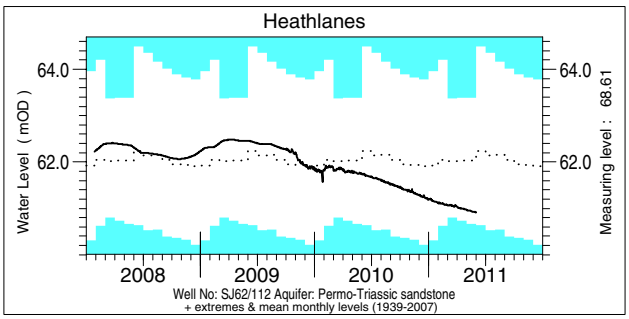


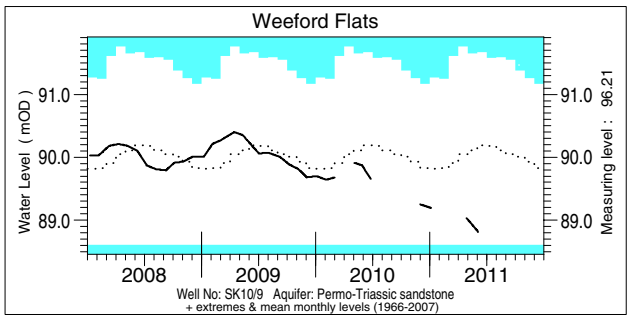


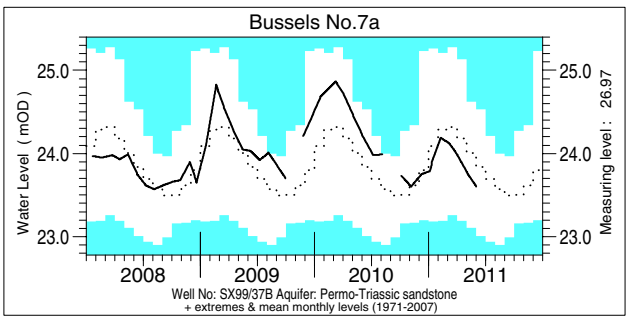


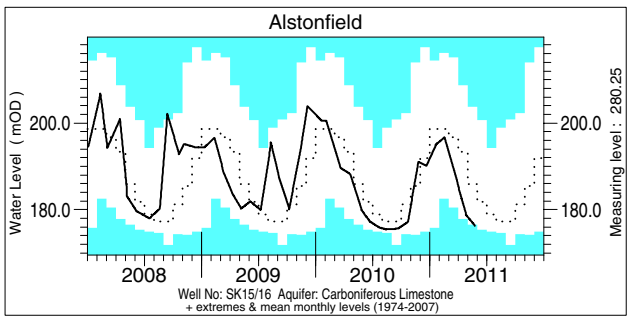








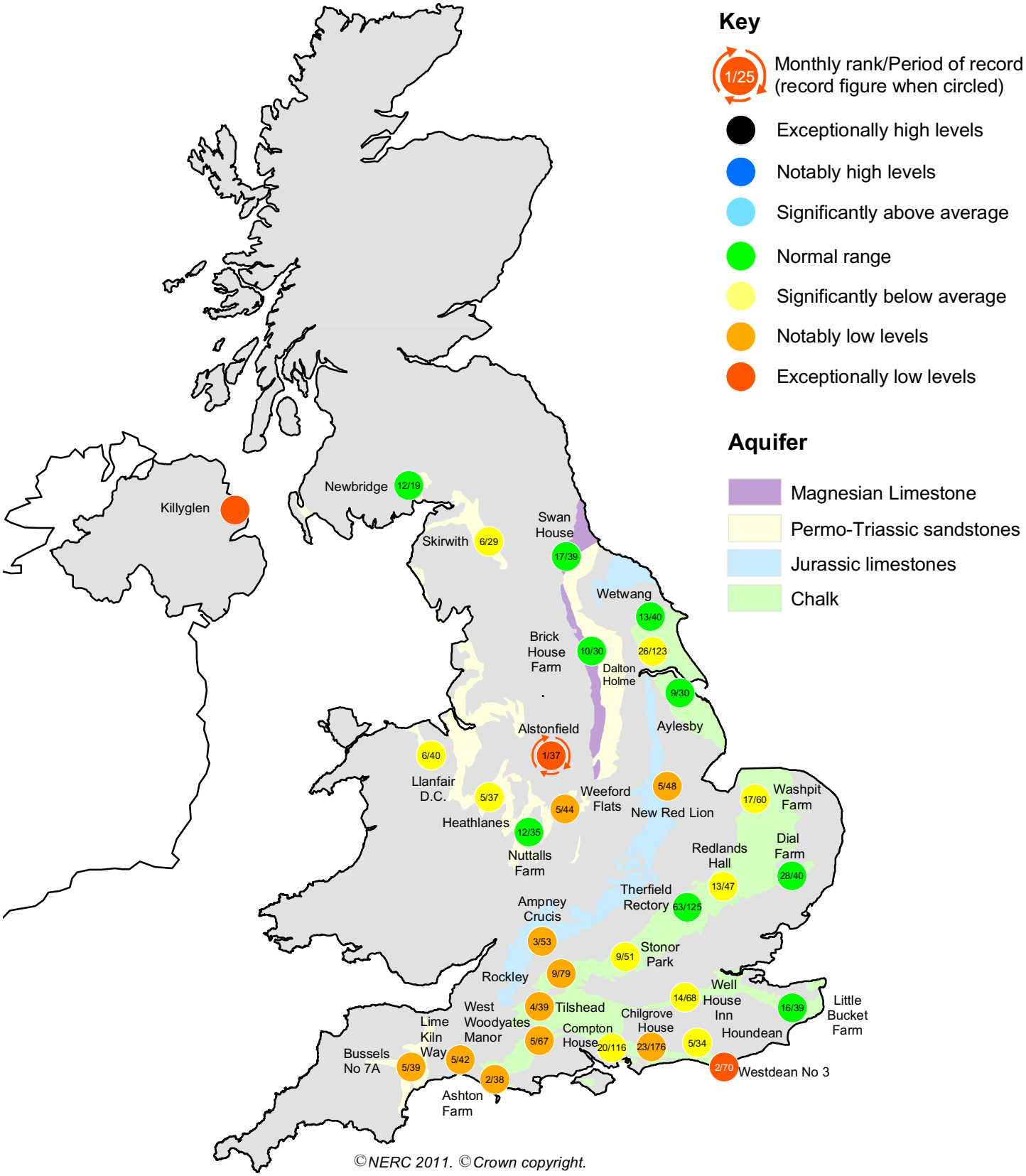




Groundwater levels May / June 2011

Borehole	Level	Date	May av.	Borehole	Level	Date	May av.	Borehole	Level	Date	May av.
Dalton Holme	17.76	20/05	18.96	Chilgrove House	44.42	01/06	48.98	Brick House Farm	12.38	17/05	13.32
Therfield Rectory	81.53	01/06	81.67	Killyglen (NI)	113.47	31/05	114.46	Llanfair DC	79.44	15/05	79.98
Stonor Park	70.51	01/06	78.06	New Red Lion	11.81	31/05	15.70	Heathlanes	60.91	31/05	62.04
Tilshead	83.87	31/05	90.13	Ampney Crucis	100.27	01/06	101.24	Weeford Flats	88.81	03/06	89.94
Rockley	133.00	01/06	136.19	Newbridge	10.32	14/05	10.25	Bussels No.7a	23.60	01/06	24.01
Well House Inn	94.79	31/05	97.08	Skirwith	130.37	01/06	130.62	Alstonfield	176.25	24/05	186.16
West Woodyates	77.06	31/05	84.60	Swan House	84.86	12/05	84.95	*Levels in metres above Ordnance Datum*			

Groundwater . . .Groundwater



Groundwater levels - May 2011

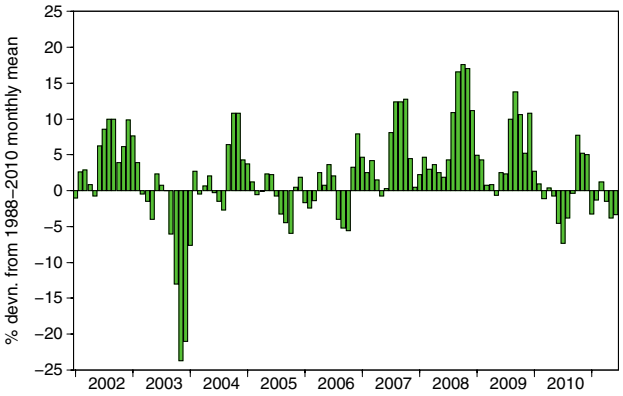
The rankings are based on a comparison between the average level in the featured month (but often only single readings are available) and the average level in each corresponding month on record. They need to be interpreted with caution especially when groundwater levels are changing rapidly or when comparing 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.

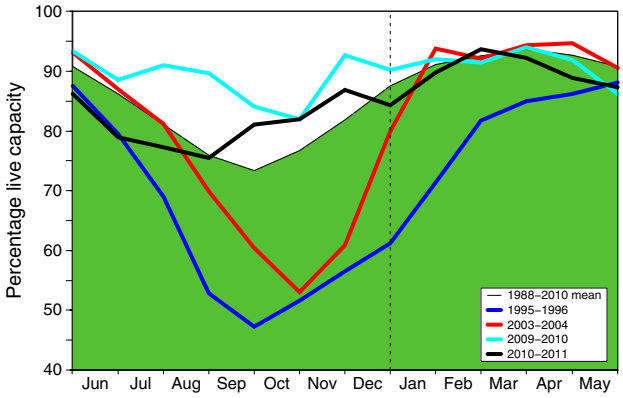
ii. Yew Tree Farm levels are now received quarterly.

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 Apr	May	Jun	Jun Anom.	Min Jun	Year* of min	2010 Jun	Diff 11-10
North West	N Command Zone	•	124929	91	86	**90**	8	66	2010	66	24
	Vyrnwy		55146	92	87	**83**	-6	72	1990	79	4
Northumbrian	Teesdale	•	87936	92	88	**95**	9	64	1991	74	21
	Kielder		(199175)	(91)	(90)	**(93)**	1	(85)	1989	(87)	6
Severn Trent	Clywedog		44922	96	97	**97**	0	83	1989	95	2
	Derwent Valley	•	39525	89	77	**69**	-19	56	1996	80	-11
Yorkshire	Washburn	•	22035	89	80	**74**	-13	72	1990	80	-6
	Bradford supply	•	41407	92	83	**80**	-6	70	1996	77	3
Anglian	Grafham		(55490)	(90)	(90)	**(91)**	-3	(72)	1997	(91)	0
	Rutland		(116580)	(90)	(89)	**(85)**	-6	(75)	1997	(90)	-5
Thames	London	•	202828	94	96	**93**	-1	83	1990	96	-3
	Farmoor	•	13822	95	100	**100**	3	90	2002	92	8
Southern	Bewl		28170	98	92	**83**	-5	57	1990	94	-11
	Ardingly		4685	100	99	**92**	-7	92	2011	100	-8
Wessex	Clatworthy		5364	92	84	**73**	-13	67	1990	87	-14
	Bristol WW	•	(38666)	(85)	(83)	**(78)**	-10	(70)	1990	(86)	-8
South West	Colliford		28540	87	82	**74**	-11	52	1997	94	-20
	Roadford		34500	77	74	**68**	-16	48	1996	88	-20
	Wimbleball		21320	91	84	**74**	-17	74	2011	90	-16
	Stithians		4967	98	88	**80**	-6	66	1990	81	-1
Welsh	Celyn and Brenig	•	131155	98	96	**96**	-1	82	1996	93	3
	Brianne		62140	94	89	**84**	-12	84	2011	89	-5
	Big Five	•	69762	94	85	**79**	-11	70	1990	83	-4
	Elan Valley	•	99106	94	83	**81**	-13	81	2011	86	-5
Scotland(E)	Edinburgh/Mid Lothian	•	97639	96	93	**94**	4	52	1998	95	-1
	East Lothian	•	10206	100	99	**99**	3	84	1990	99	0
Scotland(W)	Loch Katrine	•	111363	91	85	**92**	5	66	2001	70	22
	Daer		22412	97	96	**99**	8	70	1994	85	14
	Loch Thom	•	11840	96	96	**95**	4	74	2001	98	-3
Northern Ireland	Total+	•	56920	91	83	**80**	-5	69	2008	82	-2
	Silent Valley	•	20634	90	80	**75**	-5	56	2000	82	-7

() 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.

06/11